A. Sydney Roberts. M.D

CONTRIBUTIONS

TO

ORTHOPÆDIC SURGERY.

BY

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WITH A BRIEF BIOGRAPHICAL SKETCH.

BY

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PREFACE.

THIS work represents all the collected writings of the late Dr. A. Sydney Roberts except a collection of quotations entitled "In and Out of Book and Journal," which enjoyed a large sale as a popular gift-book.

The present collection is undertaken for private distribution only, for the sole purpose of increasing the interest in the subjects of which it treats, and is prepared by the editor as a debt of gratitude for many past kindnesses.

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J. K. Y.

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MEMOIR

OF

DR. ALGERNON SYDNEY ROBERTS.

INTRODUCTION.

EACH profession has its own manner of honoring its dead.

There is a custom among the members of the Bar suggestive of brotherhood. When one dies who has adorned the profession, a general meeting of the Bar is called, a Judge presiding. At such meeting each and every member may pay his tribute to the departed—placing, as it were, a flower upon the bier of a brother whose victory they had witnessed.

In our profession, that of medicine, no such custom obtains. Would it not be well by this or some means to inculcate such a spirit of *camaraderie?*

In lieu of such a custom, it seems highly fitting that I, as pupil, friend, successor, upon whom in some measure his mantle has fallen, should pay my tribute to the sacred memory of the departed. When one of the medical profession whose ability and attainments mark his individuality pre-eminent passes into eternity, those who linger may take note of his scholarly attainments and professional skill, and emulate his many virtues.

Biographies of men of eminence and merit, while calculated to please a large class of readers, have a greater and more intrinsic value. They present to those in the heyday of youth a stimulus and encouragement; to those in the meridian of their career, the satisfaction that a justifying parallel may be discovered; while to those who are entering the evening of well-earned rest from labor, a reconciliation may often be found by adopting, as Cooper remarks, "the comfortable self-assurance that the frowns of fortune or some unlooked-for fatality have alone prevented them from enjoying a similar distinction or becoming equally useful members of society."

If in the present undertaking my expressions occasionally savor somewhat of enthusiasm, my respect for him when a student, my gratitude to him as his pupil, and the affection borne him during my later association with him, may be offered in apology of its degree if not in justification of its fault.

I would take this opportunity of expressing my deep sense of gratitude to those friends who have furnished me with various data relating to the subject of this history, without which it would have been incomplete.

Dr. Roberts was the son of Algernon S., Jr., and Sarah (Carstairs) Roberts, grandson of Algernon S. Roberts. He combined the sturdy elements of the Welsh blood with the purest Scotch, his father's Welsh ancestry having first settled in this country in 1683, and his mother coming of a long line of Scotch ancestors.

He was born December 19, 1855, in Philadelphia. His early education was received at Hallowell private school, from private tutors, and especially from Mr. Henry Galbraith Ward, now a distinguished lawyer in New York city. His education and preparation for college were completed at an early age, as a private pupil of Professor Thomas Chase, of Haverford College. The influence of Professor Chase and Mr. Ward upon the development of his mind is shown in the scope of his medical works and the character of the literature produced by him.

When Mr. Ward first met him he was a slight and rather shy boy, but constantly improving in strength and confidence. His remembrance of Dr. Roberts is as a very favorite pupil. He was very regular and faithful in his studies, and gave promise of a future which he afterward developed in his chosen profession. He was restive under restraint, and school discipline was irksome to him, as he learned more rapidly than many of his companions. Yet, in fact, he did not apply himself closely to study until he commenced the study of medicine, which he took up with great earnestness.

During his youth he was very fond of drawing, and was very clever with tools, traits which in after life were of the greatest service to him.

His inclination toward the study of medicine as a profession was first shown while at Haverford College with Mr. Chase, when he wrote to a member of his family of his desire to study medicine, and asked to have a skull sent to him, adding that he "would like one with all the teeth."

Eminently fitted by nature, environment, and education for the medical profession, the decision having once been made, he devoted himself to its study with all the energies of his soul, as Gross has said of Valentine Mott: "He loved surgery as his mistress, and his constancy merited all the favors which she so lavishly showered upon him."

With a decidedly artistic taste, his leaning was toward the study of architecture, and particularly drawing and similar studies, and he told me his tendency always was in favor of the profession of a railroad engineer, especially bridge-building.

There is no doubt that if he had decided to enter the profession of engineering his success would have been equally as great as in the one which he chose. In this connection the incident of Dr. Physick recurs to us as being a circumstance of similar kind. Dr. Physick's father was a silversmith, and it was always the son's regret that his father would not permit him to follow in his footsteps, although, as every one knows, Dr. Physick was the most distinguished surgeon of his time.

Dr. Roberts was particularly fortunate in the choice of a preceptor. It was in the office of Dr. Keen that young Roberts first became fully inspired with that love for his profession which ever afterward was a remarkable feature of his career.

Henceforth forever his ambition was not simply to be the doctor, as Pope would have it,

> "Sole judge of truth in endless error hurled,
> The glory, jest, and riddle of the world,"

but to be a great surgeon.

To be a great surgeon is an ambition for which any one might strive, for, with Gross, I unhesitatingly assert, without fear of successful contradiction, that it "requires as much intellect, talent, genius, and knowledge to form a great surgeon as it does to form a great lawyer, judge, divine, general, or statesman."

Dr. William W. Keen at this time was laying for himself the foundation of the enviable reputation that he now enjoys. From the introductory address delivered by Dr. Keen in his course of lectures on anatomy at the Philadelphia School of Anatomy the following year, we gain some idea of the character of the instruction given by him at that time. As the successor of Dr. Agnew in the old Philadelphia School of Anatomy, he demonstrated not only his thorough knowledge of this important branch of medicine, but also his ability to instruct students, and moreover to entertain them, by his delightful descriptions of the early history of practical anatomy.

In addition to the regular winter term in the Medical Department of the University of Pennsylvania, Dr. Roberts attended three full spring courses of lectures in this school, and was graduated therefrom on March 12, 1877.

His fondness for the study of pathology led him early to use the microscope in the pursuit of his studies, a somewhat unusual procedure in those days, but by virtue thereof he secured honorable mention for his thesis, and subsequently became Assistant Demonstrator of Histology.

Having determined to enter the profession of medicine, Dr. Roberts began his study with all the energy of his young manhood. Roused by the earnestness of his preceptor, Dr. W. W. Keen, and surrounded by the spirit of enthusiasm everywhere rife in the University, his progress was marked.

To thoroughly understand the influence of the times, one must mark the conditions of the University at the entrance of Dr. Roberts.

The Medical Department of the University contained at the time but seven major chairs.

The spirit of progress and development that characterized the institution from its beginning, in 1740, as a charitable school manifested itself in marked epochs of change.

Dr. Roberts entered the study of his profession in 1873, when every department throbbed with latent life, only wanting the accepted time to manifest itself in marked and brilliant change. Daily contact with this spirit through the formative years of his development assured the permeation of his character with the same animation that prompted the actions of his preceptors.

Every energy of his young manhood, every ambition of his life, every demand of his intellectual nature found its response in the spirit of the institution during those years.

Prominent among those who toiled and waited stood Dr. William Pepper.

Recounting the years of progress, and identified with the University, he reviewed the past and forecast the future. In his most interesting address upon "Higher Medical Education—the True Interest of the Public and Profession," he recounts the long heroic struggle of the friends of the University to obtain an ideal standard. Weeks and months had lengthened into years, hope had given place to disappointment, effort had ended in discouragement times over, before the glad day of victory had dawned.

Dr. Roberts took up his lifework at this auspicious time, his year of graduation, 1877.

This year marked, according to Dr. Pepper:

1. The establishment of a preparatory examination.

2. The lengthening of the period of collegiate studies to at least three full years.

3. The careful grading of the course.

4. The introduction of ample practical instruction of each student both at the bedside and in laboratories.

5. The establishment of fixed salaries for the professors, so that they would no longer have any pecuniary interest in the sizes of their classes.

Such standards maintained meant new men in new places. The realms of science with their hidden treasures awaited the enthusiastic student explorer who brought to this undiscovered country intelligence, enthusiasm, and patient perseverance.

The few noble lives that had uplifted the standard of advance were reinforced by able men in the new lines that diverged from their original centre. The number in the Faculty was increased, a long list of clinical instructors, demonstrators, and lecturers was added. Faculties of departments increased with each advance. Enthusiasm spread from the council chambers of faculty and trustee conferences to the students in the amphitheatre. The stimulus to mental activity that did not scorn the drudgery of toil, nor ignore the opportunities of daily doing, developed from the pupils men who became in turn leaders in other circles, representatives of the new developments and expressions of the ideas of their Alma Mater. Little by little the alpine height of excellence was attained until the University stood peer with other institutions of acknowledged eminence. An expression of the higher manifestation of her influence was exemplified when at her instance the State Board of Examiners was suggested, and again the profession felt the fortifying bulwark of her power. Standards of excellence were demanded that should protect alike physician and patient.

In the midst of this consuming energy Dr. Roberts stepped into the arena of the profession, full of enthusiasm and culture, proud to have the lines of life fall to him in an hour of accepted progress. Stimulated to action, he would at once do credit to his profession and to his Alma Mater who conferred his degree. One cannot wonder that then to him came the ambition that would pay tribute to the power that had placed him at once upon a plane of advanced thought and enrolled his name among her instructors. To him it was not an ambition to find place amongst institutions that "sprung up as mushrooms in a night," but he toiled to be worthy at once of position in his profession and University.

The class of '77, in which Dr. Roberts graduated from the University of Pennsylvania, contained several men who have since distinguished themselves in the different branches of their profession. Among them we notice the names of James M. Anders, Joseph Price, Matthew N. Cryer, Francis X. Dercum, Henry F. Formad, Thomas H. Fenton, Isaac C. Gable, Herman Haupt, Jr., William Hobson Heath, William C. Hollopeter, Rush S. Huidekoper, Fairfax Irwin, John H. Musser, J. Wilkes O'Neil, Andrew J. Parker, and George A. Piersoll.

In 1877 he served in the Emergency Corps of the State militia in the coal region riot of Pennsylvania as volunteer in the First Troop, Philadelphia City Cavalry, being assistant to Dr. William G. Porter, surgeon to the First Brigade, N. G. P. In this capacity he served in the West Penn Hospital, Pittsburg, being later removed with the troops to Scranton.

Immediately upon his graduation from the University of Pennsylvania he was elected to the position of resident physician to the Blockley Hospital (which position he accepted later), where he served his full term and made the acquaintance of the members of the staff, who were afterward of great service to him and whose colleague he soon afterward became, being very early appointed surgeon to this institution. At the suggestion of Dr. S. Weir Mitchell, he decided to turn his attention to orthopedic surgery as a specialty. With this in view, he became resident physician in the New York Orthopedic Hospital, then, as at the present time, under the care of Dr. Newton M. Shaffer, surgeon in charge. The influence of this training is shown throughout his work in this special department of surgery which he adorned with so much brilliancy. For two years he practised in this institution. Having in his mind the old couplet,

> "A little knowledge is a dangerous thing;
> Drink deep, or taste not the Pierian spring,"

he returned time and again to this fountain of knowledge, each visit seeming to add renewed energy and skill to this promising surgeon.

With a view to practising his profession in Philadelphia, he opened an office at 133 South Fifteenth Street, and at once attached himself to several hospitals in the capacity of assistant surgeon. Almost immediately he was appointed Visiting Surgeon to the Philadelphia Hospital, Surgeon to the Episcopal Hospital Out-Patient Department, and Instructor in Orthopedic Surgery in the University of Pennsylvania. These appointments (with occasional visits to other hospitals, in consultation with other surgeons) occupied his time very fully and added greatly to his amount of knowledge and his success in this special department.

Through his personal exertions the orthopedic shop of the University Hospital was organized, a building erected for the purpose and thoroughly equipped at an expense of nearly $2000. The continuation of the usefulness of this shop, and the furnishing of free apparatus to indigent persons, have been secured in perpetuity by the endowment by members of his family of the A. Sydney Roberts Apparatus Fund.

This was the first, and is still the only shop of its kind connected with a medical college hospital. Its continued usefulness proves the foresight and wisdom of Dr. Roberts' good judgment in establishing it.

It was at this time that my personal knowledge of Dr. Roberts began, and during those happy days when I "walked the boards" of the Philadelphia and Presbyterian Hospitals in company with my preceptor, Dr. William G. Porter, I had an opportunity of seeing Dr. Roberts at work in these institutions. I was at once impressed with his thoroughness, his grasp of the subject, and the success he obtained in the treatment of this neglected branch of surgery. The impressions then gained were only intensified by more close association with him in after years.

His experiences at the different hospitals led him early to desire to be a teacher. The occasion soon offered itself in lectures delivered at the University of Pennsylvania and in the course of clinical lectures which he delivered at Blockley upon orthopedic surgery, the latter being the first clinical lectures ever delivered upon the subject in Philadelphia.

As a teacher he was thorough, clear, and impressive. Without any effort at rhetorical display, he impressed the students at once with his thorough knowledge of the subject and of his desire to impart freely to them all the knowledge he had acquired.

His diagnosis was accurate, and his selection of the proper treatment or apparatus was made with the greatest consideration for the comfort and speedy recovery of the patients. If an operation was required the necessity for it was stated in such a manner that it was never refused.

His practice was principally among the better class of society, and much of it came to him from consultations with other physicians and through the recommendation of Dr. S. Weir Mitchell, Dr. William W. Keen, and Dr. Newton M. Shaffer, all of whom indorsed him in most unqualified manner. His practice was active during the short time he was engaged in it, and there is no doubt that had he continued he would have acquired a large clientèle and a lucrative income from this source. While his practice was largely among the better and more influential classes, he was as kind to the poor as to the rich, and I have known a mother, who was too frail to carry her child to the hospital, advised by him to bring it to his office to be treated cheerfully and thoroughly without a fee. Among his papers were found many letters from poor patients expressing their gratitude, and many of the nurses on duty at the Philadelphia Hospital during Dr. Roberts' service have remarked his kind manner to the destitute.

At this time he employed assistants for certain portions of his work. A large number of black and white sketches and colored drawings were made, casts were taken, and his hospital-books were kept most accurately by Dr. S. R. Jenkins, now of Charlottetown, Prince Edward's Island, Canada; Dr. William S. Johnson, now of Germantown, and myself. His manner toward his assistants was always kindly and considerate, and on one occasion I was myself the recipient of a trip South through his interest in my physical condition.

Although his career was brief, he performed a number of important and difficult operations upon patients committed to his care. These were always done in a most thorough and skilful manner, and every detail was carefully thought out before any operation was undertaken. His instruments and apparatus of all kinds were of the finest, and he used them as freely in the treatment of the poorest individuals as in operations upon the more wealthy patients. Soon after his election to Blockley he several times performed osteotomy of the femur (Macewen's operation) with full antiseptic precaution and with perfect results. Excision of the knee he frequently performed, as well as tenotomies of all kinds, after which latter operations he usually employed an apparatus of some kind specially prepared for the patient.

As a surgeon, he was cool, deliberate, and thorough, and his success was uniform and phenomenal.

His genius was dazzling, burning ever brighter with a steady flame. His career, like that of Bischat, was meteoric, brief, but brilliant; and if the measure of talent and genius be success, the estimate placed upon his career must be great. The limits were boundless, but few men ever attain the topmost round of the ladder of fame, and genius must add time to her industry, no matter how steady and persistent.

Some of his lectures before the students at the

Philadelphia Hospital were afterward published in book form, and comprised two upon club-foot, two upon knock-knee, and one upon flat-foot, with a description of a new plantar-spring for its relief. His writings include a complete article on Pott's disease of the spine, in Keating's "Encyclopædia," vol. iv, a most comprehensive article. In conjunction with Dr. Samuel Ketch, of New York, he wrote an article upon club-foot in Buck's "Reference Handbook of the Medical Sciences." This article contains the best bibliography upon this subject extant, and I doubt if anything will ever be written to compare with it. In 1884 he read a paper before the Pennsylvania State Medical Society upon "Chronic Articular Ostitis of the Knee-joint," with a description of a new mechanical splint, which was published in the "Medical News," on July 26, 1884. Among other articles written at this time was one upon the spinal arthropathies, published in the "Medical News," February 18, 1885, which attracted considerable attention. The photographs collected, illustrative of this subject, but not published till subsequently, comprise the best group of photographs upon this subject that has ever been collected. About this time he reported a case of deformity of the forearm and hands, which was published in the "Annals of Surgery," in February, 1886. This contains the pictures of the splint, modified from that of Dr. Shaffer, of New York, and employed by Dr. Roberts in the treatment of knee-joint diseases. After his retirement from practice he published a volume of selections from literature, which he called "In and Out of Book and Journal," which was published by Lippincott & Company, and had an extensive sale.

His writings are not as large as one would expect considering the amount of work which he did. This is probably due to his dislike to writing and his attention to more practical matters. His writings are of the highest order, and reflect great credit upon him for the amount of research and the quality of the matter contained.

He reported many operations before the Pathological Society, and exhibited specimens, several of which I now have in my possession.

He was a Fellow of the College of Physicians of Philadelphia, a Fellow and Vice-President of the American Orthopedic Association, a member of the Philadelphia County Medical Society, the Pathological Society, the Neurological Society, the State Medical Society, the American Medical Society, and a delegate to the International Medical Congress in London.

In personal appearance Dr. Roberts was of medium height, strongly and compactly built, of a florid temperament, high forehead, good features, and carrying with him the impression of great reserve force. His manner was that of a cultured gentleman, and his associations such as would develop a manner which was at once kind and firm. His characteristic was a particular sensitiveness. His disposition was quick and impulsive, but kind and forgiving; a warm and faithful friend. With truth it could be said that his friendship was eternal.

The estimate of Dr. John H. Musser, his most intimate friend, is so thoroughly descriptive of Dr. Roberts' best qualities, that I take the liberty to quote it in full. Speaking of his friend Roberts, he writes:

"Fortunately for me, our friendship was not alone professional. On two occasions I travelled in Europe with him, and on several occasions in this country. Here it could be seen he was a man of affairs. This was the least, however. I constantly marvelled at his wide acquaintanceship with the fine arts—painting and painters, sculpture and sculptors, architecture, etc. He was familiar with the development of art in all its phases and of all its schools. His early training in painting taught him to be an excellent critic. He could criticise accurately the coloring or appreciate the value of the thought in the work of art and its development. Furniture, tapestries, decorations, metal work, glass, and china had been the subject of study, and their relations to industrial development. After a visit with profit and pleasure to an art gallery, a museum, a palace with its art treasures, it was interesting and marvellous to go with him to some great mechanical works or some piece of engineering and see with what rapturous delight he appreciated it, and with what knowledge of technical detail he could explain the mysteries of the mechanism. When I tell you he was a critic of no mean order, and a man of exquisite taste, with an extraordinary appreciation of the beautiful in art, you can readily see how enjoyable a companion he was.

"Roberts also loved nature, and, whether on the boundless ocean, in the mountains of Switzerland, in the pastoral scenes of England, or the rougher charms of Scotland, he was always full of enthusiasm and appreciation of the beauties of nature. Roberts's fondness for animals led him to study them, and he was an excellent judge of horse, of cow, of dog. He was fond of out-door sports, and was an expert in shooting, rowing, and the like. How almost unlimited were his sympathies, and how boundless was his knowledge! He had a most excellent memory, and the history of the countries we travelled through was at his fingers' ends. This added to the charm of our travels.

"Curiously, although of broad culture Dr. Roberts was not a linguist. Language was not mastered easily by him, although his writings show he was a master of English; his conversational powers, that he could command it at will.

"Roberts appreciated music. I recall the delights he showed at the music of the evening service at Cologne Cathedral. He was not as familiar with the literature and development of this art as others."

Dr. Samuel Ketch, another personal friend of Dr. Roberts, has paid tribute to his memory in his Presidential Address, published in the last volume (1897) of the "Transactions of the American Orthopedic Association."

His office was neat, plain, and well arranged, and one could see at a glance that it was the office of a practical and progressive surgeon. In office details his early education and business qualities were everywhere conspicuous. His horses and carriages were neat and elegant to a degree. His office hours were from 8 to 11, and were always promptly kept. His stationery was always the same Imperial Bond, of a beautiful marine-blue tint, and his penmanship had a style and character that were unmistakable.

While in the enjoyment of everything that would tend to make him happy, and with the prospect of a great and growing future before him, his health began to fail, and he was compelled to retire from practice in 1888 and seek change in the country. In resigning his positions at the different hospitals (two of which it was my privilege to receive), a sincere regret was expressed in his resignation that he was compelled to give up practice at this time.

In his letter of November 23, 1888, to me, in speaking of resigning his position as instructor in orthopedic surgery, he evinced his keen interest in the future progress of *conservative* orthopedic surgery. "I have to-day," he writes, "sent to the University and to the University Hospital my resignations, and hope you may be an applicant for the positions I vacate, and I trust that if you secure the appointments you will push the work in the interest of conservative orthopedy."

Having decided to retire from active practice, he gave away many of his instruments, the most expensive ones to his personal friend, Dr. William G. Porter, to his preceptor, Dr. William W. Keen, and myself. All of his orthopedic apparatus and all of his special books upon orthopedic surgery were received by me in this way, and my indebtedness to him has already been expressed by the partial dedication to him of my work upon orthopedic surgery.[1]

Although in feeble health for some time, his death occurred suddenly and unexpectedly, at Newport, on August 17, 1896. The funeral took place from his late residence, at Bala, on Thursday morning, at 11 o'clock, the interment being private. His earthly remains were interred in the family vault at Laurel Hill Cemetery.

At the University Club, just before the dinner, March 11, 1898, when a guest of Dr. De Forest Willard and myself, Dr. Newton M. Shaffer said of his friend Dr. Roberts, "Had he practised until to-day, his reputation would have been national."

Accidental expressions of character in a man's life many times live after him in enduring form. Near the home of his ancestors, at the side of the public highway, it pleased Dr. Roberts to erect a fountain at which the hurrying traveller might pause and drink.

The shadows may fall and shut from sight familiar scenes, the passing throng, the granite fountain with its cooling stream, but through the darkness unheeded the limpid stream flows on and in the morning blesses the new day.

> The years glide on, the shadows fall;
> But works his hands have wrought live on!

[1] Treatise on Orthopedic Surgery.

CLUB-FOOT: TALIPES.

CLUB-FOOT: TALIPES.

DEFINITION. Under the generic term Club-foot, or Talipes, are included all cases of deformity of the foot, whether on an antero-posterior or transverse plane, and which are presented in a departure from the normal relation of the foot to the leg or of the foot to itself. This abnormal relation may consist of a flexion, extension, inversion, or eversion.

SYNONYMS. Ger., *Klumpfuss;* Lat., *Pes contortus;* Fr., *Pied bot;* It., *Piede torto;* Sp., *Pié truncado.*

VARIETIES. Club-foot is most conveniently divided into two classes, namely, the simple and compound, and of the former we have four typical forms. These are talipes varus, talipes valgus, talipes equinus, and talipes calcaneus. The first form, talipes varus, is characterized by an elevation of the inner side of the foot, the sole being turned inward and the anterior portion of the foot adducted. In talipes valgus, its opposite, the outer side of the foot is raised and the sole everted. Talipes equinus presents itself as an elevation of the heel, the foot being in a position of extension, the patient walking on the ball of the foot. In talipes calcaneus the toes are raised, the foot being in a position of flexion, and the patient walking on the heel. The two first-mentioned deformities occur on a lateral, the two latter on an antero-posterior plane. To these four simple forms some authors add other forms: Talipes cavus, where the arch of the foot is increased, and talipes planus, its opposite, where the sole rests upon the ground, the arch being diminished. Recently Shaffer, of New York, has described another class, that of non-deforming club-foot. Any combination of the simple varieties gives us the compound form: talipes equino-varus and equino-valgus, and calcaneo-varus and calcaneo-valgus. Schematically these different forms may be pictured as follows:

VARIETIES .	Simple . .	Lateral . .	Varus. Valgus.
		Antero-posterior .	Equinus. Calcaneus.
	Compound .	Equino- . .	Varus. Valgus.
		Calcaneo- . .	Varus. Valgus.
	Other forms .	Cavus. Planus. Non-deforming.	

RELATIVE FREQUENCY. In obtaining information concerning the relative frequency of the different forms, much difficulty is experienced, owing to the different nomenclature, notably for varus and equino-varus, used by those making statistics on the subject. From Tamplin's table, published in the "London Medical Gazette" for October, 1851, and covering 1780 cases of club-foot, both congenital and acquired, 764 of the former were recorded to 1016 of the acquired form. By these tables it is shown that by far the larger number were of the acquired variety, the proportion, as stated by

Adams, being as 3 : 2. Of the congenital variety, the tables show a preponderance of cases of talipes varus, but no distinction is evidently made between the simple varus and the compound form, talipes equino-varus. The tables are appended:

CONGENITAL.

	Cases.
Talipes varus	688
Talipes valgus	42
Talipes calcaneus	19
Talipes varus of one foot and valgus of the other.	15
Total	764

Of the 688 cases of talipes varus, 182 affected the right foot only; 138 affected the left foot only; 363 affected both feet, and 5 cases were complicated with other deformities.

Of the 1780 cases, 1016 were non-congenital; 999 were distributed as follows:

ACQUIRED.

	Cases.
Talipes equinus	401
Talipes valgus	181
Talipes equino-varus	162
Talipes calcaneus and calcaneo-valgus	110
Talipes equino-valgus	80
Talipes varus	60
Talipes varus of one foot and valgus of the other.	5
Total	999

Reeves, in an experience of ten years at the Royal Orthopedic Hospital, London, gives equino-varus as the most frequent congenital form, and also states that the primitive forms of club-foot are rare as congenital deformities. Sayre, in his work on "Club-foot," and also in the article in his work on "Orthopædic Surgery and Diseases of the Joints," gives no statistics as to the relative frequency, but states that the simple forms of club-foot are very rare, the deformity being nearly always a combination of two forms. F. Busch gives equino-varus as the most frequent form. Duval has recorded 1000 cases of club-foot, and of these 574 were congenital; 364 of these were in males and 210 in females. His statistics as to relative frequency are very valuable, and are as follows:

	Cases.	Boys.	Girls.
Equinus and equino-varus .	417	215	202
Varus	532	302	230
Valgus	22	14	8
Calcaneus	9	6	3
Extreme calcaneus . . .	20	13	7

Adams, in his work on "Club-foot," gives talipes equinus as by far the most frequent non-congenital deformity. Little states that he has seen two cases of congenital equinus, as does also Brodhurst. Tamplin discredits entirely the congenital origin of pure equinus, and states that he had not seen a case. Detmold has reported 167 cases of club-foot, and states that of these 93 occurred in both feet. Gross remarks that the congenital variety rarely affects both feet in an equal degree; that in his own experience the single forms were considerably greater in number. Lannelongue has collected statistics at the Maternity Hospital (Paris) covering a period of ten years, from 1858 to 1867 inclusive. He has shown that in 15,229 births, 8 children were born with club-foot, which gives a proportion of about 1 case in 1903 births. As yet the influences of climate and social position have not been determined. It probably occurs more frequently among the poorer classes.

From the foregoing statistics, which have been considered sufficient, the following facts may be deduced:

1. The greater relative frequency in males.
2. That the varus types are the most frequent.
3. That the right foot is affected more frequently than the left.
4. That both feet are more frequently affected than a single one.
5. That the purely primitive forms are rare.

ETIOLOGY. There are two classes of club-foot, namely, the congenital and acquired, and in studying their etiology we shall consider the former class first. In no department of medicine is there so much that is mysterious and unexplained as is involved in the causation of deformities of congenital origin. From earliest times they have been the subject of a vast amount of labor and inquiry, and while these investigations have resulted in many speculations and a few facts, the theories established by them still leave much to learn concerning the real origin of this class of cases. The question is beset with difficulties from the onset, from the fact that the life of the fœtus in utero is not subject to any direct scientific means of investigation, and we are compelled to study the subject from such aids as comparative physiology, embryological data, and post-partum existence and diseases furnish us.

Could we positively admit the question of diseases of the fœtus, such as pertain to post-partum existence, the problem would be relatively simple. Many authors, notably Little, have, from the similarity in the deformities of the congenital and acquired paralytic forms, assumed this ground. Outside of the similarity in the appearance of the deformities, this view is not tenable, for it has not been proven that a fœtal myelitis or meningitis has existed. The microscope has not, as yet, demonstrated changes taking place in the fœtal brain or cord, such as occur in infantile, cerebral, or spinal paralysis. An electrical examination shows very markedly differing reactions in the muscles of the two forms, and patients suffering with congenital club-foot can, by the exercise of volition, use the muscles of the leg and foot, while such is not the case in the acquired form. These differences, together with the external appearances of the parts affected—the one cold, flaccid, and atrophied; the other of normal surface temperature, plump, and of rounded contour—indicate an entirely different causation of the deformity.

Heredity, with its mysterious influences, physical and psychical, also enters into this complex question, and is undoubtedly a factor in the etiology of many cases. Did space permit, many instances might be quoted as illustrative of this. From these we can as yet deduce no better explanation of its influence than the transmission of personal configuration.

Arrest of development has also been assigned as a cause for the production of congenital club-foot.

Although many cases occur in which there is a coexistence of such deformities as spina bifida, hare-lip, and cleft palate with club-foot, yet the feet themselves show no arrest of development, but only the same change of plane as is shown in the cases born without these coexisting deformities. Changes in the tarsal bones, principally the astragalus and os calcis, have been described by many authors, but by none more thoroughly than by Adams and Hueter. These changes consist in alterations in the form and plane of these bones, but they are by no means constant, and differences of opinion are held as to their being primary or causative, or secondary, as results of the deformity itself. The most recent investigations tend to maintain the latter theory. It has also been found that use of the deformed foot largely increases the malposition and form of the tarsal bones. A. Luecke also considers the osseous structure as the seat of primary lesion in club-foot. He and others have shown that at a a certain period all fœtuses are club-footed, and Luecke claims that by the constant movement of the child in utero the articular surfaces are so modified by the attrition produced as to enable the child's feet to assume a normal position before birth; any interference with these movements would, however, prevent this attrition, and the child would be born club-footed. Against this ingenious thèory it may be argued that use increases the deformity after birth. Why it should act differently before is not easy to understand. We also know that in acquired cases, such as are due to spastic paralysis, for instance, want of use does not so change the articular surfaces as to cause permanent club-foot, tenotomy in many cases restoring the foot to its form and function. Perhaps of all the theories advanced, that which ascribes congenital club-foot to abnormal intra-uterine pressure, due to lack of amniotic fluid, has received the largest number of adherents. Most of the older writers, and many modern ones, prominently Volkmann, Kocher, Vogt, Banga, and Parker, are among its most noted advocates. Here it is maintained that the fœtal foot is permanently fixed in one position by the intra-uterine pressure, and consequently, at birth, the child is club-footed. It has, very reasonably, been argued against this view, that if a decreased amount of amniotic fluid and consequent abnormal pressure were productive of club-foot, other organs which had been subjected to the same pressure would also be deformed. Yet such is not the fact, clubbed hands, legs, and thighs being among the rarest of deformities, very seldom complicating the pedal malformation. It has also been shown that many children have been born club-footed where no appreciable difference in the quantity of liquor amnii, judging from previous labors, could be ascertained; and we have recently seen a case of double equino-varus in a twin, the other child showing no deformity whatsoever. Billroth states as follows: "The typical form of this congenital deformity appears to indicate that it depends on a disturbance of a typical (symmetrical?) development of the lower extremities; for if fœtal disease, disturbance of an irritative nature, or abnormal pressure in the uterus were at fault, cases would probably differ." He also quotes Eschricht as showing that at the commencement of their development the lower extremities lie with their backs against the abdomen, the hollows of their knees being against the belly; so during the earlier months the legs must rotate on their axes, and the toes which pointed backward must point in the opposite direction. If the embryonic extremities lie so close as to appear united under a common skin, or be really united, the above-mentioned rotation of the limbs cannot take place, and in this deformity (siren) the feet are turned directly backward. This rotation on the axis, which was arrested in the above case, does not take place fully in club-foot, the rotation in the foot is not fully accomplished. Billroth states further, that according to this, congenital club-foot would come among the cases of obstructed development; about its cause he concludes we know as little as we do of other deformities of the same class.

H. W. Berg, of New York, in a very original article, gives failure of rotation as the cause of congenital equino-varus. He has studied the subject from specimens seen at the New York Hospital and Wood's Museum of Bellevue Hospital, and describes the changes in the position of the lower extremities at different periods of fœtal life. He shows that in early life the whole leg is rotated outward, and this outward rotation is accompanied by an exaggerated varus, and still later, an equino-varus. This diminishes as the rotation to the normal position progresses, but he states that even when the rotation of the leg has been entirely completed some of the varus still remains, and calls attention to the very slight varus of the new-born. In addition he states that equinus is often seen in fœtuses of two, three, and four months. This he does not always find, and it disappears in the course of the normal growth of the foot. He concludes that in the early stage of fœtal life varus or equino-varus is physiological. He does not think pressure necessary to the production of the deformity, its cause consisting, in his opinion, of a non- or retarded rotation inward of the lower extremity. We consider this theory of non- or retarded rotation as of such importance from an etiological stand-point that we quote his account of its mechanism in full. He says: "As soon as the joints are formed we find the thigh rotated outward as far as possible, and flexed upon the body. The leg is flexed upon the thigh, but not completely, for this is prevented by the extreme outward rotation of the thigh, which brings the inner border of the leg in apposition with the abdomen of the child. We have, then, the inner border of the thigh and the tibial border of the leg pressed against the abdomen of the fœtus, the legs crossing each other a little below their middle. All of the intra-uterine pressure, therefore, is thus brought to bear directly upon the outer border of the thigh and leg, corresponding to the fibular border of the leg, and also upon the dorsum of the foot. The result of this is that the foot is rotated in and extended (equino-varus) until the sole is almost on a line with the inner border of the leg, and lies against the body of the fœtus, while the dorsal surface of the foot is on a convex-curved line with the outer border of the leg, to adapt itself to the concave wall of the uterus. This, I believe, is a stage in the normal development of every healthy fœtus; and were the extremities to remain in this position, all children would be born club-footed. But nature provides against this by the inward rotation of the extremity, which gradually takes place, carrying the leg away from its position against the abdomen of the fœtus; and when this rotation is completed we find the extensor surface of the thigh flexed and in relation with the body of the child, while the legs are flexed upon the thighs, the inner or tibial borders facing each other. Now the soles of the feet lie against the uterine walls, and the intra-uterine pressure is exerted directly upon them. This produces extreme flexion of the foot upon the leg, together with an outward rotation of the foot; this movement, from the constitution of the ankle-joint, accompanying extreme flexion. Thus is antagonized the varus or equino-varus existing hitherto. It is evident, then, that upon the completeness of the internal rotation or torsion which takes place in the lower extremity depends the rectification of the early varus of the foot. Should this rotation not take place at all, or be incomplete, the foot will continue to maintain its early relation to the body of the fœtus and uterine walls, and the child will be born more or less club-footed. If this be so, we should expect to find in club-footed children that the extremities are rotated outward. And this we do find upon examination. In all of the cases of congenital club-foot (equino-varus) which I have seen since my attention has been directed to this subject, I have found that the thigh and leg, as a whole, were rotated out, and the tibia bent at its lower part, so that the feet were approximated to each other in addition to being in the clubbed position. All this is seen to be the result of non-rotation of the leg." In 1884, two years after Dr. Berg's article appeared, Drs. Parker and Shattuck published a pamphlet on "The Pathology and Etiology of Congenital Club-foot." Their theory, as shown in their argument, is as follows: "Our argument is that the feet of the fœtus occupy various positions during the period of intra-uterine life, and that this occurs in order that the joint-surfaces, the muscles, and especially the ligaments, be developed so as to allow of that variety of positions and movements which are afterward to be natural to the foot; and we hold that when anything (mechanically) prevents the feet from assuming these positions at the proper time, or maintains them in any given position beyond the limit of time during which they should nominally occupy such position, a talipes results. The variety of talipes will depend upon the date of its production; its severity will be in direct ratio to the mechanical violence at work. If the inversion of the foot, which is normal during the earlier months of fœtal life, be maintained beyond the normal period of time, the muscles and ligaments will, as a consequence, be adaptively short on one aspect of the limb, and too long on the other; a normal position of inversion will finally become a deformity. Talipes calcaneus is, we believe, produced in a similar manner; it occurs, however, later during intra-uterine life, when a flexed position of the foot is normal. Being thus less fundamental in character, it is also less severe as a deformity than varus."

To any one who has read Berg's monograph, it will appear surprising that no mention of it is made by Parker and Shattuck. This is all the more remarkable in that Berg had fully anticipated not only all that they have advanced, but had followed these data and observations to their legitimate logical conclusions, which for some occult reason Parker and Shattuck have avoided. Had they cited Berg's paper, we would have been forced to the conclusion that they had attempted to prop up the old fanciful mechanical theory with the support of real embryological data.

We have endeavored to give as succinctly as possible the different theories in vogue concerning the etiology of congenital club-foot. They may be briefly summarized as follows:

1. The theory of pathological changes affecting the child in utero.

2. The theory of mechanical forces acting upon the fœtus in utero.

3. The theory of heredity.

4. The theory of arrest of development.

5. The theory of non- or retarded rotation.

In conclusion we would state that it certainly would seem most reasonable, with our present knowledge of the subject, to ascribe the causation of congenital club-foot to the last-mentioned theory, which has at least for its credit the fact of its being demonstrable, rather than to those which for their foundation either have only the similarity to conditions produced by disease after birth, or are entirely fanciful.

Etiology of Acquired Forms. By far the larger number of cases of club-foot occur as acquired forms, and of these infantile paralysis (poliomyelitis anterior) produces the greatest number.

Without entering into a lengthy description of this disease, which can be found in any of the text-books on nervous diseases, and also in another portion of this work, it will be sufficient to state that it usually occurs during the period of dentition, beginning with fever and gastro-intestinal disturbance, with or without convulsions, and is followed by paralysis more or less severe. This paralysis is followed by a rapid improvement in many of the muscles involved, those of the upper extremity and trunk usually recovering first, while those of the lower extremity remain unilaterally affected. The paralysis is followed by atrophic changes, loss of electro-muscular contractility, especially to the faradic current, and deformities, of which club-foot is the most frequent. For a long time it was taught that the deformities produced by infantile paralysis were due solely to the loss of power in one set of muscles and the preponderating action of their antagonists. Thus, in consequence of this loss of balance in the muscles supporting the leg and foot, were produced the altered relations which give rise to the various forms of acquired club-foot. Delpech taught that a muscle could be in a condition of permanent or tonic spasm, and the opponents being paralyzed, the deformities were produced. That this view is faulty has been proven by more recent researches. Hueter first called attention to the fact that, owing to the position assumed by the paralyzed limb, its weight caused contractions, and that the so-called antagonistic contractions were not at all muscular actions, but were due to atrophy and lack of growth. Volkmann, in his now classical lecture, has gone very thoroughly into the mechanism of the production of club-foot due to infantile paralysis. He has shown that, owing to the superincumbent weight of the body, the limbs assume positions which gradually become permanent; that the so-called tonic retraction does not occur, and that the shortening of the muscles is due not to contraction, but to growth of the limb, the foot remaining in its deformed position.

A form of paralysis usually designated as spastic or active—spastic paralysis (Erb), paralysis with rigid muscles (Adams), and tetanoid paraplegia (Seguin)—is also productive of club-foot. In this class of cases a more general dispensation of the consequences of the lesion seems to be inflicted. The patients have a silly or semi-idiotic look, although their intelligence seems rather to be retarded than obliterated. They frequently squint, and their progression is peculiar and quite characteristic. They walk on their toes with their knees pressed together, and, in order to maintain their equilibrium, throw one limb over the other, walking as it were cross-legged. There is general rigidity and spasm of the muscles, all the reflexes being greatly exaggerated. The form of club-foot in these cases is usually an equinus, and the contractions can, for the time being, be rectified by continuous pressure, but upon its cessation the feet instantly assume their old positions. Its pathology would seem to indicate, in some cases, a lack of development, in others a lesion of some portion of the motor tract of the brain, followed by secondary changes in the lateral columns of the cord. Rupprecht, of Dresden, has studied the nature and treatment of this condition very thoroughly, and has shown not only that tenotomy in this class of cases is often followed by improvement in the position of the feet, but that in some cases there was an accompanying improvement in the mental status of the patient. For further information on this very important class of cases the reader is referred to his very valuable remarks in Volkmann's series of clinical lectures. Many authors believe that this, or a similar condition, is an accompaniment of various spinal diseases, acute compression, syphilis, tumors, and caries.

Among other conditions due to disturbance of the nervous system, pseudo-hypertrophic paralysis, post-hemiplegic contractions, and neuromimesis are productive of club-foot. While the two former classes are rare as causes of acquired talipes, the latter or neuromimetic are more frequent, and have of late years attracted considerable attention. Examples of these very interesting cases have been cited by Paget, Little, Skey, Shaffer, Weir Mitchell, Haward, and others. They undoubtedly depend upon the neurotic diathesis, and may, by their similarity to the real condition, be very deceptive. Shaffer has devoted considerable space to this class of cases in his work on "The Hysterical Element in Orthopædic Surgery," a perusal of which will greatly aid the student in the diagnosis and treatment.

Cases due to reflex paralysis have been reported by Sayre and others, who claim that a functional disturbance of the nervous system can cause spasm of certain muscles, which, continuing for a time, while healthy growth is going on in their opponents, so disturbs the balance of power as to produce a permanent deformity. This mode of the production of club-foot has recently been the subject of much discussion, many authorities altogether disbelieving the origin of the deformity by this means.

The paraplegia accompanying Pott's disease of the spine is also a cause of acquired club-foot. It generally occurs as an equinus, and is very similar to the spastic cases previously mentioned. It disappears as the paraplegia improves.

One of the most frequent causes of acquired talipes is joint-disease of the lower extremity. Here it may either occur symptomatically or follow the disease of the articulation. Especially is this true of the ankle-joint, where, at different periods of the inflammatory trouble, the foot assumes an equinus, varus, or valgus position.

A very interesting class of cases are those due to occupation. In these cases, occurring principally in bakers, blacksmiths, printers, and other trades, the principal factors are the weight of the body and long-continued position, and it is in this class that we often see the inflammatory forms of club-foot. A similar class of cases are those observed in growing boys and girls, and usually occurring at about the time of puberty. Here the deformity, which is a valgus, is probably due to increased weight and rapid growth of the body, without a corresponding growth of the muscles and ligaments of the feet.

Long-continued decubitus, as in the continued fevers, has been productive of club-foot, generally an equinus. Volkmann mentions one case in which, after severe typhoid fever, an equinus resulted, and in which a year was occupied in restoring the feet to their normal position by active orthopedic treatment.

Traumatisms, resulting in deep cicatrices and burns in the neighborhood of the ankle-joint, are also causes of acquired club-foot.

History and Literature. In studying the history of club-foot it has been thought best to divide the subject into three periods: a Pre-continental period, including the years from 460 to 370 B.C.; a second, the Continental and Early English, including the seventeenth and eighteenth centuries; and a third, or Continental and English, which embraces the nineteenth century and brings us down to the present day. To render the study more complete, separate notice is given of American contributions, especially valuable for their originality in the mechanical improvements devised for the relief of this deformity.

I. *Pre-Continental Period—B.C. 460–370.* The earliest author on the subject of club-foot whose writings are preserved or accessible is Hippocrates. He mentions very clearly deformities of the articulations, and in all his works on ancient surgery, says his translator, there is not a more wonderful chapter than that relating to club-foot, on which he gives most valuable information. He says: "There is more than one variety of club-foot, the most of them not being complete dislocations, but impairments connected with the habitual maintenance of the limb in a certain position." He says further: "Most cases of congenital club-foot are remedial, unless the declination be very great, or when the affection occurs at an advanced period of youth." For early treatment he relied on bandages, for the application of which he gave very particular instructions. He says: "After the application of the bandages, a small shoe made of lead is to be bound on externally, having the same shape as the Chian slippers. This is the mode of cure, and it neither requires cutting, burning, nor any other complex means." This might imply that he had seen or heard of other means of curing club-foot, but of them, if they existed, we have no record.

For a period of two thousand years or more the subject of club-foot was apparently completely ignored, and nothing was added to the knowledge collected by Hippocrates and handed down to us by Polybius. It was regarded by all as a subject of ill omen, and those unfortunately afflicted by the deformity as being especially the objects of divine wrath. Superstition forbade men from even mentioning it, much less of devising means for its cure. Celsus, whose writings cover so large a field, does not even mention it—a fit criterion of the condition of the times.

II. *Continental and Early English Period—Seventeenth and Eighteenth Centuries.* It was not until the middle of the seventeenth century that the question of club-foot again came into notice.

In 1641 Ambroise Paré, "Les Œuvres" (Lyons), ascribed club-foot to the circumstance that the mother, during her pregnancy, had been sitting too much with her legs crossed. He also gives a model of a boot for the treatment of the deformity. He was followed in 1643 by Severinus, who wrote of the subject. ("De Recondita Abscessum Natura," Francof., 1643.)

In 1658 Arcæus, "De recta curandorum valuerum rational" (Amstel.), describes a process for the removal of the distortion, and figures an apparatus and a boot by which he treated deformities. Fabricius, in 1723, "Opera Chirurgica" (Batavia), proposes an iron boot for treating deformities of the feet.

In 1741 Andry first used the term orthopedy, and published a work on the subject in two volumes, entitled "L'Orthopédie" (Paris). It is evident from his remarks that he does not limit the use of the term to club-foot, as some authors erroneously suppose, but, under the derivation ὀρθὸς, straight, and παιδὸς, genitive of παις, child, the whole subject of the retification of deformities is included.

Du Verney, in his "Traité des Maladies des Os" (Paris, 1751), contributed a very important chapter to the subject of club-foot. He recognized the muscular contraction as a cause, and described the distortion as due to the influence of the muscles and ligaments. He writes of varus and valgus, and ascribes these distortions entirely to the unequal tension of the muscles and ligaments. He concluded that those muscles which are extremely tense draw the parts toward them, while their antagonists yield, being relaxed.

The year 1784 brings us to the most important era in the history of club-foot which we have yet to record, and from this date a marked impetus was given to the proper study and treatment of the subject. Thilenius, a physician of Frankfort, proposed in this year a section of the tendo Achillis for a case of talipes equinus, and the operation, an open one, was performed by the surgeon Lorenz. It was completely successful, and the same operation was subsequently performed by Sartorius. Thilenius has written under the title, "Medicinische und Chirurgische Bemerkúngen" (Frankfort). At about the same time Venel, called by some the "Father of Orthopedics," settled in Orbe, Switzerland, and founded an orthopedic institution. His success was such that Wanzel, then eleven years of age, was placed under his treatment with double club-foot. By means of his shoe he succeeded in curing him in twenty-two months. This induced Bruckner, of Gotha, "Ueber Natur, Verfahren und Behandlung der einwärts gekrümmten Füsse" (Gotha, 1796), and Naumburg, of Erfurt, "Abhandlung ueber die Beeinkrümmung" (Leipsic, 1796), to use and perfect Venel's method. Wanzel studiedmedicine later, and in his inaugural thesis, "Dissertatio Inauguralis medica de Talipedibus Varis" (Tübingen, 1798), described the procedure used by Venel. Besides the authors already quoted, Ehrmann, of Germany, Tiphaisue and Verdier, of France, and Jackson, Sheldrake, and Mark Anthony Petit, of England, contributed to the literature and treatment of club-foot.

Of these the most important are the writings of Thomas Sheldrake, of London (1798), who considered the contraction of the ligaments as the essential cause of club-foot. He aimed his treatment essentially at these tissues. His own words are as follows: "The essential operation to be performed in curing a club-foot is to produce such an extension of some of the ligaments as, if it happened by accident, would constitute a sprain. It certainly is the duty of the operator so to conduct this operation that none of the consequences which would have taken place from an accidental operation shall ensue." Mark Anthony Petit, of England (1799), is claimed to have had the first example of tenotomy on record, and to have been the first surgeon to perform it.

This closes the second period in the history of club-foot, and while we can see the gradual progression from a purely empirical idea, both of the nature and treatment of the deformity, to a broader and more comprehensive conception of the subject, it will be admitted that as yet no decided scientific departures had been made. The nearest approach was the operation of Thilenius, which foreshadowed, as it were, the researches which were to follow, and which have proved of such invaluable worth to the sufferers from club-foot.

III. *Continental and English Period—Nineteenth Century*. More general attention seems to have been directed toward the study and treatment of deformities at the beginning of this century, and many master-minds in different countries labored to bring the subject from out of the half mystical, half empirical atmosphere in which it was enshrouded at the close of the last century.

This period was opened auspiciously by the writings of Ortlepp in Germany, whose work, "De Talipedibus," etc. (Jena, 1800), contains many excellent suggestions; and of Bailly, in France, who wrote under the title "Du traitement et de la curabilité du pied-bot invétéré" (Lyons, 1802).

They were followed in 1803 by Scarpa, of Pavia, who in his work on club-foot, "Memoria chirurgica sui piedi torti congeniti dei fanciulli, e sulla maniera di corregere questa deformita" (Pavia, 1803), maintained the opinion entertained by Hippocrates, that the tarsal bones are not dislocated, but twisted on their axes, and only partially separated from their mutual contact. He contended that the primary disturbance is in the osseous system, and that, consequent on this displacement, the muscles are elongated or retracted, according to their position. He proved by dissection the inaccuracy of the supposed cause of club-foot residing in arrest of development or malformation. He designed an apparatus, universally known as "Scarpa's shoe," for the mechanical treatment of club-foot, the essential principles of which are retained to the present day, and on which most of the apparatus used at present are constructed. Jorg, of Leipsic, wrote on club-foot under the title, "Ueber Klumpfusse und eine leichte und zweckmässige Heilart" (1803).

On the 10th of May, 1806, Sartorius repeated the operation of Thilenius. The operation, by open wound and "brisement forcé" combined, ended in anchylosis. In 1809 Michaelis, of Marburg, wrote a treatise "Ueber die Schwachung der Sehnen," etc. He contended that in almost every case of club-foot the tendo Achillis is too short. He operated upon several cases of talipes equinus by partial division and rupture of the tendo Achillis. He reports that after the operation he at once brought the feet in their natural position. He seems to have operated very frequently. In less than one year he had performed eight operations of tenotomy: three for equinus, one for varus, three for contracted knees, and one for contracted fingers.

Artopoeus, in 1810, "Sur la torsion congénitale des pieds des enfans," and Goepel, in 1811, "De Talipedibus varis ac valgis, corumque cura," were also important contributors.

In 1816 Delpech, of Montpellier, executed the fourth operation of tenotomy on record. He virtually did a subcutaneous operation, inasmuch as he made a small opening through the skin and remote from the tendon. He laid down the following important rules for the performance of the operation:

1. The tendon was not to be exposed. The knife was to be entered at a distance from the tendon, and not through an incision in the skin parallel to it.

2. After section the divided ends of the tendon were to be brought together, until reunion.

3. Gradual and careful extension was to be made before complete union.

4. Complete extension being made, the limb was to be fixed in this position, and kept there until union was perfect.

From Delpech's work, "Chirurgie Clinique de Montpellier" (Paris, 1816), and "De l'Orthomorphie" (1828), it does not appear that he again performed tenotomy.

In 1817 D'Ivernois wrote an essay on club-foot entitled "Essai sur la torsion des pieds et sur le meilleur moyen de les guérir."

He was followed in 1820 by Palletta, who attempted to prove that the primary cause of the deformity consisted in a deficiency, complete or partial, of the internal malleolus ("Exercitationes pathological.," Paris, 1820).

In 1823 Rudolphi, in his "Grundriss der Physiologie," added much valuable information to the pathological anatomy of club-foot. He believed that club-hand and club-foot did not depend on extrinsic causes, but frequently occurred in young children from irritation and spasmodic action. He also first called attention to the fact that distortions occur in the embryo as early as the third and fourth months of fœtal life.

From 1823 to 1831 many important contributions to the study of club-foot were made. Of these the most noticeable were those of Mellet, "Considérations génerales sur les déviations des pieds;" James Kennedy, of Glasgow, "On the Management of Children in Health and Disease" (1825); Stolz, in 1826, "Mémoire sur une variété particulière du pied-bot;" Bruns, "Dissertat. inaug. de Talipede varo" (1827); Pech, "De Talipedis vari et valgi causa" (1828); Cruveilhier, "Anatomie Pathologique" (Paris, 1829), who entertained erroneous ideas of club-foot and hand, thinking that a cramped position in utero was the sole cause of these congenital distortions; Tortuae, in 1829, "Praktische Beiträge zur Therapie der Kinder-Krankheiten" (Münster); Buchetmann, 1830, "Diss. inaug. Abhandlung ueber die Plattfuss" (Erlangen); and Loeb Davides (1830).

From the time of Delpech until 1831 it does not seem, judging from the writers just quoted, that the operation of tenotomy had been placed on such a basis that its performance had been often repeated, or its merits further investigated. In 1821 Stromeyer not only resuscitated, but established the operation on a permanent and scientific basis. By his discoveries he not only made the operation popular, but, showing the impunity with which muscles and tendons might be divided, opened the field for the relief of deformities which before had baffled the surgeon, and which had condemned the sufferer to a lifelong incapacity. Like all new departures, however, his disciples undoubtedly overdid the operation, and its applicability was oftentimes lost in the desire to perform it. Thus its proper application and the counter-indications for its performance have only been the result of experience; but to Stromeyer and his influence is undoubtedly due the success attained by surgeons at the present day in the operative treatment of club-foot. He wrote under the title "Beiträge zur operativen Orthopädik" (Hanover, 1838). In 1833 Stork wrote very learnedly on "De Talipedibus varis." He was followed in 1835 by Vincent Duval, whose writings, "Traité pratique du Pied," and "Des Vices Congénitaux de Conformation des Articulations," contain many useful observations. He made many important statistical deductions, and also proposed a classification and nomenclature, which, however, have not come into general use. He is also said to have been the first operator upon the tendo Achillis in France. In the same year Blance wrote his "Diss. inaug. de novo ad Talipedem varem." Ryan, of London, in his "Practical Treatment of Club-foot" (1835), criticises the three divisions of club-foot into equinus, varus, and valgus, as having the merit of being short, but the want of being exact. Thus, he says, it is necessary that the form of club-foot called equinus should be carried to the greatest degree of development to give to the patient's foot the appearance of a horse-foot, and an examination of thirty cases seemed to justify this criticism. In regard to the etiology, he considered general or partial paralysis due to cerebro-spinal disease, and the bad position of the child in utero as the two great causes; other less important ones he found in direct injuries, contusions, inflammation of the knee or tibio-tarsal joint, and nerve lesions. He did not think tenotomy a justifiable operation, unless all other means failed.

In 1836 W. J. Little, of London, who was a sufferer from acquired club-foot, and who vainly attempted to have an operation performed in England, proceeded to Hanover, where he was operated on by Stromeyer for an equino-varus. In July of the same year he himself performed the operation in Hanover. He then went to Berlin, and with Dieffenbach treated numerous cases of distortion. On February 20, 1837, Little is said to have divided the tendo Achillis for the first time in England, although the honor was claimed by two men before him, by M. A. Petit, in 1799, and by Whipple, of Plymouth, in May, 1836, who states that when he performed the operation he was not aware that it had been performed on the Continent, and that Brodie, to whom he wrote on the subject, discountenanced it, but that Liston sanctioned the operation. To Little, however, is undoubtedly due the credit of popularizing the operation in England, and to his influence the advancement of orthopedic surgery is largely owing. He is said to have been the first to use the term "Talipes" (*Talus*, an ankle, and *pes*, a foot) in its generic signification, although the term had previously been used by writers in a more limited sense. He saw and described talipes calcaneus, and made extensive researches into the pathological anatomy of club-foot, considering the muscles as the parts primarily attacked. In regard to tenotomy, Little says: "The most favorable time for division of tendons is a few months before the child may be expected to walk—about the age of six or eight months, until which time mechanical apparatus should be used." Little wrote his "Treatise on the Nature of Club-foot" in 1839, and "On the Nature and Treatment of the Deformities of the Human Frame" in 1853, both being standard works on the subject to this day. Kennedy, of Dublin, "Observations on Cerebral and Spinal Apoplexy, Paralysis, and Convulsions of New-born Children," and Martin, "Premier Mémoire sur le Pied-bot," were also among the most prominent publications of this year; the latter ascribing congenital club-foot to deficiency of the liquor amnii. In 1837 Sewald (Berlin) wrote his celebrated thesis, "Diss. inaug. de Talipedibus," as also Lode, "Diss. inaug. de Talipedibus varis et curvatura Manus," etc. In the same year Pivain wrote his essay entitled, "Sur la Section du Tendon d'Achille," etc. Attention was also called to the subject of flat-foot, by Nevermann, in an article entitled "Ueber den Platfuss und seine Heilung." In 1838 Kness studied the subject carefully, and embodied his researches in an article, "De Talipede Varis," and Wigel in the same year gave a *résumé* of the operative treatment under the title "De Operatione Vari."

In 1839 Velpeau, of Paris, gave much attention to the subject of club-foot, and wrote on the subject in his "Nouveaux Eléments de Médecine Opératoire." He advised, after division of the tendons, the reduction of the foot, by a powerful instrument, to its normal position, and also its immediate fixation. He called attention to the importance of the posterior tibial tendon, and describes the operation for its division, its dangers, and advantages.

In the same year Krauss wrote on "The Cure of Club-foot, Bent-knee, Long Neck, Spinal and other Deformities, with Cases." He was an ardent advocate of tenotomy, although he says "in congenital club-foot, if advice be early sought, a cure may be attempted by mechanical means alone, but nevertheless, in children one and two years old tenotomy is better." Hauser "on Talipes Varus" (Tunice), and De Russdorff, "De Talipedibus," were also important contributors in this year. Between the years 1834 and 1840 we find tenotomy practised, and its effects upon the tendons very carefully studied, by such men as Bouvier, of Paris, Pauli, Von Ammon, Phillips, Held, Scoutetten, of Strasbourg, Bonnet, of Lyons, Jules Guérin, of Paris, Dieffenbach, of Berlin, and Pirogoff. The researches of Bonnet are described in his "Mémoire sur la section du tendon d'Achillo dans le traitement des Pieds-bots;" Pauli in his essay "Ueber de Klumpfuss und dessen Heilung." The other contributors are: Von Ammon, who studied the effect of tenotomy very carefully in his "De Physiologia Tenotomæ;" Phillips, "Subcutaneous Tenotomy in Club-foot;" Held, "Sur le Pied-bot;" Scoutetten (Strasbourg), "Memoir on the Radical Cure of Club-foot;" Bonnet (Lyons), "Traité des Sections Tendineuses," etc.; Jules Guérin (Paris), "Memoir upon the Etiology of Congenital Club-foot;" Dieffenbach (Berlin), "Ueber die Durchschneidung," and Pirogoff, "Ueber die Durchschneidung der Achilles."

From the experiments of Bonnet, he was led to regard the cause of congenital club-foot as residing in the tibial nerve. Pirogoff described two modes of performing tenotomy:

1. Introducing the knife between the skin and tendon and cutting inwardly. 2. Introducing the knife between the bone and tendon and cutting outwardly. The latter operation was always followed by effusion of blood into the sheath of the tendon.

Jules Guérin believed tenotomy was not necessary for very young children, and that bandages were alone sufficient for the reduction of varus. He is among the first to have used plaster of Paris in the treatment of club-foot.

Scoutetten's mode of treatment was by tenotomy and an apparatus combining fixation with flexion and extension.

In 1840 Coates published his "Practical Observations on the Nature and Treatment of Talipes or Club-foot," etc. (London), and Heine, of Stuttgart, his "Beobachtungen ueber Lähmungszustände der Extremitäten und deren Behandlung," a very scientific work on the production of the deformities.

In 1841 Vallin, in his "Abridged Treatise on Club-foot" (Nantes), gave it as his opinion that muscular contraction played the most important part in the production of club-foot. He says: "The circumstance which has the most influence upon the efficacy of the treatment of club-foot by apparatus is the possibility of acting directing upon the displaced bones, and upon the causes which produced their displacements."

In the same year Kennedy, of Dublin, wrote his "Observations on Paralytic Affections met with in Children," which contains many important notes on club-foot. In 1842 Dunbar writes of the subject in his "Notes on the Surgery of Deformities, Club-foot." In this year Lizars (Edinburgh), "Operation for Cure of Club-foot," says that "the child must be old enough to walk before the operation of tenotomy is performed. Two or three years of age is the earliest time at which tenotomy should be practised." After tenotomy, he advised a bandage from the instep to the toes, and over this a paste-board splint. In 1843 Rilliet and Barthez write learnedly on the subject in their "Traité clinique et pratique des Maladies des Enfants," and Petitjean wrote his work "Du Pied-bot." In 1845 Chelius, in his "System of Surgery" (London), devotes some space to the subject. In 1846 the most important work was that of Tamplin, whose "Lectures on the Nature and Treatment of Deformities" (London) was long one of the standard works on the subject, and may be advantageously consulted by the student at the present day. He devised many new modes of treatment, and his statistics as to relative frequency are very valuable. Meyer, "De Talipede varis," etc., and Muller, "De Valgi pedis ætiologia quædam," also wrote in the same year. Morrison, in 1847, "Sur les Pieds-bots," and Berstedt, "De Pedum Deformitatibus" (1848), are valuable contributions. In 1849 Lonsdale wrote his celebrated work "On Some of the More Practical Points Connected with the Treatment of Deformities" (London).

In 1850 Degaillé wrote on the etiology and treatment under the title "De l'Etiologie et du Traitement du Pied-bot." He was followed, in 1852, by Bishop, of London, whose work, "Researches into the Pathology and Treatment of Deformities in the Human Body," is a careful summary of the subject. At about this time much attention was given to the repair of tendons after tenotomy, and, although investigations concerning this process had been made by Von Ammon, Guérin, Pirogoff, Koerner and others, it was left for Gerstaecker (1851), "Diss. Histol. de Regeneratione Tendinum;" Thierfelder (1852), "Trans. Path. Society" (London, vol. vi., 1855); J. H. Boner (1854), "Die Regeneration der Sehnen," etc., who performed many experiments on rabbits, but especially Paget, "Lectures on Surgical Pathology" (London, 1853), who has detailed minutely the microscopic changes through all the stages of the reparative process, and to whom we are largely indebted for our knowledge of the subject, to show the exact mode in which the required elongation of muscles is obtained in order to cure the deformities for which the operation is performed. Adams, in 1855, also performed experiments upon rabbits in which the tendo Achillis had been divided subcutaneously, and has written "On the Nature and Treatment of Club-foot" (London, 1856), and a "Treatise on the Reparative Process in Human Tendons" (London, 1860), in which he gives a *résumé* of the published descriptions of experiments on animals, as well as post-mortem examinations in the human subject. His work "On Club-foot: its Causes, Pathology, and Treatment," is the most exhaustive on the subject, and received the Jacksonian prize for 1864. It has passed through several editions.

Brodhurst, of London, has contributed largely to the subject of club-foot, the most important of his writings being "On the Nature and Treatment of Club-foot" (London, 1856) and his work "Orthopedic Surgery." He was a decided advocate of tenotomy, and employed it to the exclusion of all other means of treatment, considering it better, even in the most simple cases, to divide the tendons. He made numerous experiments upon the reparative process following the section of tendons, the results of which were embodied in a communication to the Royal Society (November, 1859), entitled "On the Repair of Tendons after their Subcutaneous Division." From 1853 to 1863 many valuable papers upon the subject of club-foot appeared. Among the most noteworthy were those of Todd, "Clinical Lecture on Paralysis" (London, 1854); Bouchut, "A Practical Treatise on the Diseases of Children" (1855); Beckel, "De Pede Varo" (1856); Vetter, "De cyllopodia cum descript. casus pedi vari;" Esau, "Beiträge zur Lehre von Plattfuss;"

Quicken, "De Talipedibus" (1859); Ebner, "Die Contracturen der Fusswurzel und ihre Behandlung" (1860). In 1863 Barwell, "Cure of Club-foot without Cutting Tendons," rendered himself famous by offering objections to, and strongly opposing, the practice of tenotomy, which after nearly a century of use had, of course, become very popular, and was supported by all the great surgeons. His treatment was directed to the restoration of the lost equilibrium in the opposing sets of muscles; to substituting a force for the paralyzed muscles, to be applied as nearly as possible in the direction and position of the paralyzed muscles; to treating the foot, not as a whole, but as a compound of many bones; and to allowing the weakened muscles to regain their power by what might be called passive motion. This he endeavored to accomplish by the use of india-rubber bands, also called "artificial muscles." In his objections to tenotomy he argues that the contraction is the result of paralysis in the opposing muscles. When the tendon is cut, all opposition to such contraction is annihilated, and the muscle itself contracts and the calf shortens. Tonic contraction of the muscle, however, still continues, and the cicatricial contraction will reproduce the same deformity when the apparatus is removed. Non-union occasionally takes place. Weber, "Ueber die Anwendung permanenter Extension durch elastische Stränge bei pes valgus" (1863), also advocated elastic force. Adams, in 1866, writes that Heather Bigg had used the same plan several years prior to Barwell. Many works appeared during the latter end of this period, and the literature of club-foot is now very voluminous. Stoess, in 1866, wrote on "Du Traitement du Varus;" Richter, in 1867, on "De Talipedibus Varis;" Mezger, in 1868, "De Behandlung van di Stortistic Pedis mit Fricties;" Hirschfield, in 1869, "Ueber die Behandlung der Klumpfüsse;" Francellon, in the same year, "De l'Etiologie du Pied-bot Congénital." In 1870 Nieden, "Ueber die Entstehungsweise und Ursache des angeborenen Klumpfusses;" Volkmann, "Ueber Kinderlühmung und paralytische Contracturen" (Klinische Vorträge, No. 1), and Marx, "Ueber Pes Varus." In 1871 James Hardie, "On the Pathology of Club-foot and other Allied Affections" (London); A. Luecke, "Ueber den angeborenen Klumpfuss" (Volkmann's Klinische Vorträge), and Brodhurst, "Deformities of the Human Body" (London). In 1872 Reverchon, "Sur le Pied-bot," and "Du Traitement des Pieds-bots par le Massage forcé." In 1877 Chalot, "Du Pied Plat et du Pied Creu Valgus Accidentels." In 1878 Kocher, "Zur Etiologie und Therapie des Pes Varus Congenitus" ("Deuts. Zeit. f. Chir.," Bd. ix.), and Bornemann, "Zur Therapie des Pes Varus Congenitus." In 1880 Van Hees, "Ueber Pes Equino-varus." In 1881 Ruprecht, "Angeborene spastische Gliederstarre und spastische Contracturen" ("Klinische Vorträge"); Dieffenbach, "Ueber Pes Varus und seine Behandlung;" Routier, "Du Pied-bot Accidentel," and Ulcoq, "Du Pied-bot Consécutif à la Paralysie Infantile et de son Traitement." In 1882 Pascaud, "Of Certain Orthopædic Apparatus employed in the Treatment of Club-foot"; Noble Smith, "Surgery of Deformities." In 1883 Schwartz, "Des Differentes Espèces de Pied-bot, et de leur Traitement." In 1884 Parker and Shattuck, "The Pathology and Etiology of Congenital Club-foot." In 1385 Reeves, "Practical Orthopædics" (section, Talipes or Club-foot).

This brings us to the close of the third period, and down to the present day. We have endeavored to give the more important works which mark the history of the subject, and to note those particularly whose views characterized the development of new theories as to etiology and treatment.

American Contributors—Nineteenth Century. In 1835, four years after Stromeyer performed his first operation, Dr. James H. Dickson, of North Carolina, is reported to have performed the operation of subcutaneous tenotomy for the first time in America.

In 1839 Mütter, of Philadelphia, delivered "A Lecture on Club-foot," in which he advocated well-regulated and continued extension, which he believed was the only thing necessary, especially for the young and feeble. In other cases he advised tenotomy and the proper fixation and retention of the foot, followed by apparatus. He believed the immediate or proximate cause of congenital club-foot was a contraction of the tendo Achillis. Accidental causes of acquired club-foot he ascribed to contusions, sprains and luxations, fractures, preternatural laxity of the ligaments, and partial paralysis of the lower extremities.

In 1840 Detmold, of New York, in his "Essay on Club-foot," states that the only remedy to be relied upon in the cure of club-foot consisted in the extension of the contracted muscles, gradually increased and continued until one set of muscles lose the inclination to spasmodic contraction, and their antagonists regain their activity. In regard to the causes of club-foot, he believed the first and most frequent cause to be "irregular muscular action," the stronger muscles contracting, and the weaker ones yielding; second cause, paralysis; third cause, a local stimulus or irritation, setting up contraction. He thought that in cases due to the first cause, the prognosis was gravest, and most favorable when the condition was due to prolonged contraction from a local stimulus. A pupil of Stromeyer, and having had the opportunity of seeing him operate, he was an ardent advocate of tenotomy, and to him and Mütter is due the credit of making the operation of subcutaneous tenotomy popular in this country. Although many articles in different journals appeared upon the subject of club-foot, and many plans of treatment showing much originality were devised, it was not until 1866 that a methodical account of the subject was given by Prince, in his "Orthopædics" (Philadelphia). He also gives a very ingenious plan for holding the foot, for the purpose of affixing apparatus for the removal of the deformity. He was followed in 1867 by Davis, who was the originator and promulgator of the "extension" theory, and to whom much credit is due for his original work in the treatment of deformities. In his work, "Conservative Surgery," he claims that he had practised Barwell's plan many years before Barwell adopted it. In 1868 Bauer's "Orthopædic Surgery" was published. It is undoubtedly the most complete and scientific work upon the subject up to this date, and its chapter on Talipes is a very comprehensive and exhaustive one. In 1875 Sayre, in "A Practical Manual of the Treatment of Club-foot," shows himself a decided advocate of "Barwell's artificial muscles," although he does not believe in this method to the exclusion of other means of mechanical treatment and tenotomy.

In this work he gives many excellent practical suggestions for the treatment of the deformity, and in this, as well as other departments of orthopedic surgery, he has done much for the advancement of the subject.

Shaffer, of New York, has devised many important improvements in mechanical appliances for the cure of club-foot, and has contributed valuable articles to the literature of the subject. The most important of these are: "Traction in the Treatment of Club-foot" (1878); "Hysterical Joint-Affections" (1880), in which he reports very interesting cases of "hysterical club-foot;" and "Non-deforming Club-foot" (1885), originating in this last contribution a new class of cases, previously little observed or studied.

Phelps, of Chateauguay, advocated and practised division of the tendo Achillis, and then of all structures down to the bones opposite Chopart's joint. He read a paper on the subject before the International Medical Congress at Copenhagen, entitled

"The Treatment of Equino-varus by Open Incision."

Hingston, of Montreal, "On Certain Forms of Club-foot" (1884), reports four cases of severe equino-varus treated by open incision.

Berg, of New York, has written a very original and valuable article on "The Etiology of Congenital Talipes Equino-varus" (1882), the studies of the author throwing much light upon this very vexed question and antedating the researches of Parker and Shattuck, of London, by several years. Many other names might be added to the foregoing ones, most conspicuously those of Pancoast, of Philadelphia; Hutchison, of Brooklyn; Yale, of New York; Bradford, of Boston; all of whom have added either to the treatment or the literature of club-foot.

VARIETIES ESPECIALLY CONSIDERED. Under this heading will be included a short account of the different forms of club-foot and their treatment, as well as some considerations concerning their morbid anatomy, pathology, diagnosis, and prognosis.

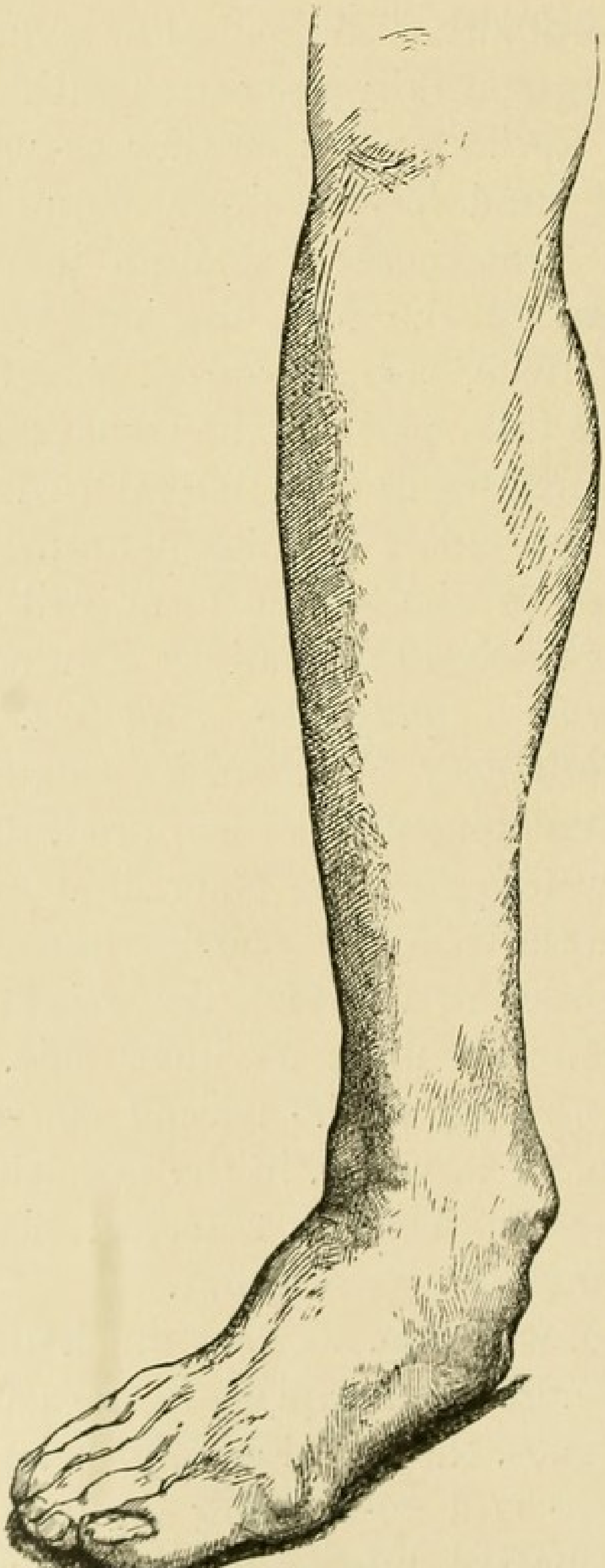
The purely primitive types of club-foot are so rare, either as congenital or acquired deformities, that authors have, under the titles Varus, Valgus, Equinus, and Calcaneus, usually included the compound forms, and nearly all works upon the subject have described the changes found in them when referring to the bones, ligaments, muscles, etc., involved in the malformation. This has led to much confusion in both nomenclature and statistics. It was thought necessary to call attention to this fact before proceeding to a description of the primitive types.

Talipes Varus. Synonyms: Ger., *Klumpfuss;* Fr., *Pied-bot varus.* The simple form is undoubtedly one of the rarest of either congenital or acquired deformities, it being generally associated with equinus, and almost all authors when writing of varus describe the compound form, Talipes Equino-varus. In the mildest form there is a slight inversion of the anterior part of the foot, the heel not being elevated. In a true case of varus, therefore, the deformity would take place at the transverse tarsal joint, the deformity being on a lateral plane. The changes, bony, muscular, and ligamentous, as well as the treatment of the simple form, will be best described under the head of Talipes Equino-varus.

Talipes Valgus. Splay-foot, Flat-foot. Synonyms: Ger., *Plattfuss;* Fr., *Pied-bot valgus.* This deformity may be congenital or acquired, the latter form being very frequent, the congenital rare. In the congenital form there are eversion and elevation of the outer border of the foot, the weight of the body being sustained upon its inner side. With this we find a sinking of the normal convexity of the arch. Here, as in varus, in the primitive type, the deformity takes place on a lateral plane, and occurs at the transverse tarsal joint.

The bones are, as a rule, not very much displaced, the principal changes taking place in the astragalus and scaphoid bones, the os calcis only being implicated when there is a co-existing equinus. The astragalus is generally pushed downward and forward, and is seen as a prominence upon the inner side of the foot, with the rotated scaphoid bone,

FIG. 1.



Acquired talipes valgus.

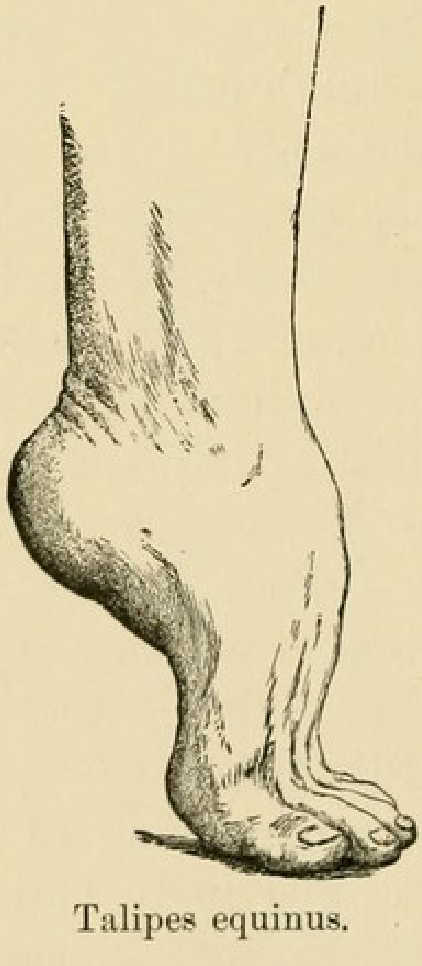
which is also prominent. The cuboid bone is involved, being slightly rotated outward, and the malleoli have a lower plane than normal. The ligaments implicated are those upon the plantar surface and inner side, the calcaneo-scaphoid ligament being relaxed.

The muscles principally involved are the peronei and the extensor longus digitorum, the tendo Achillis only participating when there is an equino-valgus.

Pes Valgus Acquisitus (see Fig. 1). The acquired form, generally known as splay-foot or flat-foot, occurs very frequently, and if all the cases were grouped under the common title of Talipes Valgus, would undoubtedly constitute the most frequent form of club-foot. A reference to the section on the Etiology of the Acquired Forms shows the different causes of this deformity. The principal ones are paralysis, rhachitis, ankle-joint disease, rheumatism, and it is common in growing boys and girls, as well as in certain occupations requiring long standing in one position.

It also occurs secondarily in knock-knee and traumatism. In talipes valgus pain is a very prominent symptom, and many cases have been justly described as "inflammatory flat-foot." The general changes found in the acquired forms consist essentially of a flattening of the arch of the foot, the weight of the body falling mostly upon its inner side. This brings the scaphoid and internal cuneiform bones closer to the ground, and it is at these points that the patients complain greatly of pain. The astragalus may also be displaced in the same direction. In some cases there are muscular contractions, the contraction taking place in the abductors, the adductors being in a condition of paresis. Where the cases occur as a result of infantile paralysis, the tibialis anticus is usually affected, more rarely the tibialis posticus, and in these cases in which the paralysis is of long standing or extensive, the prognosis is unfavorable. The cases are always tedious, necessitating a long time for their cure, but otherwise, as a class, talipes valgus of the acquired form is usually relieved by treatment.

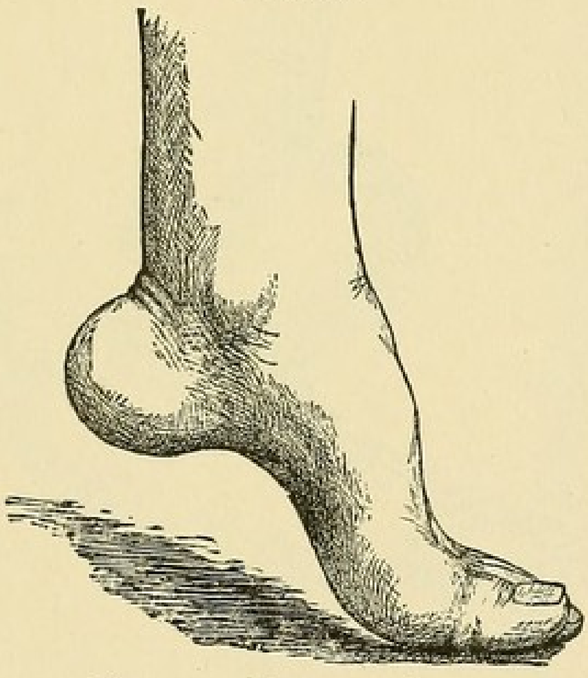
FIG. 2.



Talipes equinus.

Talipes Equinus (see Fig. 2). Synonyms: Ger., *Pferdefuss, Spitzfuss;* Fr., *Pied-bot equin.* This may be a congenital or acquired deformity, but congenitally it occurs very rarely, Little and Broadhurst stating that they had seen but two cases, and Tamplin, according to Adams, discredits it entirely as a congenital deformity. In a typical case the foot should be extended, the patient walking on the ball of the toes. The acquired form of talipes equinus is, on the contrary, a very frequent deformity; especially is this true of the paralytic form.

Fig. 3.

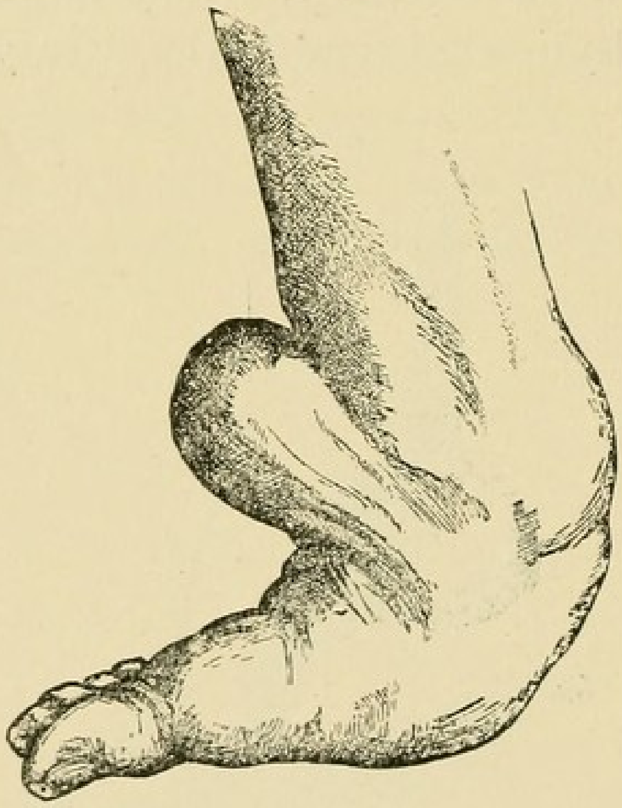


Severe talipes equinus.

The most frequent cause of the deformity is found in infantile spinal paralysis. Its influence in the production of the different forms of talipes, and the explanations have been mentioned under the section on Etiology. Other causes are found in spastic paralysis, neuro-mimesis, post-hemiplegic contractions, wounds, cicatrices, and long-continued decubitus.

In this form of talipes the os calcis is raised, and may even be in direct contact with the tibia. The astragalus is displaced downward, showing as a prominence on the dorsum of the foot. Where the deformity has advanced there occurs a decided bend at the transverse tarsal articulation, and the scaphoid is brought in contact with the os calcis.

FIG. 4.

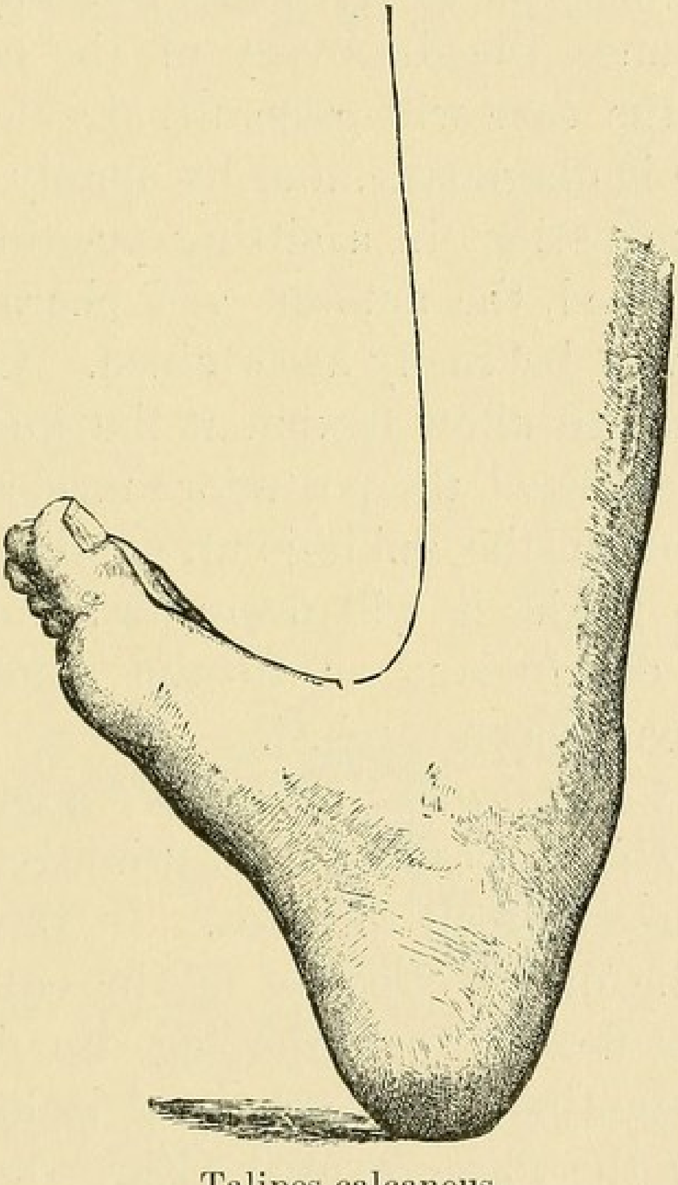


Severe talipes equinus.

In the severer forms there is also a marked contraction of the plantar arch, these cases constituting the pes cavus of some authors. Where the patient has extended the toes in walking, the proximal phalanges form articulations with the superior surfaces of the metatarsal bones. In some old cases where the deformity was allowed to exist without interference, the bones after death have been found very light and cancellous.

The ligaments are contracted upon the plantar surface, and elongated upon the dorsum of the foot. Adams found the astragalo-scaphoid ligament much lengthened, as also the interosseous and calcaneo-astragaloid ligaments.

FIG. 5.



Talipes calcaneus.

The muscles involved are the posterior ones, the gastrocnemius, plantaris, and soleus acting through the tendo Achillis. Pancoast asserts that the soleus is chiefly at fault, and has operated upon this muscle; but extension and flexion at the knee-joint so affect this deformity, increasing or lessening it, as to show the marked influence of those muscles attached to the condyles of the femur.

The prognosis in talipes equinus is very favorable, patients having been relieved of the deformity at all ages.

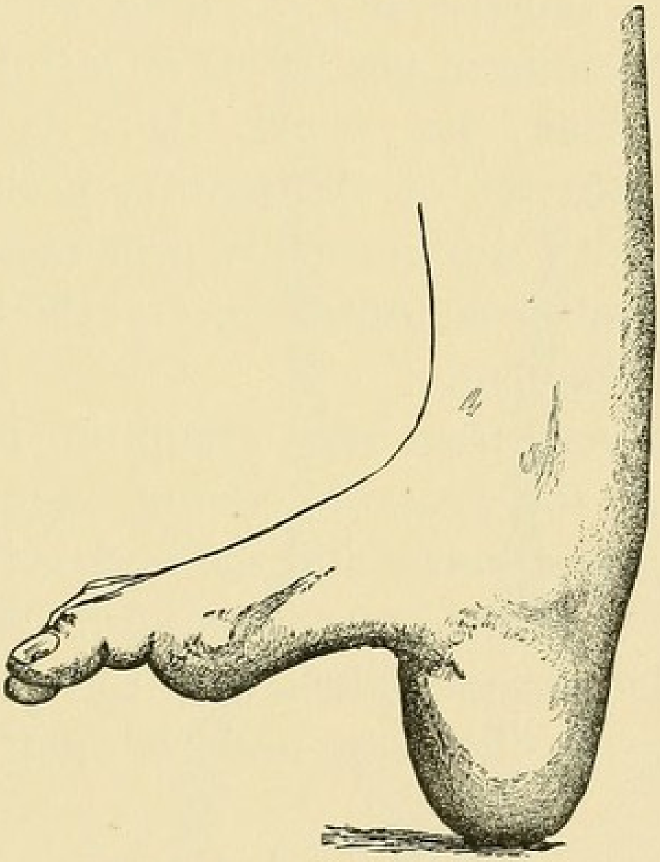
The diagnosis is easily made, the only difficulty being at times the discovery of the cause. The history of the case will generally decide this. Its appearance is diagnostic, and by simply raising the leg with the patient in a sitting position, the knee being depressed, the amount and character of the deformity will be easily ascertained. Care should be taken not to allow flexion at the knee-joint, for if this be permitted, the posterior muscles will allow more flexion at the ankle-joint, so that if the deformity be slight it will disappear, thus showing that false conclusions as to the amount of the deformity have been reached.

Talipes Calcaneus. Synonyms: Ger., *Hackenfuss;* Fr., *Pied-bot talus.* As a primitive deformity it is the rarest of all varieties. In this condition we have the direct opposite of the equinus form. The foot is flexed upon the leg, its dorsum approaching the tibia; while the heel is lowered, and the sole of the foot elevated (Fig. 5). Here the displacement occurs at the tibio-astragaloid articulation, and, as in equinus, upon an antero-posterior plane.

In the congenital form the bones are not much altered. The astragalus seems to be drawn backward and its neck more in contact with the tibio-fibular surfaces, while the anterior part, superiorly, is posterior to the tibia. The os calcis follows the oblique direction of the astragalus, and becomes vertical in its position.

The acquired form is also very rare, and is usually the result of infantile spinal paralysis, affecting the posterior calf muscles (Fig. 6). Other causes are

FIG. 6.



Paralytic talipes calcaneus.

injuries, too rapid stretching of the tendo Achillis after tenotomy, and disease in the neighborhood of the ankle-joint.

In addition to the bony changes described under the congenital forms, there is an exaggeration of all the displacements there mentioned. The ligaments posterior to the ankle are lengthened, and contracted upon the front and upon the plantar surface, the plantar fascia being contracted. The muscles involved are the extensor proprius pollicis and longus digitorum, as also the tibialis anticus. The peroneus tertius may also be involved. The deformity is easily diagnosticated, and the prognosis is favorable in congenital cases, and while this is not so true of the acquired variety, great relief may be obtained by suitable orthopedic appliances.

It will be unnecessary to give in this article elaborate accounts of pes cavus or pes planus.

In the former, *pes cavus*, there is simply an increased concavity of the plantar arch, while the dorsal convexity is abnormally prominent. It may be a congenital or acquired variety, the latter being much more frequent.

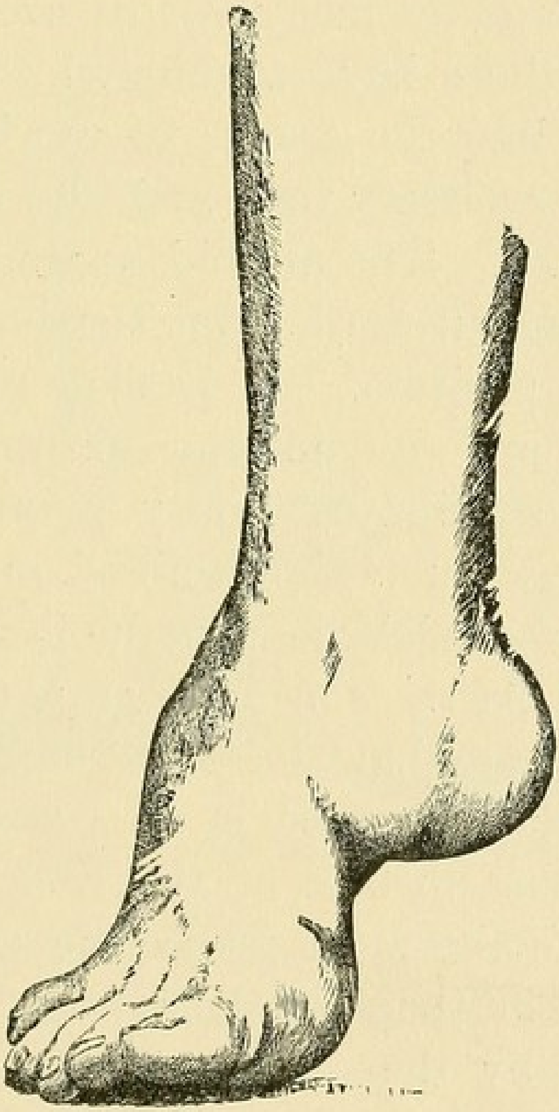
Pain is a very prominent symptom in this class of cases, and, the pressure coming upon the heads of the metatarsal bones and the heel, callosities and corns form which are very painful. Walking in many cases is accomplished with the greatest difficulty, owing to the pain, and the gait is characteristic.

Pes planus is considered by many authors as simply a spurious valgus. Here the depression is localized on the inner side of the plantar arch, but without the eversion of the sole. It is very common in certain races, and the negro is peculiarly liable to this deformity. Infants, as a rule, have flat feet, but the arch is developed when they begin to walk. None of the anatomical changes noted in typical valgus occur in this condition, excepting, perhaps, those cases in which the deformity has existed for a long time, when a true valgus may ensue.

The symptoms are very similar to those of valgus, and pain is in many cases present.

In this condition we do not have the eversion of the sole, nor is there the abnormal condition of the astragalo-scaphoid articulation, such as we see in the true valgus.

FIG. 7.



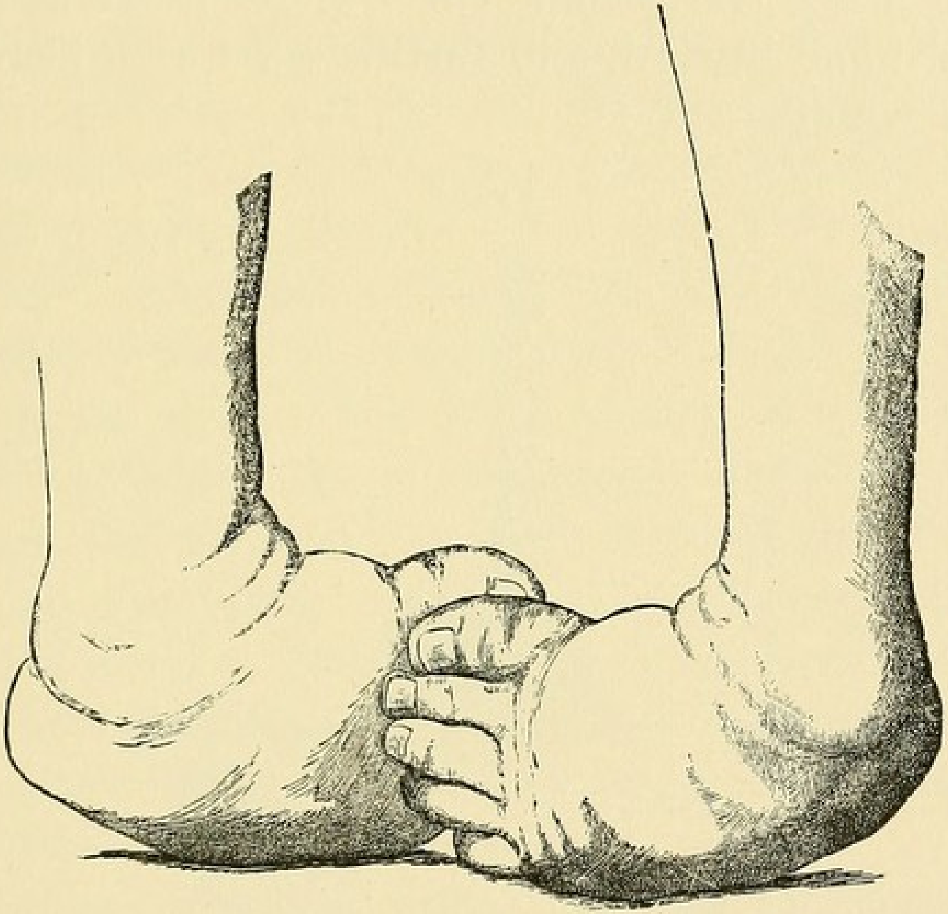
Paralytic talipes equino-varus.

Compound Forms of Club-foot. In these forms of club-foot we may have an association of all the primitive types of the deformity. When, therefore, we speak of a compound club-foot, we refer to a deformity having the characteristic qualities of two or more of the primitive types. Thus, most frequently we meet

Talipes equino-varus (Fig. 7), in which we find extension and adduction combined, the deformity taking place both on an antero-posterior and on a lateral plane. As a congenital deformity this compound form is the most frequent of all the varieties of club-foot, and is met with in every degree of severity. Authors have attempted to divide these degrees, but, like the stages of morbus coxarius, they are more arbitrary than real, and have no practical importance. The morbid anatomy shows the os calcis drawn upward, from the horizontal to a more vertical position. It is also rotated on its vertical axis, and its anterior extremity directed inward, its posterior extremity pointing outward and toward the fibula. The cuboid, maintaining its relation to the os calcis, follows the inward direction of its anterior part. The astragalus follows the os calcis forward, so that the posterior portion of its superior articular surface is in contact with the inferior articular surface of the tibia, the anterior part of its articular facet projecting at the dorsum of the foot. The shape of the astragalus may be so much altered by these changes that the anterior articular surface looks inward instead of forward. The scaphoid bone is drawn inward, upward, and backward, carrying with it the cuneiform bones, the metatarsal bones retaining their relation to the tarsi, being displaced inward. Many authors have written upon the deficiency of the inner malleolus, considering it to be one of the causes of the deformity.

Neither Little nor Adams has found this in his dissections. The question of these changes being primary or secondary has already been discussed in speaking of the etiology.

Fig. 8.

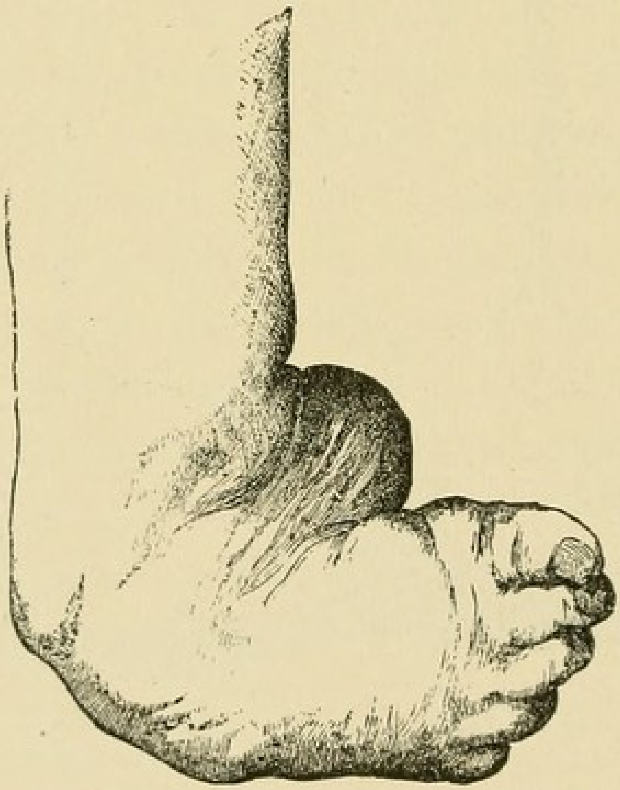


Double congenital equino-varus.

The ligaments at birth show very little alteration in structure, but in more advanced cases the plantar ligaments are contracted, as also the internal lateral and posterior ligaments. These may offer great resistance to eversion of the foot, and Adams has shown that the anterior portion of the internal lateral ligament, passing from the malleolus to the scaphoid bone, may render this particularly difficult.

The muscles at birth show no particular changes, and although the limb on the affected side is generally smaller than its fellow, the muscles themselves are normal, but undeveloped. It is important to remember that in consequence of the altered relations of the bones, the tendons may be much displaced. Thus the tendo Achillis is more external, being nearer the fibula, the tibialis posticus more forward and inward, and further separated from the tendo Achillis.

FIG. 9.



Severe congenital equino-varus.

Little has given the position of the tibialis posticus as being "exactly midway between the anterior and posterior borders of the leg on its inner aspect." The tendons running in front of the ankle-joint pass near to the inner side, that of the tibialis anticus passing over the inner malleolus. The vessels and nerves follow the deformity, but retain their relations to the tendons.

In this class of cases the prognosis is generally favorable, although the varus is much more amenable to treatment than the equinus.

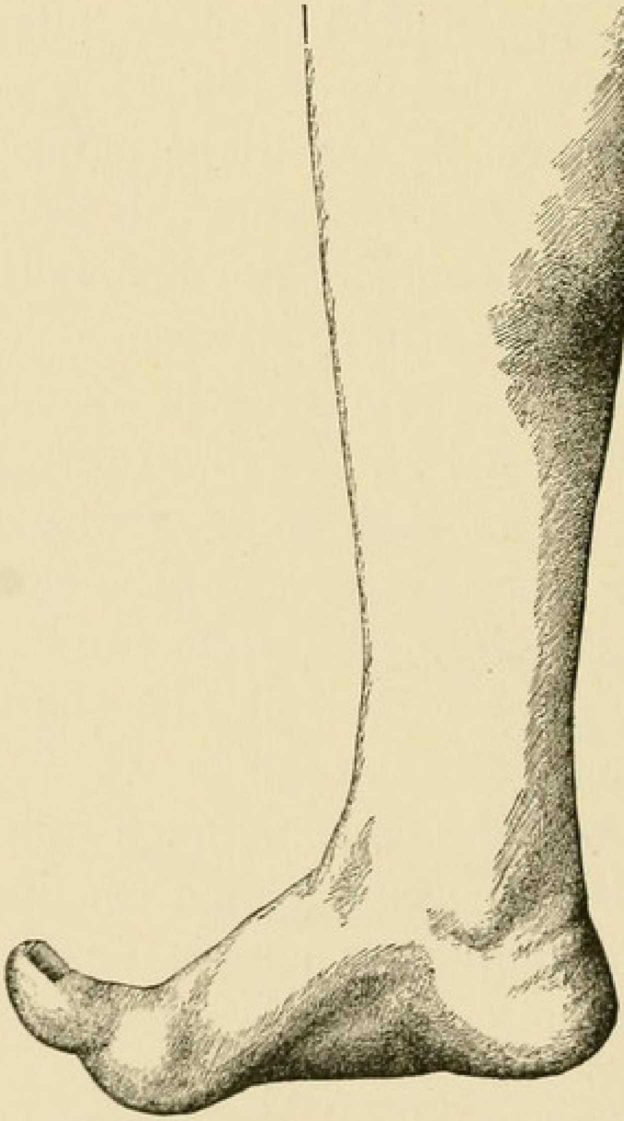
The acquired form of the compound deformity is also very frequent, being most commonly due to infantile spinal paralysis. Other causes may be found in those already given in the description of talipes equinus. The morbid changes follow closely the description given above of the congenital form. The prognosis, especially when the cause is a central one, is much more unfavorable, this being readily appreciated when we consider the destruction of the cells in the cord. We have written of this compound deformity at some length, because it is undoubtedly the most frequent of all forms of club-foot, and also is the most difficult of treatment.

Equino-valgus simply consists of the combination of the two primitive forms, equinus and valgus, and for the morbid changes the reader is referred to the description of these two varieties.

Calcaneo-varus and valgus are such rare forms of talipes that little is necessary for their description. A study of the component simple forms entering into their formation is all that is necessary for their diagnosis, morbid changes, and treatment.

Non-deforming Club-foot. For a full description of the very interesting form of cases designated by Dr. Shaffer, of New York, as "Non-deforming Club-foot," the reader is referred to the New York "Medical Record" for May 23, 1885, where an account of their characteristics and pathology, with some remarks on treatment, is given. Dr. Shaffer has undoubtedly described a new class of cases, practically unknown or unrecognized by other observers (Fig. 10). Here we shall only allude to the condition briefly. Dr. Shaffer says, "In non-deforming club-foot all the conditions found in certain

FIG. 10.



Non-deforming club-foot.

forms of talipes exist with the exception of the exaggerated deformity. That is, there is a loss of normal relation between the articulation at the ankle and the muscles which act upon it, involving also in many instances the tarsus, producing a condition which prevents normal flexion at the ankle-joint, and modified mobility, with slight deformity at the tarsal, metatarsal, and phalangeal articulations. With this state of affairs we find, as a result, varying with the conditions present, actual disability, pain, sometimes very severe, in various parts of the foot, ankle, leg, and even reflected to the lumbar region, and tender and inflamed articular surfaces, especially at the junction of the first metatarsal bone with its phalanx. If these effects be wanting, we have only an awkward or peculiar gait associated with painful callosities and corns at various points upon the foot." Furthermore, he says, "Non-deforming club-foot may occur at any age. I have seen it in infancy, when doubtless its etiology is the same as that of congenital club-foot. It occurs rarely as an acquired condition in children, though often the 'good result' of many surgeons after tenotomy and treatment leaves behind it a condition like that I have attempted to describe. It is seen very frequently during the period of second growth —the adolescent period—in both sexes, when at that particular age there are not apt to be many important sequelæ. It usually does not reach its full development until adult life and full growth is attained. It occurs more frequently in the female sex, and *when looked for*, is found sometimes in rapidly growing girls, and especially in those whose growth has been apparently arrested before the average height is reached. And what is very important and to a certain extent remarkable is this: *it is found very often associated with true rotary* *lateral curvature of the spine.* We may have a condition of non-deforming club-foot from five different causes: 1, Non-deforming club-foot seen after poliomyelitis anterior; 2, non-deforming club-foot which follows simple and uncomplicated malposition, habit, etc.; 3, non-deforming club-foot produced by traumatism, sprains, etc.; 4, non-deforming club-foot found after the infectious diseases of childhood, especially diphtheria and scarlet fever; 5, the non-deforming club-foot due, as I believe, to some remote trophic disturbance, and seen quite frequently co-existing with true lateral curvature."

All the forms which have been described may be simulated by the so-called "*neuromimetic*" or *hysterical club-foot.* Their diagnosis is always surrounded with difficulty, and the differentiation of the symptoms demands great caution. The treatment, once the diagnosis is clear, should be addressed mainly to the neural symptoms and the general "morale" of the patient. It may become necessary, all other means having failed, to divide contracted tendons, as instanced in a case in which we divided the tendo Achillis. This case is related by S. Weir Mitchell in his "Lectures on Diseases of the Nervous System" (Philadelphia, 1885, p. 129).

TREATMENT. In beginning the treatment of a case of club-foot the surgeon should have in view two principal objects: first, the removal of the deformity; second, the restoration of the functions of the foot. To accomplish this, many and various devices have been resorted to, and a history of these would furnish an interesting chapter to the subject.

It will be impossible in a limited space to describe all the methods which have been used by surgeons in the treatment of club-foot, and it will be necessary to discuss only such as are in common use at present, and embody the most scientific principles for the removal of the deformity. The remarks of Adams are here very appropriate. "The scientific treatment of talipes varus, when severe, as of several other deformities of the limbs, can only be accomplished by a judicious combination of the operative, mechanical, and physiological means, while many of the failures still witnessed in the practice of those who have not devoted much attention to the subject are due to the want of this combination of principles, too frequently considered as antagonistic to one another, but which modern science teaches us are only reliable in so far as their mutual dependence is recognized and applied by the scientific insight of the surgeon."

The general treatment of club-foot is best divided into:

I. *The Mechanical.*

II. *The Operative.*

Under the head of mechanical means are included:

1. *Manipulations;* their object being to stretch the foot to its normal position. These may consist of passive motions, shampooing, and the "kneading" of the part. The importance of the hand as an instrument for the correction of the deformity cannot be too strongly insisted upon, and the best apparatus is that which closely follows its action. "The

hand," says Bouvier, "is the ideal of mechanical means for reducing the deformity."

2. *Massage and Electricity.* These are, strictly speaking, physiological means, but as their application is mechanical, we have placed them under that heading. These agents, as applied especially to the paralytic forms, will be found referred to in another portion of this work (see article Infantile Paralysis).

3. *Splints.* The use of splints embodies the application of such mechanical principles as will serve to correct the disturbed form of the foot. They may be used as permanent unyielding dressings, *i. e.*, plaster of Paris or silicate of soda; or they may utilize elastic force, as in the apparatus of Barwell and Sayre; or, finally, they may combine extension with fixation, as seen in the various modifications and improvements on Scarpa's shoe.

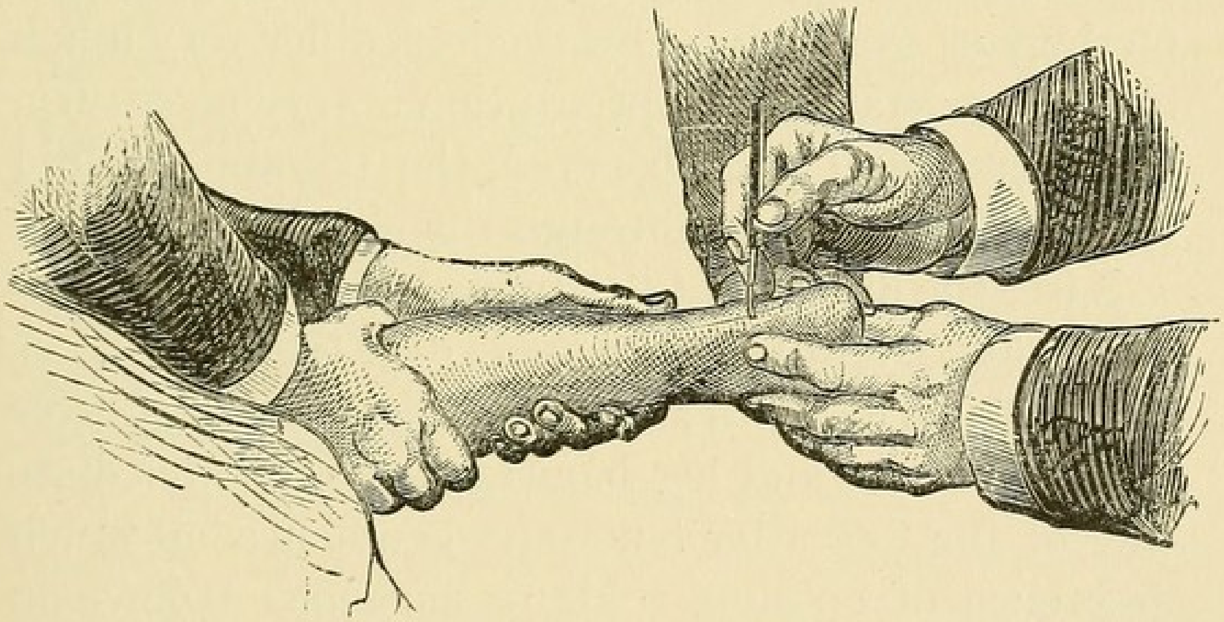
The operative treatment of club-foot consists of:

1. *Tenotomy*, or division of contracted tendons. The proper time for the performance of tenotomy has been the cause of much difference of opinion, some advocating its immediate performance, and others deferring it until such time as the patient is able to walk. In the majority of cases the early operation, if the case be of such a nature as to preclude the possibility of cure by simple mechanical means, is to be preferred. Experience alone can give the best indications for the operation, the presence of rigidity, reflex spasm (Sayre), or an excessive amount of deformity not being in themselves sufficient reasons. The patient application of mild means should always be attempted before

the performance of an operation, however slight it may seem to the surgeon.

Modes of Operating. Tendons and fasciæ are most conveniently divided from below toward the skin, but some surgeons prefer to insert the knife between the tendon and the skin and cut inward. The latter method, where the relation of the vessels and nerves is much disturbed, is attended with considerable danger. The form of tenotome used is largely a matter of choice; as a rule, only two are

FIG. 11.



Position for performance of tenotomy. (From SAYRE.)

necessary. The best tenotomes for ordinary use should be one with a straight blade and sharp point for making the skin puncture, and another with a probe-point for completing the section of the tendon. The handles should be round, flattened upon the surface corresponding to the dorsum of the blade. The patient, having been anæsthetized, is placed upon the table in a convenient position and in a good light, and one assistant grasping the part to be operated firmly, the other places the limb not to be operated upon out of the way (see Fig. 11). The preparatory puncture having been made with the sharp-pointed knife, the operator introduces the probe-pointed tenotome flatwise, as close to the tendon as possible, and beneath it, and, its cutting edge being then turned toward the tendon, a sawing motion is imparted to the tenotome, and the tendon carefully divided. An assistant should firmly tighten the tendon during the operation, and as the section approaches completion relax his hold on the part gradually. As tendons differ very much in their resistance, this precaution is very necessary, as otherwise, if not observed, the tenotome would be very likely to cut through the skin.

After the division of the tendon the knife is withdrawn and slight pressure made over the wound. A pad of lint fixed with adhesive plaster is placed over it, and the foot and leg bandaged. The immediate care of the foot after tenotomy is a source of much difference of opinion. Many surgeons believe in immediate restoration of the foot to its normal position. Others bandage it to a splint in the deformed or slightly less deformed position, and gradually restore the limb during the process of cicatrization. In our opinion the application of such apparatus as will give the surgeon complete control of the parts, and at the same time allow extension, according to the activity in the reparative process, is most desirable.

Several accidents may happen in the performance of tenotomy. Among these are, division of the skin, making an open wound; wounding of the posterior tibial or internal plantar artery; false aneurism and inflammation in the sheath of the tendon, or imperfect union of the tendon. These are to be treated according to ordinary surgical principles.

Adams has given a *résumé* of the different accounts of the reparative process in the tendons, such as were found by Hunter, Mayo, Von Ammon, Guérin, Pirogoff, Koerner, Paget, and others. These observations show that the space between the divided ends of the tendon soon becomes filled up by plastic matter and serum; that in this new matter bloodvessels multiply rapidly, the new tissue surrounding the divided ends as callus unites the ends of fractures. This becomes changed into connective tissue and firm, and combining with the intermediate substance contracts gradually, assuming as it does the character of new tendon.

2. *Myotomy.* Little need be said of this procedure. It is scarcely ever done. Professor Joseph Pancoast, of Philadelphia, believed in the sole action of the soleus muscle in the production of equinus, and divided the muscle for the relief of this deformity, but the operation has never come into general use.

3. *Tarsotomy and Tarsectomy.* The first mentioned procedure is the division of such bony structures as are involved in the deformity by means of the osteotome, the second consisting of the removal of a wedge-shaped piece of the bones. When we

consider how seldom these operations seem to be necessary, it is somewhat surprising that, as was recently shown by Lorenz, fourteen operations have been devised, exclusive of tenotomy, for the correction of talipes. They are: 1, Linear osteotomy of the scaphoid practised on the plantar surface (Hahn); 2, linear osteotomy of the tibia above the malleolus (Hahn); 3, enucleation of the cuboid (Solly); 4, enucleation of the astragalus alone (Lund, Maron); 5, the same with the resection of the tip of the external malleolus (Maron, Reid); 6, excavation of the spongy portion of the astragalus, leaving the articular surfaces (Verebely); 7, enucleation of the astragalus, and excision of a wedge-shaped piece from the anterior portion of the os calcis (Hahn); 8, enucleation of the astragalus and cuboid (Albert and Hahn), or of the astragalus and scaphoid (West); 9, enucleation of the astragalus, cuboid, and scaphoid (West); 10, enucleation of the scaphoid and cuboid (Bernet); 11, resection of the head of the astragalus (Lücke, Albert); 12, excision of a wedge from the outer half of the neck of the astragalus (Hueter); 13, excision of two wedges, perpendicular to each other, with bases at Chopart's articulation, and the astragalo-calcanean joint (Rydygier); 14, excision of a wedge without regard to any individual bones (O. Weber, Davies-Colley, R. Davy). In the experience of the authors these operations are rarely necessary, and, perhaps, only applicable in adult cases which have resisted all other forms of treatment, or in relapsed cases in which the inflammatory products have so agglutinated the different structures as to render other measures impossible. For a full description of these different surgical procedures the reader can consult the special treatises, and also the article of Davies-Colley ("Transactions of the Medico-Chirurgical Society," vol. lx. p. 11).

4. *Brisement Forcé.* Under this procedure are classed all operations which have for their object the immediate restoration of the form of the foot, either by the hand or by powerful instruments.

5. *Multiple Tenotomy and Open Incision.* The division of all the contracted tendons at one sitting has been performed, but has not met with general approbation, owing to the fact that no appropriate point of resistance is left afterward that can be utilized for mechanical treatment. Indeed, although it is the practice of English surgeons to divide many tendons, the tenotomy in this country is usually limited to the tendo Achillis, plantar fascia, and tibialis anticus and posticus.

Open incision has recently been commended by Drs. Phelps and Hingston. A more extensive experience in this procedure will best decide its relative merits.

6. *Amputation.* As a *dernier ressort* in severe paralytic cases, in which the patient prefers an artificial foot, and where all ordinary means have been exhausted, amputation has occasionally been performed.

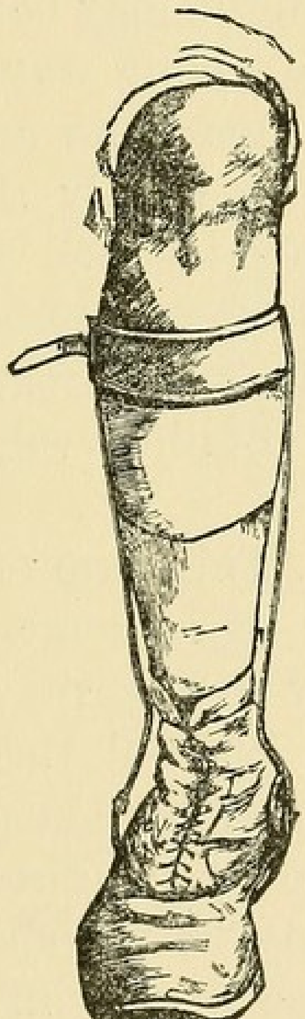
TREATMENT OF SPECIAL VARIETIES. Having finished the general remarks on the treatment of club-foot, we will now proceed to give an account of the special varieties.

Talipes Varus. Pure varus, either as a congenital or acquired deformity, occurs so infrequently that a consideration of the principles involved in its treatment, and the means employed, had best be deferred until we arrive at the treatment of talipes equino-varus.

Talipes Valgus. Congenital cases, treated soon after birth, may be cured by manipulations alone, these having for their object the carrying of the foot to a more inverted position. To retain the foot in a good position after these movements, adhesive plaster (Maw's) with a roller bandage may be employed. Where the deformity is rather more severe, external splints of a simple character, composed of tin, gutta-percha, or hatter's felt, may be used. These are moulded to the part, and a gradual inversion of the foot accomplished. The application of massage and electricity to the weakened anterior tibial muscle may be resorted to with advantage, and rest should also be enjoined. In the more severe forms of congenital valgus tenotomy of the peronei and extensor longus digitorum occasionally becomes necessary.

In *acquired valgus* the treatment also varies with the amount of the deformity and cause. In mild forms unattended by contraction of tendons, the application of a simple ankle support, composed of two lateral uprights connected with a band to encircle the calf, and with an inner pad corresponding to the axis of the astragalo-scaphoid articulation, and attached to the bottom of a shoe, may be used. In the majority of cases additional support may be obtained by the insertion of a tempered steel sole into the shoe, so moulded that its convexity has a direct bearing upon the weakened plantar arch (see

FIG. 12.



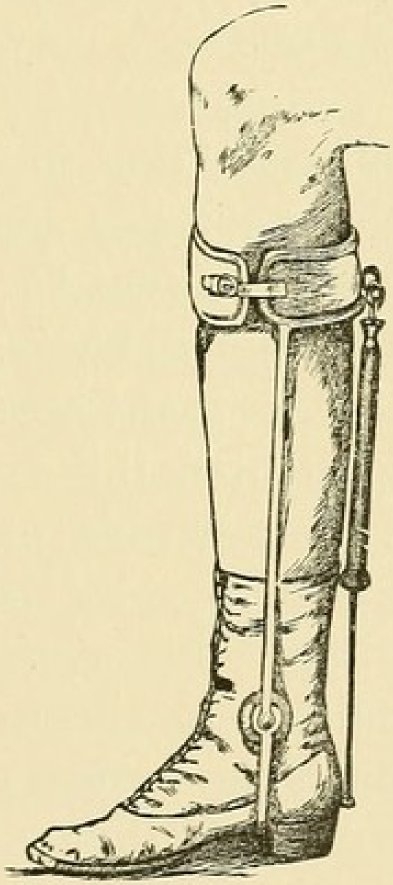
Ankle support for valgus.

Fig. 12). In this condition Drs. Barwell and Sayre advocate the use of elastic bands to supply the action of the weakened tibialis anticus muscle. In addition, where the means above referred to cannot be procured, good results may be obtained by the use of plaster-of-Paris or silicate of soda splints, moulded to the foot in a position of varus and allowed to set, care being taken to remove them from time to time, when the parts should be carefully inspected, and the splint readjusted to the corrected deformity. In this connection, as the treatment for the two conditions is the same, talipes planus or spurious valgus may be considered. Here there being a simple giving way of the arch, due to relaxation of the ligaments and plantar fascia, it is only necessary to supply this deficiency by a tempered steel sole inserted in the shoe. In more pronounced forms, approaching in character true valgus, the same treatment as was advocated in speaking of talipes valgus will be necessary.

Talipes Equinus. This form of club-foot occurring so infrequently as a congenital deformity, it will not be necessary to describe any special treatment for its relief. We will, therefore, proceed at once to a consideration of the acquired form. The most frequent cause of acquired equinus being infantile spinal paralysis, we should endeavor to improve the condition of the affected muscles by electricity, massage, etc. The paralysis occurring in the flexor muscles, we must be prepared to counterbalance the antagonism of the extensor muscles by suitable apparatus. The best method of doing this is accomplished by those instruments which combine the principles of extension with fixation. Of these there are many, most of them being improvements on the original Scarpa's shoe, and we will revert to these more fully when describ- the treatment of talipes equino-varus.

Talipes Calcaneus. Here, as in most of the typical simple forms, little need be said of the congenital variety. When there are no contractions of the anterior tibial muscles, simple manipulation and passive motion will easily overcome the deformity.

FIG. 13.



Apparatus for talipes calcaneus, with artificial posterior muscle.

When the deformity is more severe, an ankle support, having a stop-joint, preventing motion of extreme flexion, may be used, or a similar support, to which an artificial posterior muscle is attached, similar in character to that shown in Fig. 13. In the large majority of instances the treatment just described will be all that is necessary; but in some cases it is expedient at times to resort to tenotomy of the tibialis anticus, extensor proprius pollicis, longus digitorum, together with the peroneus tertius. All of these tendons may be reached through a single puncture made in front of the ankle-joint, close to the inner border of the tendon of the extensor longus digitorum, care being taken to avoid the anterior tibial artery. Mechanical support, such as has been already described, may be used after the operation.

In those cases which are due to infantile spinal paralysis, and in which a marked contraction of the plantar fascia produces a "cavus," it may be necessary to divide the contracted fascia, but this must be carefully considered, as many cases obtain a certain amount of support from this very contraction. Where the deformity arises from excessive length of the tendo Achillis, the muscles themselves being unimpaired, a radical procedure consists in excision of the elongated tendon and suture of the divided ends. The operation is performed as follows: An incision being made down to the tendon, the sheath is opened and raised by a blunt hook or spatula, and folded or pinched between the fingers, so that the amount necessary for excision may be accurately ascertained. A silver-wire, silk, or gut suture is then passed through the tendon, about a fourth of an inch above and below the place of the incision of the tendon. This will prevent the slipping of the ends into the sheath. The ends are then approximated, the sutures twisted and buried into the tendon. In the opinion of the authors this will seldom be found necessary, although several successful instances are upon record.

TREATMENT OF THE COMPOUND FORMS. In the treatment of the compound forms of the deformity, the various elements entering into their formation will have to be dealt with. Thus, taking for example equino-varus, we have to deal with a deformity taking place on two distinct planes, the equinus being on an antero-posterior one, and corresponding only with the tibio-astragaloid articulation, and the varus on a transverse plane, corresponding to the transverse tarsal joint. It is plain, therefore, that all appliances intended for the relief of the compound forms of club-foot, and which have for their object the rectification of both elements simultaneously, are essentially false. That the elements entering into the formation of the compound forms should receive separate treatment has been especially emphasized by Dr. Little and Mr. Adams, of London. Little has stated that the varus or valgus should be thoroughly corrected before entering upon the treatment of the antero-posterior deformity, and Adams has pointed out the advantage and advisability of using the os calcis and contracted tendo Achillis as a fixed point upon which the tarsus may be extended, thus obtaining by these means a gradual unfolding of the deformed foot.

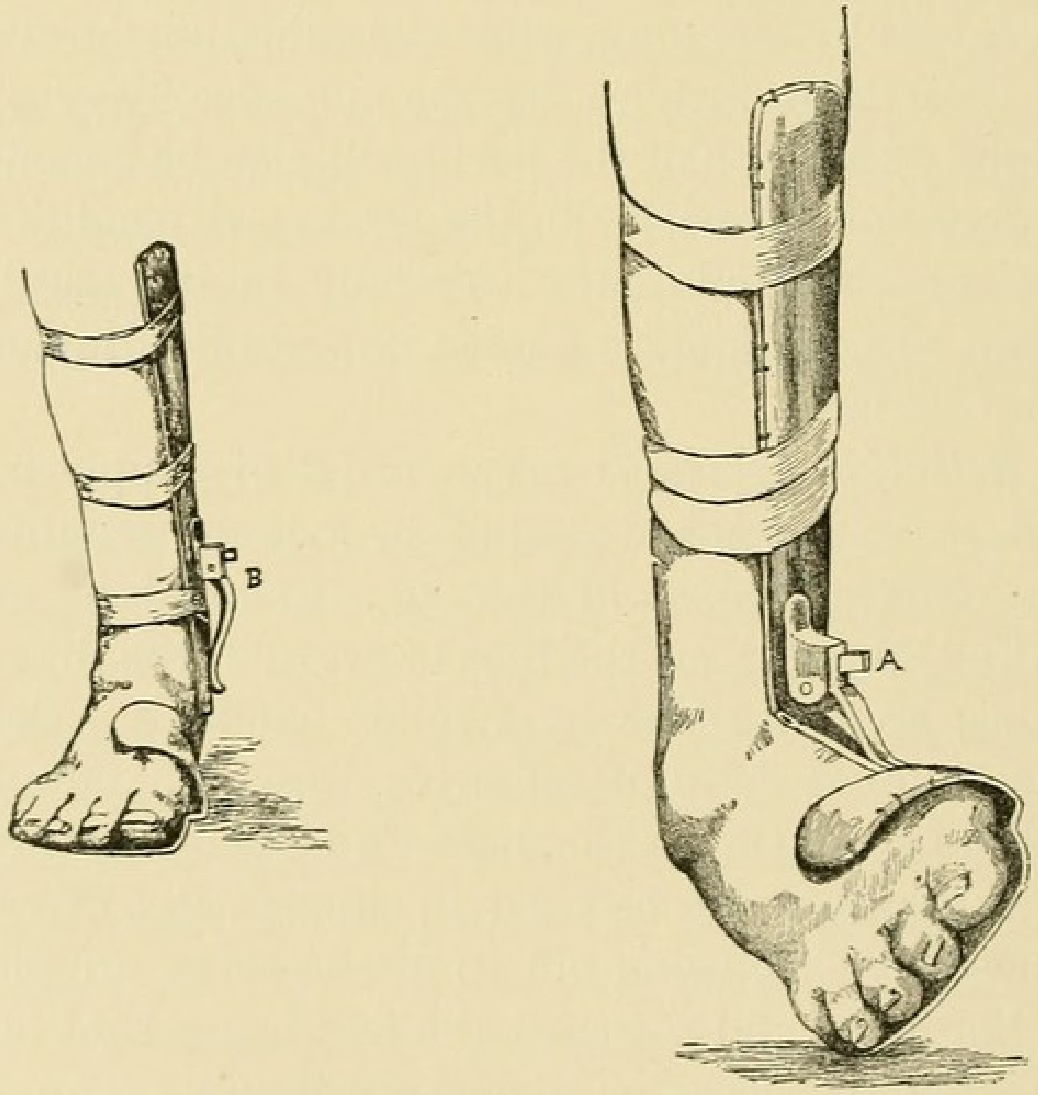
Talipes Equino-varus. By far the largest number of cases, both congenital and acquired, coming under the care of the orthopedic surgeon, are cases of talipes equino-varus, and we shall endeavor to give somewhat in detail the various methods in use for the treatment of this deformity. We have already pointed out the advisability of dividing the treatment of compound forms into two distinct periods. Thus in equino-varus our attention will be first directed to the inversion, or to the deformity occurring on a lateral plane. Of the various methods in vogue, the following will be considered:

1. Manipulation, massage, and electricity.
2. Retentive dressings.
3. Extension and fixation.
4. Elastic extension.
5. Tenotomy, combined with extension and fixation.
6. Brisement forcé.
7. Tarsotomy or tarsectomy.

Manipulations and massage may with advantage be used in the slighter cases of varus, but these agents are useful in all cases of whatever severity, and the nurse is to be especially informed of the value of these agents. It is undoubtedly a fact that much can be done with the hand alone, and many cases of varus have been cured by these simple processes. The attendant should be instructed as follows: The foot being firmly grasped and the os calcis being fixed, the anterior part of the foot is to be gradually brought into a valgoid position. This motion should be repeated several times at short intervals; the foot is then shampooed and may be placed in a light retention dressing. The manipulations should be used morning and night, and the splint modified as the amount of varus is corrected. It may be well in this connection to say a few words concerning *massage*. This is not, as is popularly supposed, a simple rubbing of the parts, but consists in a systematic "kneading" of the skin and deeper structures. These movements should consist of alternate friction and manipulation, the circulation of the skin being increased by pinching, while the subcutaneous cellular tissue and muscles may be more deeply grasped. Light percussion of the parts will also be beneficial. The use of electricity in the weakened condition of the muscles, but more especially in the paralytic forms of club-foot, is a most important adjuvant to the treatment.

Retention dressings may consist of simple adhesive plaster attached around the foot and secured on the external aspect of the leg; it should be gradually tightened as the foot is everted, the dressing being kept in place by a roller bandage. This is the simplest form of retentive dressing. Moulded splints of gutta-percha, hatter's felt, sole-leather, or rawhide may also be used in simple cases of varus. These articles, being cut to fit the parts, are placed in hot water and softened, the foot being held in the position the operator wishes to secure. The substance used is then moulded to the parts, and secured by a roller bandage. The dressings may be changed from time to time according to the improved position. Splints of plaster of Paris or silicate of soda may be applied in the same manner. As dressings they have the disadvantage, when applied as fixed splints, of not allowing a careful daily inspection of the parts, excoriations and sloughs being especially liable to ensue. When they are employed it would seem advantageous to cut them, as they would then still retain their retentive properties, and allow manipulation, massage, etc.

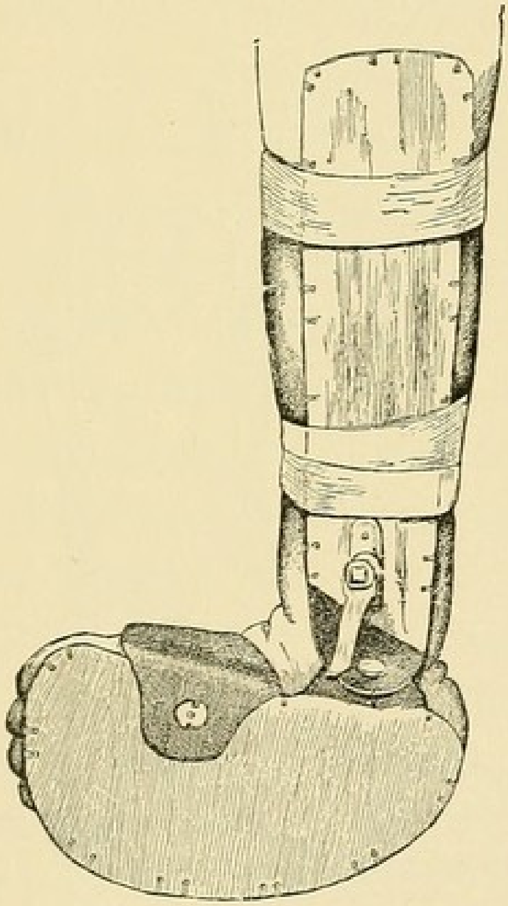
FIG. 14.



Varus brace applied; A, before, B, after the deformity has been corrected.

Extension and fixation may be most effectually used in overcoming the lateral deviation by the use of Shaffer's modification of Taylor's ankle support (see Fig. 14, A and B; Figs. 15 and 16). This consists of a steel trough fitted to the internal aspect of the leg, extending from the internal malleolus to the upper third of the tibia. Hinged to this is the continuation of the trough, terminating in a joint which articulates with the foot-plate, allowing antero-posterior motion at this point. This joint has been added to Shaffer's original "lateral shoe," and by it we can adjust it to a coexisting equinus. A

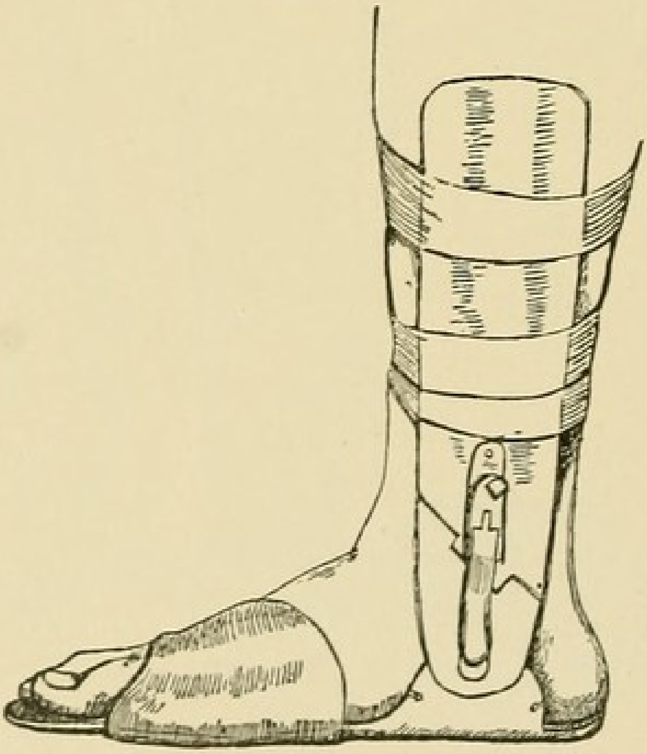
FIG. 15.



Lateral view of varus brace, applied to deformity.

worm or endless screw operated by a key, and seen at A, Fig. 14, acting upon the sole-plate at right angles to the direction of the hinge, enables the surgeon to apply the apparatus accurately to the extremes of varus (or valgus), and by means of a key to bring the foot in the desired position. The splint should always be applied to the foot in its deformed position, and maintained there by a roller bandage, as seen in Fig. 14, A. Then, by the use of the endless screw operated by the key, the foot can be brought into the corrected position as seen in Figs. 14, B, and 16. This simple apparatus, which, with a little instruction, can easily be applied and adjusted by the nurse or parent, allows of daily inspection, manipulation, and massage. In the severer forms of equino-varus, in which the lateral

FIG. 16.



Lateral view of varus brace, showing deformity corrected.

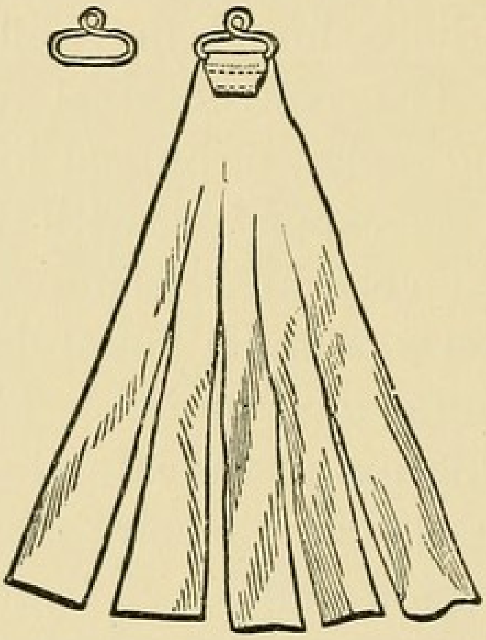
element is in excess, owing to the marked tarsal deviation and plantar contraction, the simple lateral brace above described has been found insufficient, and Shaffer has for these cases devised a more powerful apparatus, which can best be described in the following personal communication.

"The success which has attended the use of the extension or traction shoe[1] in the treatment of the antero-posterior deformities of club-foot, led me to seek some method by which traction could be applied to the lateral deformities of the tarsus—and especially those found in confirmed cases of equino-varus. The conventional club-foot shoe with the ball and socket or hinged joint in the foot-plate, at a point corresponding with the medio-tarsal joint, has proved very unsatisfactory, especially in cases where there was much tarsal deformity or any considerable plantar contraction. The limited success attending the use of the lateral shoe[2] led me to use this splint as a starting-point for further experiment. After various efforts I have perfected an apparatus which may be described as follows: To this simple lateral shoe, with its hinged lever and screw, which imparted a lateral force principally to the os calcis, I added the antero-posterior worm and screw of the extension shoe, which latter gave an antero-posterior pressure. I then divided the foot-plate (with its retaining side curve) at a point opposite the medio-tarsal joint, and instead of the ball and socket or hinge, I added an extension or traction bar to the *concave* or (in varus) the inner side of the tarsal deformity, with the centre of motion at the convex or (in varus) the outer side of the foot. The apparatus is placed upon the inner side of the foot (in varus), and the heel being retained in the heel-cup by the conventional strap or pad, the hinged bar and screw are first used to

[1] Vide New York Medical Record, November 23, 1878.
[2] Op. cit.

make pressure laterally against the os calcis. The key controlling the worm and screw is then used to

FIG. 17.



flex the foot sufficiently to exert a slight degree of force upon the gastrocnemius muscle, and when this

FIG. 18.

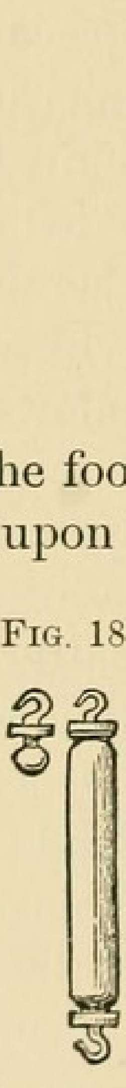
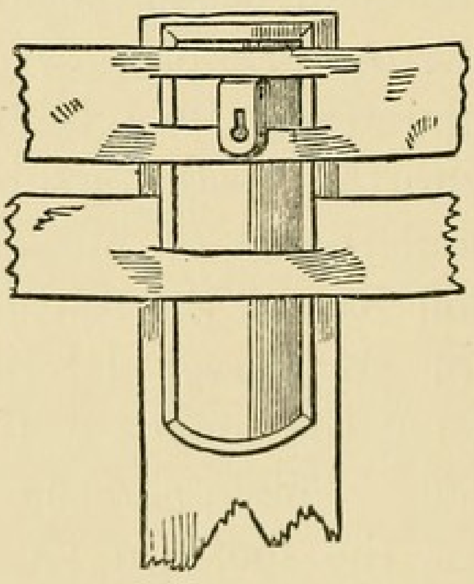
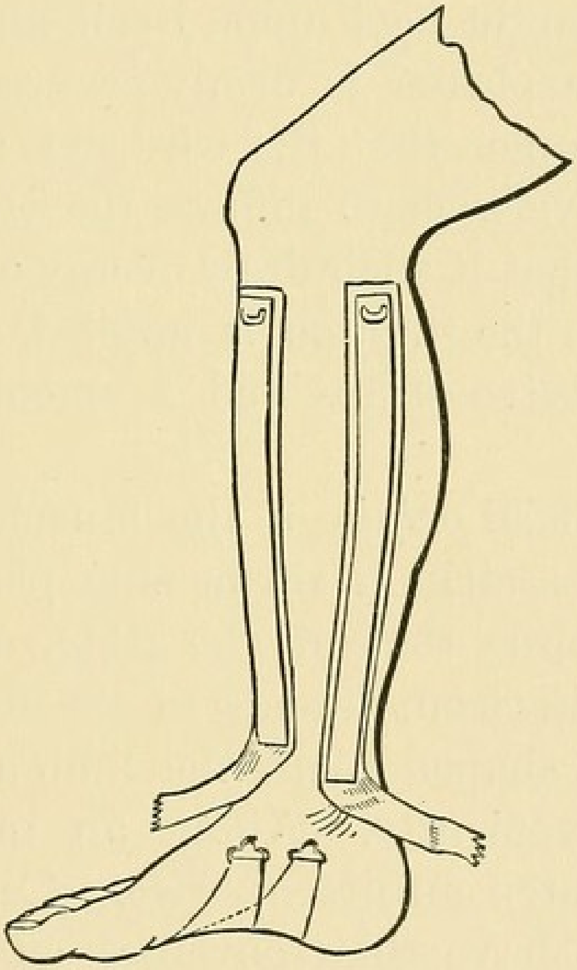


FIG. 19.



position is gained the tarsal traction is applied by using the extension or traction rod, which, acting upon the hinged centre of motion at the outer border of the foot, carries the anterior part of the foot forward, and direct traction is exerted upon the resisting tarsal tissue. In many severe cases of talipes equino-varus, the tarsal traction shoe has overcome the deformity without the aid of tenotomy."

FIG. 20.

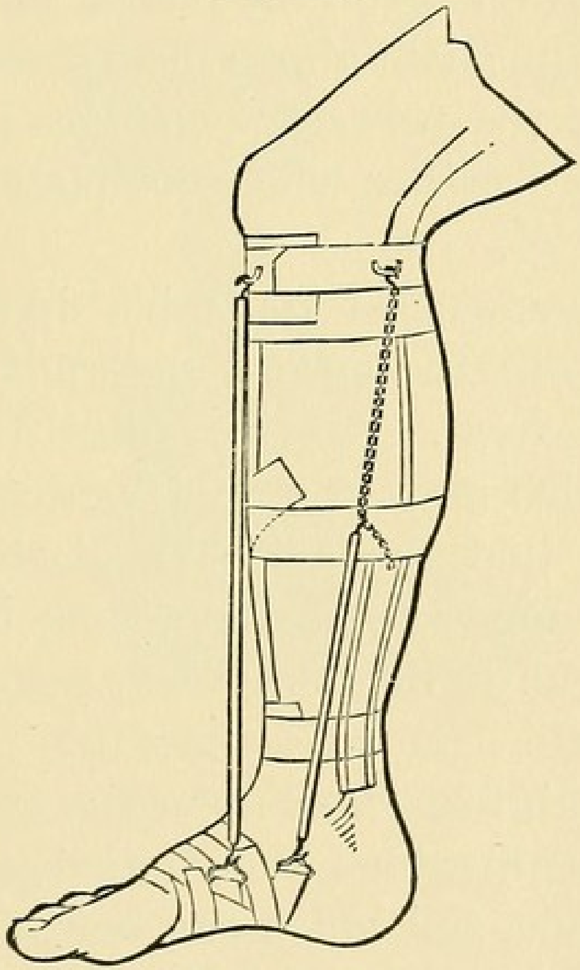


Elastic Extension. To Mr. Richard Barwell, of London, is due the credit of first employing elastic traction in the treatment of club-foot, and Dr. Sayre has popularized it in this country. For the principles embodied in Barwell's method the reader is referred to the section on History and Literature.

The application of Barwell's dressing has been so lucidly explained by Professor Sayre that we quote his remarks in full: "This consists in cutting from stout adhesive plaster, spread on canton-flannel, or the 'mole-skin plaster,' a fan-shaped piece. In this are cut several slips converging toward the apex of the piece, for its better adaptation to the part (see Fig. 17). The apex of the triangle is passed through a wire loop with a ring in the top (Fig. 17), brought back upon itself, and secured by sewing. The plaster is firmly secured to the foot in such a manner that the wire eye shall be at a point where we wish to imitate the *insertion* of the muscle, and that it shall draw evenly on all parts of the foot when the traction is applied. Secure this by other adhesive straps and a smoothly adjusted roller.

"The artificial *origin* of the muscle is made as follows: Cut a strip of tin or zinc plate, in length about two-thirds that of the tibia, and in width one-fourth the circumference of the limb (see Fig. 19). This is shaped to fit the limb as well as can be done conveniently. About an inch from the upper end fasten an eye of wire. Care should be taken not to have this too large, as it would not confine the rubber to a fixed point. The tin is secured upon the limb in the following manner: From the stout plaster above mentioned cut two strips long enough to encircle the limb, and in the middle of each make two slits just large enough to admit the tin, which will prevent any lateral motion; then cut a strip of plaster, rather more than twice as long as the tin, and a little wider; apply this smoothly to the side of the leg on which traction is to be made, beginning as high up as the tuberosity of the tibia. Lay upon it the tin, placing the upper end level with that of the plaster (see Fig. 20). Secure this by passing the two strips above mentioned around the limb (Fig. 21), then turn the vertical strip of plaster upward upon the tin. A

FIG. 21.

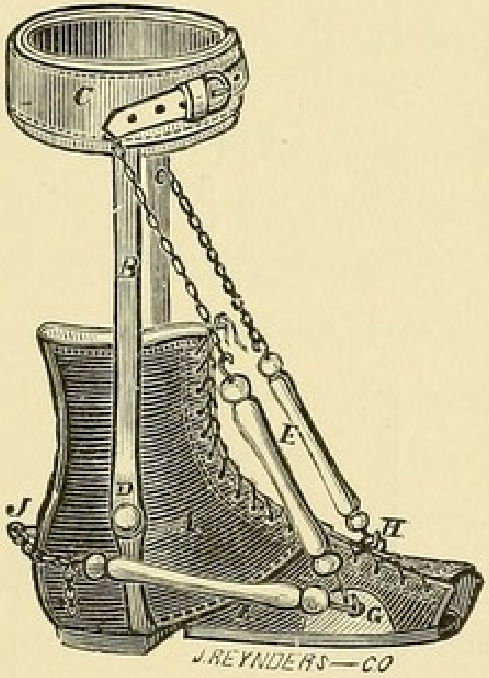


slit should be made in the plaster where it passes over the eye, in order that the latter may protrude. The roller should then be continued smoothly up the limb to the top of the tin. The plaster is again reversed, and brought down over the bandage, another slip being made for the eye, and the whole secured by a few turns of the roller. A small chain, a few inches in length, containing a dozen or twenty links for graduating the adjustment, is then secured to the eye in the tin.

"Into either end of a piece of ordinary india-rubber tubing, about one-fourth of an inch in diameter, and two to six inches in length, hooks of the pattern here exhibited (see Fig. 18) are fastened by a wire or other strong ligature. One hook is fastened to the wire loop on the plaster on the foot, and the other to the chain above mentioned, the various links making the necessary changes in the adjustment." The dressing when complete is shown in Figs. 20 and 21.

The arrangement of Barwell's dressing may be changed to suit the special deformity which it is designed to treat. Sayre states that the only objection which may be urged against this plan of treatment is that the adhesive plaster sometimes slides and changes its position, soon becomes worn out, and requires frequent readjustment, and will often excoriate. To overcome this defect he has devised a club-foot shoe, upon the general plan of Scarpa's shoe, in which the motive power consists of elastic bands, and which can be resorted to when the child is old enough to walk. It is applicable to varus and valgus, and is thus described: In the sole, opposite the medio-tarsal articulation, is placed a ball and socket, or universal joint. "This sole and part embracing the heel consists of strong sheet steel, covered with leather on both sides. Two lateral upright bars, *B* (Fig. 22), jointed at the ankle, are fastened near the heel and to the collar-band; *G*, *H*, and *J* are points for the attachments of artificial muscles made of rubber tubing, with hooks and chains at their ends. To the inside walls of the shoe, near *A*, two flaps of chamois leather are attached to lace together, which, passing over the front of the ankle-joint, keep the heel firmly in the back part of the shoe" (Sayre).

Fig. 22.



Tenotomy Combined with Extension and Fixation. In some cases it may be necessary, where they have resisted the means described above, to resort to tenotomy. This is best divided into two distinct stages, as follows:

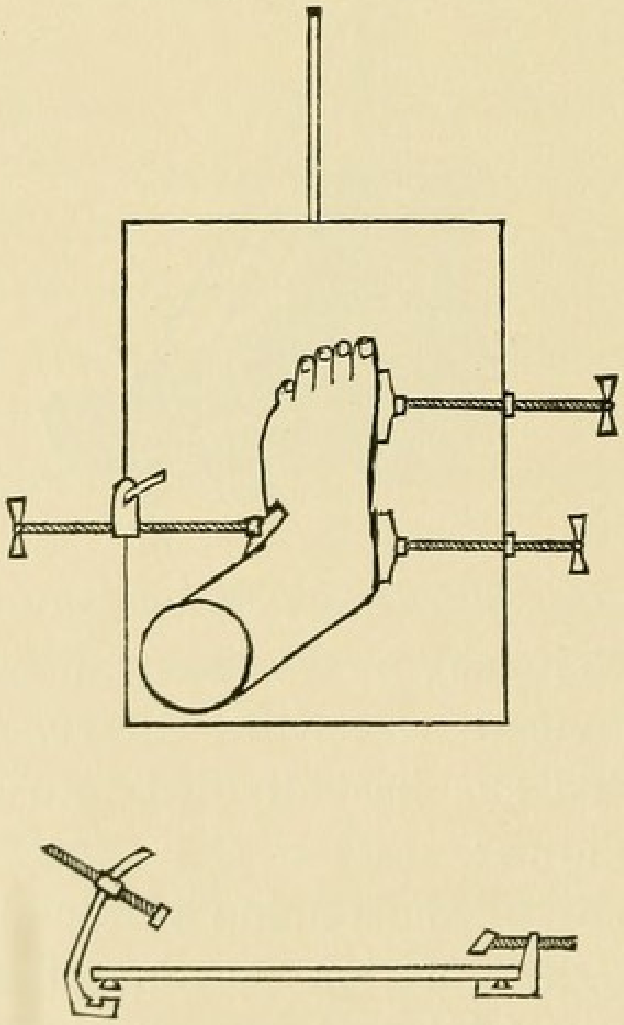
1. Tenotomy of the tendon of the anterior tibial muscle and the anterior portion of the internal lateral ligament (Adams), combined with the application of a lateral varus splint.

2. Division of the plantar fascia, and subsequent mechanical extension of the deep plantar ligaments (Noble Smith), the extension being well accom-

plished by the above-described modification of Shaffer's varus splint.

Here it may be urged, it is of the utmost importance that the strictest care be exercised after the performance of tenotomy. It is to the want of careful after-treatment that the majority of the bad results and relapses may be traced, and tenotomy should never be performed where this necessary after-care cannot be given.

FIG. 23.



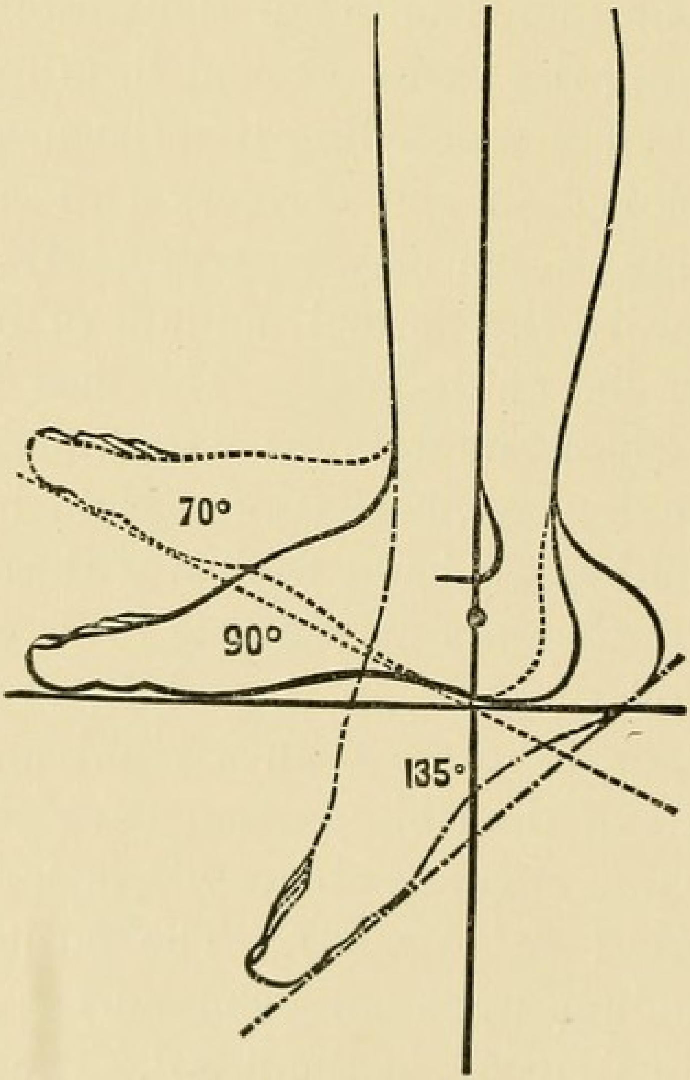
Brisement forcé, a procedure which has been attended with considerable success, and where the time at the disposal of the surgeon has been limited, has been performed in several ways. Of these the two most frequent are that in which manual force is employed, the patient being under an anæsthetic, and that in which the force is applied by means of a powerful instrument. Bradford, of Boston, has devised such an instrument, which is described in the "Boston Medical and Surgical Journal" for March 20, 1884, and is shown in Fig. 23.

Tarsotomy and tarsectomy, and their application, have already been alluded to in the remarks on the general treatment of club-foot.

Having considered in detail the various methods for overcoming the varus element in talipes equino-varus, and before proceeding to a discussion of the means employed in the correction of antero-posterior deformities, we may very properly give some consideration to the normal amount of flexion and extension at the ankle-joint. This has been summarized by Shaffer as follows: "Its function, except in extreme extension, is that of a plain hinge-joint. In the condition we have to deal with, flexion and extension are the only movements to be considered. Extension of the foot, in the adult, is limited at about 135°, or 45° more than a right angle, using the long axis of the tibia as the plane of measurement. Flexion stops at about 70°, or 20° less than a right angle (see Fig. 24). The position of the foot in standing upon an even surface, with the knee in full extension, is about 90°. The amount of flexion and extension varies in different individuals, but these figures, based upon actual experiment and measurement, represent, I think, the average of normal movement in the living adult subject."

Upon this must be based our efforts in the reduction of these deformities, and we should endeavor to obtain a resultant position of the foot as near normal as possible: thus, in talipes equinus the aim should be to make it possible for the foot to describe an arc which will end in the position shown in the figure as 70°, and in calcaneus extension should be possible until the normal position marked 135° is attained.

FIG. 24.



Various degrees of normal flexion and extension at the ankle-joint. (SHAFFER's modification of NOBLE SMITH's scheme.)

The means at our disposal for the accomplishment of this, are:

1. *Manipulation, Massage, and Electricity.* These have the same function in the antero-posterior deformity as was described in speaking of the varus element. It is only in the application of these forces that the difference exists. Here manipulations, etc., should be directed to those muscles and tendons producing the equinus, the application of the forces mentioned having for their object the conversion of the equinus into a calcaneus position.

2. *Retentive dressings* have been so thoroughly described when speaking of varus, that it is not necessary to repeat the description here. All the articles there mentioned for the construction of simple splint may be used with advantage in equinus, both before and after tenotomy.

3. *Extension and Fixation.* The ordinary forms of apparatus used to accomplish extension and fixation consist essentially of two uprights running parallel, and placed on either side of the leg, connected by a band to surround the calf; a joint corresponding to the ankle; a heel-cup with a strap and pad to secure the os calcis; and a sole-plate, with or without a hinge, to correspond with the medio-tarsal joint. This, which is the usual modification of Scarpa's shoe, is made the means for the application of force intended to act in place of the anterior and lateral muscles. The objection to the ordinary forms of apparatus used for the correction of antero-posterior deformities has led Newton M. Shaffer, of New York, to criticise them as follows: "It seems very easy to construct an apparatus with a joint to correspond with the tibio-astragaloid

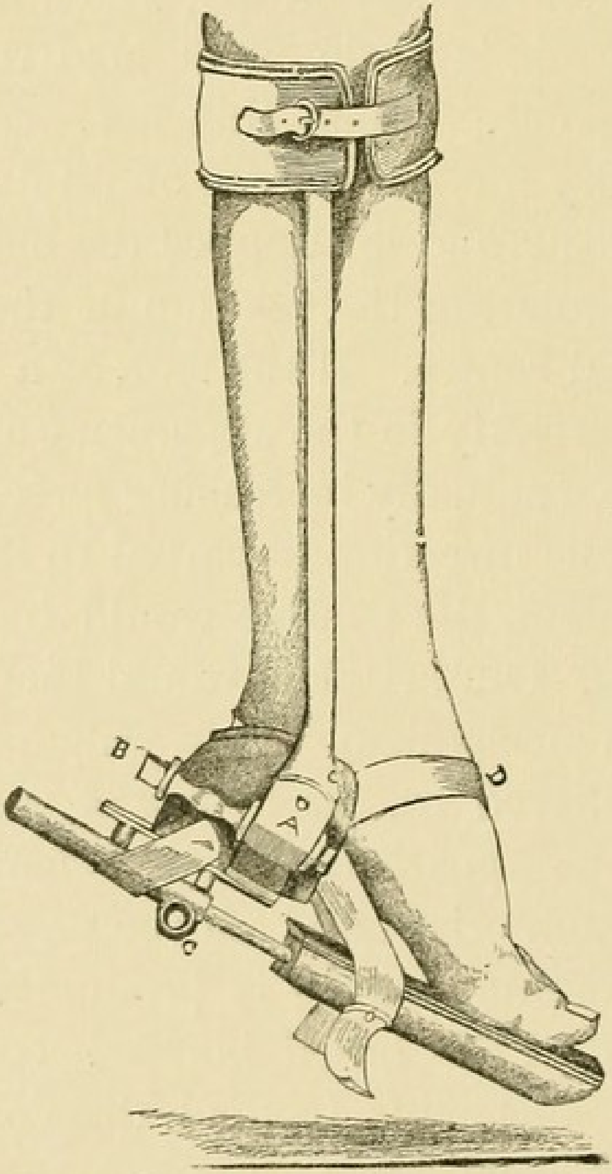
articulation, and to make this joint the centre of an artificial movement imparted to the anterior part of the foot through the medium of the foot-plate. But let us see what happens when we attempt to do this with the ordinary forms of apparatus. The centre of motion, so far as the equinus position is concerned, is at the tibio-astragaloid articulation. The resistance lies in the post-tibial muscles, and the power is applied in front to the tarsus and metatarsus—the object being simply to flex the foot and bring down the heel. As the anterior part of the foot rotates upon its artificial ankle-joint centre, or, to put it in other words, as we crowd the os calcis into the heel-cup, and attempt to flex the foot in very much the same manner we would shut the half-opened blade of a knife—the heel, unless restrained, slips forward. The attempt is made to control this movement by tying the heel down to the foot-plate and in the heel-cup, with the heel-strap. If, after this heel-strap (the analogue of the anterior annular ligament) is tied, a considerable pressure be applied in the direction of flexion (even in many cases after tenotomy), the further tendency of the heel (being restrained in front by the heel-strap) is to slip upward and backward away from this artificial annular ligament, ultimately, in many cases, resting on the top of the heel-plate, which forms the cup. When this occurs, all control over the foot is lost, as it turns toward that side upon which the contractions exist. One of the direct effects of mechanical flexion, as applied in the customary forms of apparatus, to overcome either a post-tibial or a plantar contraction, is to crowd the tarsal bones together.

"The foot-plate rotates around an axis, the centre of which is the 'ankle-joint' of the apparatus. The point at which the retaining force and counter-pressure (under the heel-strap), which holds the foot in the apparatus, is made, must also rotate around the pivotal point. Upon this heel-strap we must rely principally for the means of retaining the foot in the apparatus, and it supplies the only important means for regulating the relation of the anatomical to the artificial centre. If the foot, as a whole, could be secured perfectly in the apparatus, and be made, as we apply a gradually increasing force, to mechanically follow the direction imparted to it by the artificial mechanism, the trouble would be reduced to the minimum. Our artificial would then correspond to the human mechanism. But, principally through the causes referred to, the centre of rotation in the foot and in the apparatus become changed in their relations to each other, and all the pressure exerted under these circumstances is productive of injury. As pointed out, the tarsal bones become crowded together, the heel slips beyond the control of the apparatus, exposed points are apt to become excoriated, and the result, while sufficient force has been employed, though misapplied, is very discouraging in very many instances."

In view of the justice of these criticisms, and to overcome these faults, Shaffer has devised an improved extension club-foot shoe, a modification of Scarpa's shoe, which presents nothing novel with the exception of an extension-bar acting upon the sole of the brace.

The club-foot extension apparatus (Fig. 25) consists of the ordinary uprights fastened to the heel-

FIG. 25.

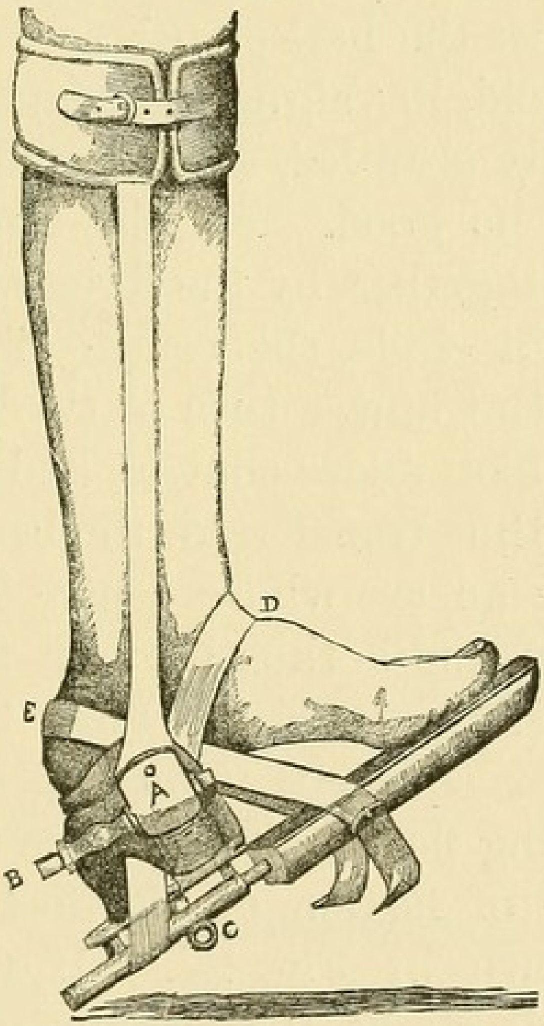


Extension equinus brace, adjusted to deformity.

piece by a plain joint on one side, and an endless screw, A, on the other. This screw allows us, by using a key, to place the foot-piece of the apparatus, as a whole, in any antero-posterior position we choose, and to alter it at will, either before or after application to the foot. That part of the foot-piece which corresponds with the tarsus and metatarsus is joined by a common extension-rod, C, to the portion which lies under the os calcis. With a key we are enabled to extend the anterior part of the foot-piece at pleasure.

To apply this instrument, we first, by means of the key, place the foot-piece in a position that will

FIG. 26.

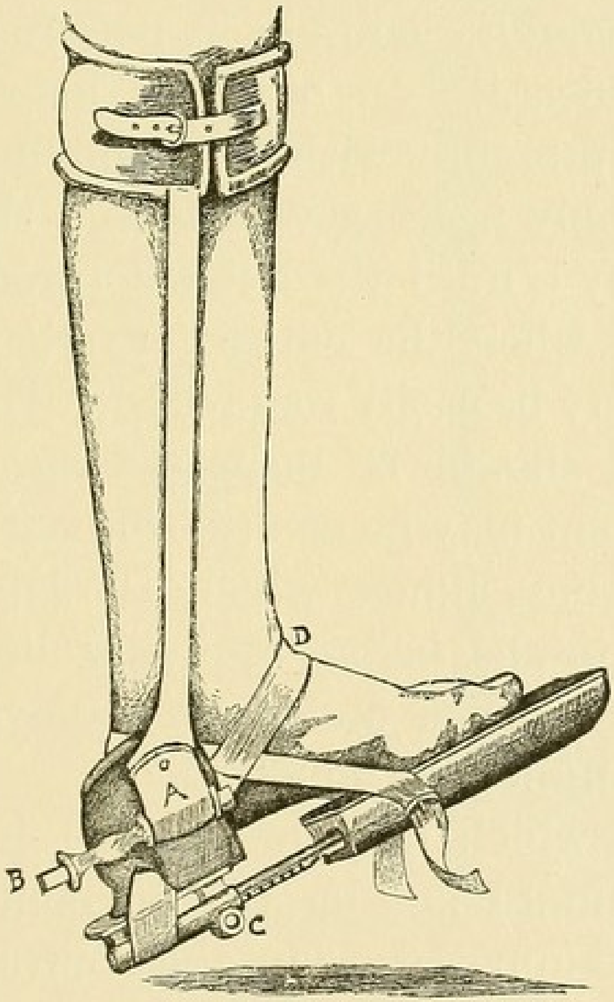


Extension equinus brace; first stage of correction.

exactly correspond with the antero-posterior position of the foot (whether tenotomy has been performed or not). We then secure the heel by tying the heel-strap, D, and by means of another webbing-strap, E, passing over the tendo Achillis, immediately above its insertion into the os calcis, secure it to the anterior or extension portion of the foot-piece by buckles on either side, as shown in the figure. The key, at B, is now used to flex the foot, in overcoming to the desired extent the tendo Achillis resistance. "When this shall have been accomplished it will be found, as in all similar apparatus where the artificial flexion alone is depended on to overcome the post-tibial resistance, that the posterior aspect of the heel is pressing against the heel-plate" (see Fig. 26). In varus the cuboid, in valgus the scaphoid bone, becomes uselessly crowded, and in a direction which does little or no good. All the tarsal bones are also crowded together by the force which is acting in the arc of a circle, the centre of which is the ankle-joint. But now, a turn or two of the key, at C, brings the foot under control, and the centre of motion being thus transferred, the heel must necessarily describe an arc whose centre is at the point of resistance, D, and is thus brought firmly into the heel-cup, and if the extension force be further applied, will rest squarely upon the extension-bar, thereby securing flexion at the ankle corresponding to the degree of flexion of the foot-piece of the brace, as shown in Fig. 27. If the tarsal deformity be only slight, the pressure at the cuboid or scaphoid is modified; the compression of the tarsus is relieved; the plantar fascia, the plantar muscles, and the tarsal ligaments are actually stretched; besides which, the os calcis is placed under restraint; in this way the traction force passes through the tarsus directly to the tendo

Achillis. The mechanical counter-extension, of course, is at the heel-strap, D. It simply retains the foot in a position that allows a certain amount of force to be expended on the contracted tissues. The greater pressure under the heel-strap, however, is exerted by flexing the foot with key B, rather

FIG. 27.



Extension equinus brace; complete correction.

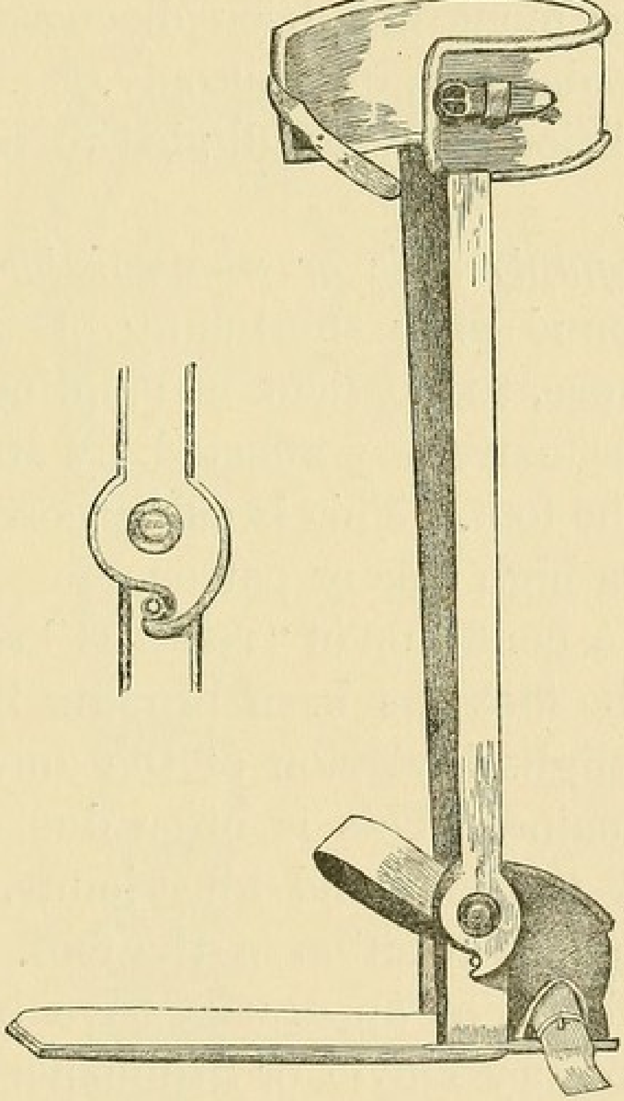
than by using the extension at C. Particular pains, however, should be taken not to make these combined forces too great. "As a matter of precaution I always place several thicknesses of sheet-lint or a thick layer of absorbent cotton (this latter makes an excellent elastic pad) under the heel-strap and at the sides of the heel-cup. If a very considerable extension is necessary, I pass an additional padded strap over the lower end of the tibia, passing the tapes attached back of the two uprights, securing them in front over the pad. It is a matter of surprise to me how well, with a little care, pressure is tolerated at this exposed point under the heel-strap, and, also, how little traction, applied in the manner indicated, through the tarsus, is necessary to accomplish the object." In order to inspect the part exposed to pressure without removing the apparatus, it is only necessary to loosen the heel-strap and turn key C until the extension-rod drops from the cylinder, when the entire posterior part of the apparatus may be easily removed. "The part under the heel-pad should be inspected *once a day*. An important point may be mentioned here: it is always well to overcome almost wholly the lateral malposition of the tarsus before applying direct traction. Time will be saved, and some annoyance also, if this rule be uniformly followed."

The force which may be exerted by the above apparatus should not be applied continuously, as is popularly supposed. On the contrary, it should be used as an *intermittent force*, and at stated intervals.

In order to maintain the position gained by the extension as used above, it is well to place the foot in a retention shoe whilst the patient sleeps. The same apparatus may be used when the foot has been brought to a right angle, where it can be secured by means of a stop-joint (see Fig. 28).

Should the above extension and fixation apparatus be unobtainable, good results are often secured by the use of the means described under the head of Retentive Dressings.

FIG. 28.



Retention equinus shoe.

4. *Elastic extension* has already been spoken of in detail when discussing the treatment of the lateral deformity. The methods of Barwell and Sayre, so adapted as to meet the antero-posterior deformity, as shown in Figs. 20, 21, and 22, describe the apparatus used by them.

5. *Tenotomy, combined with extension and fixation*, will comprise the division of the tendo Achillis, with the necessary after-treatment, this completing the third stage in the treatment of the compound form, talipes equino-varus. No especial description is required for the division of the tendo Achillis, and the after-treatment has been discussed under the general consideration of tenotomy.

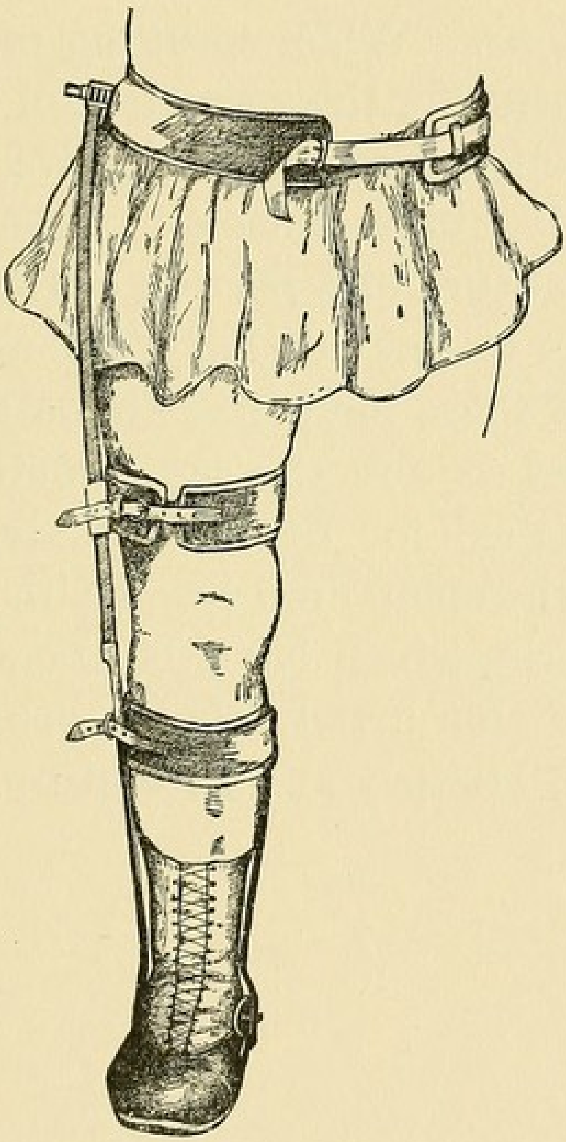
Two conditions may be alluded to before closing this section.

First: *Symptomatic or compensatory equinus*, a condition found after shortening of the leg from whatever cause, the patient attempting to equalize length of the extremity affected by standing upon the ball of the foot. This is easily corrected by the addition of a high sole or patten.

Second: A condition of "*residual*" *varus.* Often, even after the foot has been brought into excellent position, a slight inversion of the anterior part of the foot remains. This is often due to a relaxed condition of the hip- and knee-joints, allowing of abnormal inward rotation of the foot. To correct this, many forms of apparatus have been devised. Those of Gregory Doyle, or Stillman's modification (see Fig. 29), as also those of Dr. Sayre and Dr. Stedman, afford the best means at our disposal for overcoming this condition.

Talipes Equino-valgus. The principles of the treatment of club-foot having been fully discussed under the caption Talipes Equino-varus, it is only necessary here to speak of the modification of methods caused by the difference in the direction of the deformity, and the tissues involved. Owing to its extreme rarity the surgeon is seldom called upon to treat cases of this kind; but here, as in talipes equino-varus, it is necessary to overcome the ele-

Fig. 29.



Stillman's modification of Gregory Doyle's spiral spring apparatus for residual varus.

ment of valgus first, which may be accomplished by means similar to those mentioned when speaking of equino-varus, the extension force, however, being applied to the contracted peronei group; after the reduction of the lateral deformity, the equinus is overcome by the same means as serve to correct the same deformity coexisting with varus. Massage, electricity, and the other adjuvants heretofore mentioned should all be used in the manner already described.

Similar methods will apply to *Talipes Calcaneo-varus* and *valgus*. When speaking of Talipes Calcaneus, the means for the correction of the deformity were fully discussed, and attention was called to the application of rubber muscles posteriorly, and to excision and suture of a portion of the tendo Achillis. Reference to this portion of the article will furnish details of these methods; the lateral deformity will, of course, require the same methods of treatment as are called for by similar lateral deviations occurring in the compound forms already described.

For the works which have been consulted in the preparation of this article the reader is referred to the section on History and Literature.

POTT'S DISEASE.

POTT'S DISEASE.

Definition. Pott's disease of the spine, so called from the accurate, although not the first, description of caries of the vertebræ, by Percival Pott in 1779, is a lesion of the vertebral bodies or intervertebral disks, characterized by inflammatory changes, progressive in character, and ending in total or partial destruction of the parts involved, usually terminating in anchylosis more or less complete, with the characteristic posterior deformity.

Synonyms. Posterior curvature, angular curvature, spinal arthritis or osteitis; Greek, *Kyphosis;* French, *Mal-de-Pott*, *Cyphose;* German, *Spitzbuckel.* The objection to most of these terms is that they express either a pathological condition or a result of the disease, in no wise making clear or improving the conception of the trouble. It would thus seem well to retain the commonly-accepted name of Pott's disease. If any scientific term were to be adopted, Spondylitis would be the least open to objection.

ETIOLOGY.

Pott's disease is essentially a disease of childhood, although not entirely limited to this period of life, it having been found in the fœtus, in extreme infancy, in middle age, and in very old people. As a rule, however, it is most often found between the ages of three and fourteen years. Sex exerts no special influence in its production, although those who believe only in the traumatic origin of the disease speak of its more frequent occurrence in males, from their presumed greater liability to injuries.

In a general consideration of the etiology of Pott's disease it will be well to divide the subject into—

1. *Exciting causes*—traumatisms and fevers.

2. *Diathetic causes*—tubercle, scrofula, rheumatism, syphilis, etc.

Exciting Causes. In the question of causation of Pott's disease, *injury* occupies so important a place in the minds of both the profession and the laity that a brief discussion of its significance as a causative factor may not be amiss in this connection.

In almost all cases presented for examination, the information is usually volunteered that the patient has received a blow or a fall. A more careful questioning elicits, as a rule, a very vague etiological description of the traumatism. Thus it often happens that in a child presenting a marked deformity the traumatism assigned as its cause is referred to a very recent period and is in character entirely out of proportion to the supposed result. There can be no doubt that, in the majority of cases presenting clinically, the relations of cause and effect, considered from the stand-point of injury, are such as in no wise to account for the symptoms presented. If it should be accepted that the most frequent causes of Pott's disease are concussions and blows, as urged by the traumatists, it would follow that many thousands of children in daily receipt of such injuries would be the victims of this disease or of some analogous joint-trouble. That this is not the fact is proved by the comparative infrequency of the disease in question. Again, the amount and character of injury are important considerations. Thus, in many children a very slight traumatism has been given as the cause of the subsequent trouble, and in many cases, if no other conditions were present, might be accepted as a definite cause. Against these may be placed the severe injuries and falls received in childhood, terminating in a short time in perfect recovery or in death. From this it follows that in the one case there must be some special or underlying condition predisposing to the production of a chronic insidious disease, while in the other case the healthy organism so modifies the process that a different result is brought about.

The fact of the matter, as it appears to me, is that injury, considered purely as a primary determining cause, has no claims to special consideration in the large majority of cases; that Pott's disease often develops without any history of such injury as would show a conclusive connection between the injury and the disease; and that at best it is but the exciting cause bringing into activity an underlying general condition, and manifested by its local expression at the site of the supposed traumatism.

Among the causes of caries of the spine which stand in the relation of direct exciting agents, the continued fevers of childhood, measles, scarlatina, etc., and in fact all depressing conditions lowering the vitality, are prominent and direct etiological factors. The same underlying condition described as giving potency to injury is undoubtedly often present, the difference in the traumatism being simply one of character and degree. The influence of a depressing poison on a tender developing bone is none the less on account of this difference in causation, although manifest often in a different manner.

DIATHETIC CAUSES. Our knowledge of scrofula and tubercle in their causal relations to Pott's disease is as yet not of that definite character which is desirable, and therefore cannot receive more than a passing notice. When we speak of scrofula reference is had rather to a state or vulnerable condition of the tissues than to a complete pathological entity. Scrofula, therefore, we would refer to as a condition of the system rendering it peculiarly prone to chronic inflammations of a low type, retrogressive in character, and often occurring without adequate cause, accompanied by certain marked tendencies to skin-affections, glandular enlargements, and bone-disease.

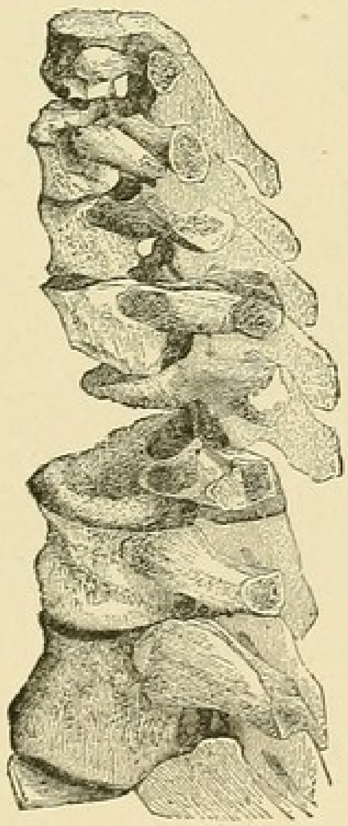
Tubercle at the present day plays so important a rôle in its etiological relation to bone-inflammations of the chronic type, and is of such consequence, that a detailed discussion would hardly be in place here. For a complete description the reader is referred to the article on tuberculosis, in another section of this work.

Syphilis and rheumatism may at times be diathetic conditions productive of Pott's disease, but as yet no direct evidences have been collected concerning these conditions and their manifestations in the malady under discussion.

PATHOLOGY.

Pathologically it may be well here to regard the lesions found in Pott's disease as identical with the changes found in other bone structures in which there is tubercular caries. This is destructive in character, and may be confined to a single vertebra or may involve several. (Fig. 30.)

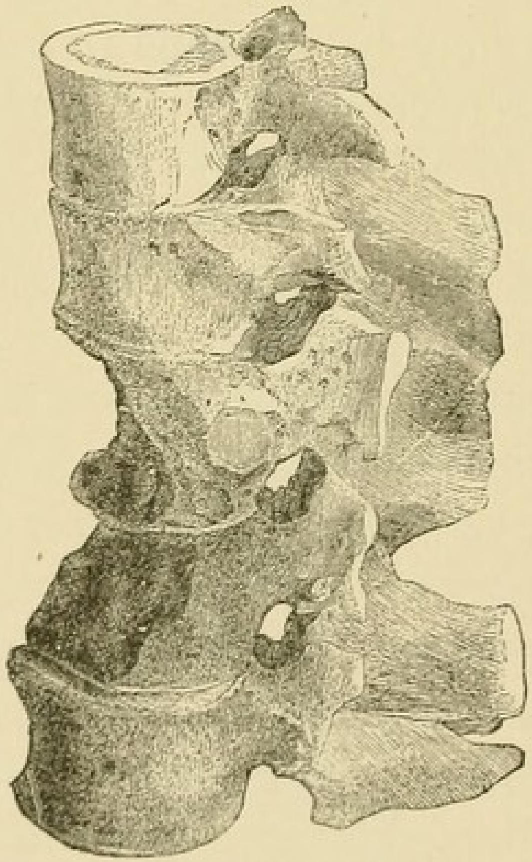
FIG. 30.



Showing extensive erosion of dorso-lumbar vertebræ.

It is in many cases attended or limited by the occurrence of a rarefying osteitis. In the strumous form of rarefying osteitis the first step in the process of inflammation is that of congestion, the bone appearing as if blood were extravasated throughout its structure; secondly, there is the formation of granulation-tissue; and lastly there occurs a degeneration and softening of the new formations, with purulent exudations and absorption of bone-trabeculæ. Now the bone-corpuscles undergo fatty degeneration, and are presently destroyed, and,

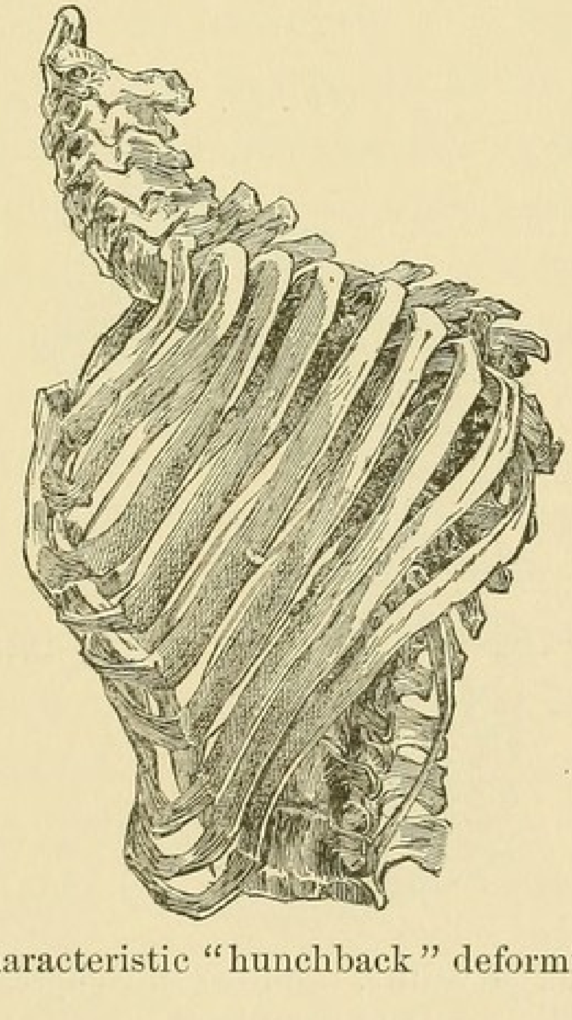
Fig. 31.



Erosion of lumbar spine, popliteal abscess, without deformity.

owing to strangulation of the vessels, caseation of the inflammatory products results. When the disease is rapid the cancellous spaces and Haversian canals are filled with pus. The process, being a strumous or tubercular one, differs from simple traumatic rarefying osteitis, arising, as it does, from an internal or constitutional cause, or from such local irritation that a slight injury would bring it into activity. Even such injury is not necessary to provoke this strumous or tubercular caries, it often arising from no appreciable cause. A peculiar feature of this caries is its limitation to spongy bone-tissue, it rarely affecting the transverse, articular, or spinous processes primarily. (Fig. 31.)

Fig. 32.

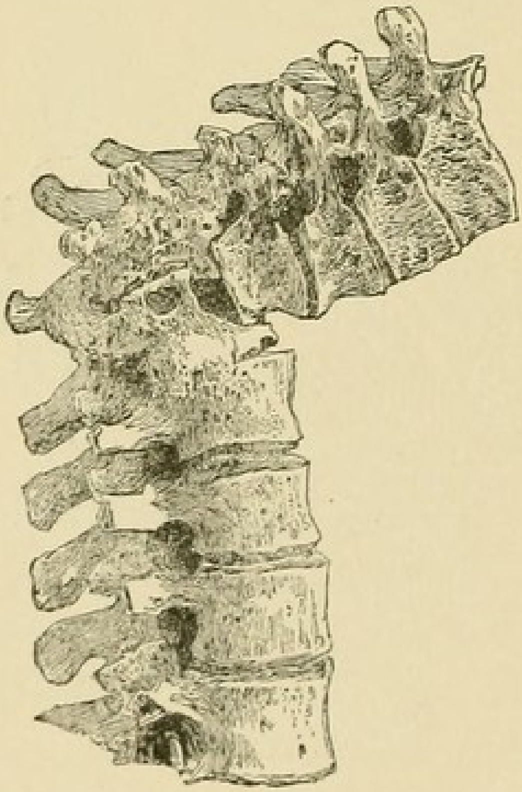


Characteristic "hunchback" deformity.

Again, this degenerative process assumes different degrees of intensity, being in some cases superficial, involving only a portion of the anterior surfaces of the vertebræ, while in other cases it not only excavates the body of the vertebræ, but also attacks the intervertebral fibro-cartilages and the adjacent soft parts, giving rise to abscess. (Fig. 32.) Not infrequently the abscess is confined within the bone, the exudation becoming purulent, the granulation-tissue breaking down, the pus and débris collecting into an abscess-cavity, and the walls of the abscess being composed of the inflamed disintegrating bone and lined by caseous pus.

It oftener happens that in rarefying osteitis the bone is absorbed in such a manner that an island of

Fig. 33.



Marked angular curvature, resulting in compression, myelitis, and paraplegia.

osseous substance is separated from the rest by a belt of granulation-tissue and dies, giving rise to the *caries necrotica*, but if it retains its vascular connection it forms a living sequestrum. While the bodies of the vertebræ are being absorbed, osteoplastic or protective osteitis takes place about the neural arches, being a conservative action, preventing by sudden dislocation a crushing of the spinal cord. (Fig. 33.)

A class of cases were first described by Brodie in which no suppuration took place, and these have at a more recent period been designated as dry caries, or *caries sicca.* They are identical with the so-called "osteitis fungosa" (Billroth), and are characterized by the presence of interstitial granulation-tissue growing throughout the bone. Here the granulation-tissue fills the Haversian canals and medullary spaces, and insidiously eats its way into the bony meshes. In this class of cases the granulation-tissue may undergo fatty degeneration and caseation without suppuration.

It will be readily seen that the foregoing condition differs widely from the simple rarefying osteitis, or caries, the result of injury, there being in the latter no underlying vice of the system. In this class of cases we have first a simple dilatation of the bloodvessels, followed by a pouring out of liquor sanguinis and leucocytes. In many cases the process stops at this point, and, the inflammation subsiding, resolution takes place, the parts returning to their normal contour. This limited caries undoubtedly explains the rapid recovery of many cases of so-called spondylitis following traumatism, and may also happen when Pott's disease follows one of the exanthemata, the patient being of sound constitution at the time.

SYMPTOMATOLOGY.

Before attempting to enter into a complete description of the symptoms as met with in the different regions of the spine in a case of Pott's disease, some general consideration of the different stages is of importance, and of these we will begin with the stage of invasion.

In the vast majority of cases the general health of the patient has been for a greater or less time below the normal standard. Even without any tubercular or strumous history or appearance that is marked, there is a condition present best expressed by the comprehensive term *malaise.* A child shows indifference to its surroundings, its usual occupations or enjoyments, and presents a listless, dejected appearance. It is easily tired and irritable, and appears sick. The appetite, previously good, becomes affected; the child loses flesh, and the skin assumes an appearance very different from the clear look of perfect health. The muscular tissues often become flabby, and the total appearance of the patient indicates that it is affected by some insidious potent malady.

Here we have the condition met with in many bone-diseases, especially where the epiphyses are principally affected, the so-called "incipient stage," or, as it has been otherwise designated, the "pre-tubercular" or "vulnerable" condition. This stage often escapes detection, the symptoms rarely being connected with the disease, and their importance being frequently overlooked. These symptoms indicate the existence of a period, and their correct interpretation at this time is of the utmost importance as regards the ultimate result of the case, this being the most favorable time to avert an increase of inflammation and prevent deformity.

STAGE OF PAIN. Succeeding the rather general disturbance just described, we come to a period the most important symptom of which is pain. The pain of Pott's disease varies greatly in character and extent, and its location is always dependent on the site of the inflammation.

It will be well in this connection to say a few words regarding the commonly-accepted idea that the pain of caries of the spine is always to be found posteriorly localized at the seat of the disease as manifested by the deformity. Much importance in making an examination of the spine has been attached to the recognition of this *local* pain, by means of hot sponges and other substances passed along the spinal column. Nothing could be more fallacious, experience showing that the pain of Pott's disease is referred to the posterior portion of the spine only in very rare instances.

The pain of Pott's disease is, as a rule, subacute, varying greatly in character and in degree, in many cases being intermittent, at other times being described as lancinating and intense. There is a marked relation between the rapidity and extent of the inflammation and the amount of pain. Its location may be tersely stated as following the general law that pain which is the result of nerve-irritation is reflected to its periphery. Thus, it is often found below the seat of the disease and anteriorly (*gastralgia*), but rarely above it, the exception occurring in some cases of cervical caries. As a rule, the pain is worse in the earlier stages and at night, and is aggravated by motion and position. Cases have been recorded, however, where pain has been entirely absent through the whole course of the disease.

STAGE OF MUSCULAR RIGIDITY. We next meet with a condition of the muscles which is of importance in both diagnosis and prognosis. This is a state of spasm or rigidity, and is supposed to be due to reflex irritation of the nerves supplying the diseased bone. Its presence is regarded as pathognomonic of osteitis. Here, as in all the large articulations, where the condition of the muscles is constantly found associated with joint disease, its function would seem to be an attempt to mobilize the part, and is nature's effort to bring about this end. It is an early sign, sometimes appearing even before pain is complained of, and continues to a very late stage of the disease. This constitutes at times the only available symptom, and is at all times of the greatest practical importance in diagnosis when properly interpreted. It is not to be confounded with the bony rigidity found at a late period of the malady, the result of partial or complete anchylosis. This reflex muscular spasm is unique in character, and its study in connection with chronic bone disease shows peculiarities not found in other conditions. It is an unyielding tetanoid spasm, present day and night, being, so to speak, forever on guard to prevent any injury to the diseased part. It yields only to complete anæsthesia, ordinary doses of opium or chloral not affecting it. Accompanying this spastic condition of the muscles, the result of nerve irritation, we also have a specific atrophy, reflex in character, and noticeable at times in Pott's disease where the muscles are well developed, especially in the erector spinæ group, and progressing in direct ratio as the disease advances. This symptom is not always so easy to determine in Pott's disease as in other articulations, located more specifically, but is undoubtedly always present.

STAGE OF DEFORMITY. Although, rationally considered, the deformity of spondylitis takes place at a later period than the stages already mentioned, it is by no means unusual, especially in public practice, for it to be the first symptom of sufficient importance to attract the attention of the parents or friends to the patient, or deemed worthy of the care of the surgeon. This projection backward of one or more spinous processes is identical with that period already mentioned when speaking of pathology, where there is a breaking down of the vertebral bodies forming the anterior support of the spine. The superincumbent weight falling on the weakened support increases the projection, causes abnormal pressure on the carious and weakened vertebræ in their changed direction, and alters the normal curves of the spinal column. Where the carious process is rapid and extensive, the amount of deformity will be proportionately large, and sharp or gradual, according to the amount of disease present. Where the long gradual curve is present, it shows a large area of inflammation, but not necessarily a rapid one. On the contrary, where only one or two vertebræ are involved in the carious process, the deformity is sharper and well defined. In the cervical and lumbar regions determination of the amount of disease by the appearance of the deformity is entirely unreliable, the deformity in these situations, owing to the anatomical position and construction of the vertebræ, rarely attaining the proportions found especially in the mid-dorsal spine. By some authors it is held that the shape of the curvature establishes the suppurative or non-suppurative character of the lesion. Thus, it has been maintained that *caries sicca* frequently involves a number of the vertebræ primarily, the resulting projection partaking more of the character of a true curvature, while but few vertebræ or only a single one are involved in the acute suppurative variety, giving rise to the sharp, angular deformity.

STAGE OF ABSCESS. Among the most common of the consequences of caries of the spine is the formation of abscesses, which during their formation and course give rise to important symptoms. While these, as a rule, are more frequently met with in the later periods of the disease, the patient is at no time exempt from them, and they may occur at the earliest time, even before deformity is visible. Again, some cases run their entire course without the appearance of an abscess, while in other cases abscesses have been detected, which have disappeared without opening or giving rise to any marked disturbance. These collections of pus, coming from the carious foci, follow the general rule of the least resistance, and in their passage important parts and organs are protected by the fasciæ. It may be stated that they open at some distance from the point of origin and according to the site of the lesion. The most common situation for the formation of these abscesses may be broadly stated to be found in connection with caries of the dorso-lumbar region. The dorsal abscesses find their way beneath the ligamentum arcuatum into the sheath of the psoas muscle, and are guided by the attachment of the sheath of this muscle under Poupart's ligament and into Scarpa's triangle, where they most commonly open and discharge their contents. Caries of the lower lumbar spine gives rise to the so-called lumbar or gluteal abscess. This has its normal outlet through the great sacro-sciatic notch, and most often points at the lower border of the gluteus maximus. Sometimes these lumbar abscesses appear posteriorly, having perforated the quadriceps lumborum, and make their appearance at or about the seat of the disease. In caries of the upper or cervico-dorsal vertebræ abscesses pass in front of or behind the sterno-mastoid, or into the posterior wall of the pharynx, where they are known as retro-pharyngeal abscesses. Again, they may be found in the thorax, forming a mediastinal abscess, and discharge into the trachea, bronchi, or œsophagus, or at some external point.

While we have, for the convenience of the reader, given the usual course pursued by these spinal abscesses, it is not to be understood that they all follow these methodical directions. Indeed, their course is subject to the greatest vagaries. Thus, we have records of cases where the abscesses opened at various abnormal positions—in the mouth, lungs, bronchi, stomach, intestines, bladder, and rectum, or in external parts remote from the site of formation. A remarkable circumstance in connection with the course of abscesses connected with spinal caries is the very rare occurrence of a fatal termination directly traceable to them. We have, however, already spoken of the protection afforded to important adjacent parts and organs by the fasciæ along which the abscess passes.

As a rule, not much disturbance of a general nature is experienced during the development and course of an abscess. The patient may have an exacerbation of evening temperature, with slight chilliness and perspiration. Pain is slightly increased, the latter ceasing, however, as the pus reaches an external situation, or where inflammation does not occur in the sac itself. The abscess may, however, occasion much local disturbance, according to its location and size. In retro-pharyngeal abscess dysphagia and suffocative attacks may be experienced, and when it opens into the bronchi there is an expectoration of pus, attended by extreme dyspnœa and collapse. All the reported cases of rupture into the peritoneum and large bloodvessels have terminated fatally. Abscesses may remain stationary for a long time, and, especially in children, give rise to very little disturbance of function or of the general health. Occasionally they are, under careful mechanical treatment, absorbed; but, as a rule, they steadily increase in size and finally rupture.

Stage of Paraplegia. It so often happens in disease of the lower cervical and upper dorsal region that we meet with paraplegia of the lower extremities that, while it cannot perhaps be considered as strictly a distinct stage of Pott's disease, it is still of sufficient importance to demand separate description. This paraplegia, which generally involves only the motor functions of the cord, has been usually believed to be the result of a compression-myelitis, and, while pathologically partaking rather of the characteristics of a pachymeningitis or meningo-myelitis, gives rise to such symptoms as would ordinarily result from a myelitis due to pressure, either from inflammatory products or abscess. Its onset is marked by a gradual diminution in the strength of the parts affected, until eventually there is complete loss of power, but usually little disturbance of sensation. All the reflexes are increased, as indeed they are very early, and at times it is possible to prognosticate the approach of the paraplegic condition by this exaggeration of the patellar tendon and other reflexes. Muscles which are the seat of paraplegia become rigid and tense, and at times marked clonus is easily produced, while at a later period, where the paraplegia has existed for a long time, permanent contracture may result. The paraplegia of Pott's disease is a bilateral affection, and, as before stated, usually involves the lower extremities. In rare cases of dorsal caries, more frequently of upper cervical, the upper extremities may be involved. The functions of the rectum and bladder are rarely disturbed, and there is little interference with the general nutrition of the patient, atrophy taking place only in the paraplegic parts. Indeed, it not infrequently happens that many of these patients gain flesh, probably from their forced confinement in one position. Recovery is often spontaneous, and seems to be the natural tendency of this form of paraplegia. Recurring attacks are not of unusual frequency, a case having been under my personal observation where two attacks took place with recovery, and other writers report similar results. Cases have also been reported where recovery took place with marked sensory disturbance, as in a case under the author's care, where both sensation and motion were lost. As a rule, the involvement of the sensory function would render the prognosis less favorable than where there was simple motor paraplegia.

DIAGNOSIS.

It may be stated as a general axiom that diagnosis is of value proportionately as it enables us to give early and prompt treatment to the patient, and in no disease is this more pertinent than in the one under consideration. No difficulty in diagnosis is experienced where, as is, unfortunately, too often the case, patients present a kyphosis and abscess well marked, or a paraplegia in full progress. Here, however, the opportunity for relief, certainly so far as deformity is concerned, is reduced to the minimum. Where we are brought into contact with a case in which we do not find this tell-tale deformity or other marked symptoms—in other words, an incipient case—the question of diagnosis becomes a more difficult one, and will necessitate a most careful inquiry into the symptoms, both subjective and objective, before we are enabled to arrive at a proper conclusion.

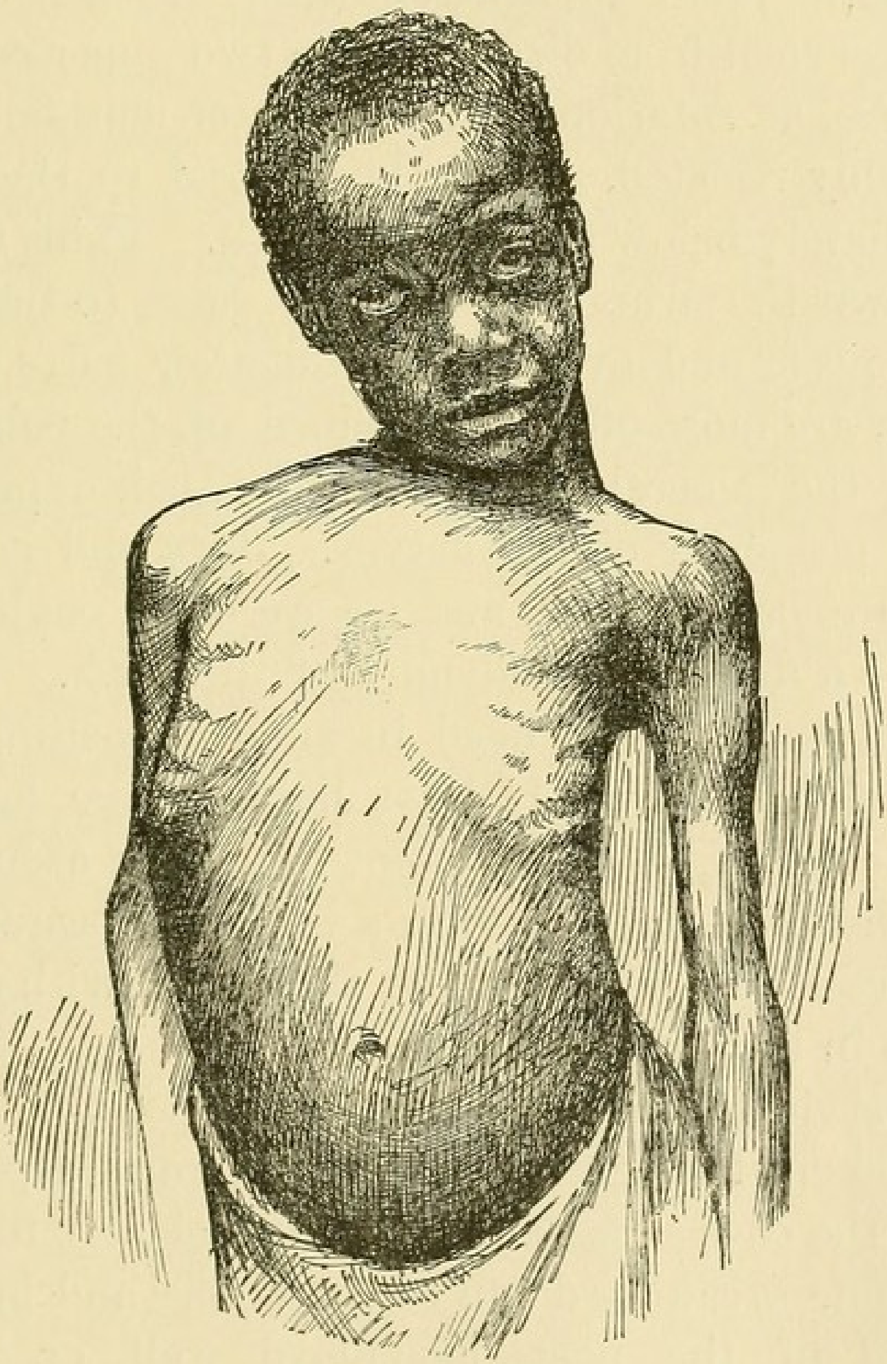
Examination of a patient presenting with symptoms which would indicate the existence of spinal caries should be conducted in the following manner: A history should be taken, according to a uniform plan, and with especial reference to certain points. The general condition, hereditary tendencies to diseases, apparent cause, and mode of invasion should first occupy our attention. Secondly, the subjective symptoms—pain, etc.—should be considered. Thirdly, the attitude and aspect will often give valuable held in diagnosis.

Most important is the physical examination of the patient, and this should be conducted as follows: The patient, after being stripped, is placed in a good light, and the surgeon, standing at his back, observes any inequalities of the spinous processes, or any deviation from the normal contour of the spinal column. In this way any marked irregularity will be at once manifest. Spinal flexibility should next receive attention. In order to have a correct perception of the spinal rigidity due to reflex muscular spasm, it is necessary that a knowledge of the normal mobility of the spine should be obtained, and this is tested best by the "Adams method," as follows: The patient, standing erect, with arms at the side, should be directed to touch the toes with the points of the fingers, the head being thrown forward on the chest. If the spine be normal, no difficulty will be experienced in performing this simple manœuvre; should there be any rigidity, the movement will be checked at a certain point. The same test practically may be applied to young children unable to stand, by placing them prone on a hard couch, the surgeon grasping the heels and elevating the whole lower segment of the body. If the spine be normal, it will be surprising, to those who have never used this test, to see what an amount of mobility can be obtained in this manner. As the thighs ascend, the spine bends, in some cases enough to allow the heels to approach the occiput. This motion would be checked at some point of the normal arc were disease present, and the spine assume such rigidity that the back would rise as a whole. Lateral mobility, which in the normal spine is considerable in extent, and of great value in diagnosis, is affected in a similar manner by the presence of disease. *Taken as a whole, spinal rigidity is the most constant and valuable symptom we possess for diagnosis*, and, in conjunction with pain and attitude, often enables us to diagnosticate serious spinal caries long before the appearance of deformity.

With these few preliminary remarks, we will proceed to the study of regional diagnosis in Pott's disease.

Cervical Caries. The different regions of the spine affected with caries are characterized by widely-differing symptoms, depending upon the mobility, nervous supply, and construction of the vertebræ forming the different segments. In the cervical region we most often have disease at the third, fourth, and fifth vertebræ, and the muscular

FIG. 34.



Cervical caries.

expression of disease at this point is quite charac teristic. The patients hold the head rigidly in a position either of flexion or extension, greater or less according to the amount of the disease. (Fig. 34.) On attempting to move the head, the surgeon is resisted by marked reflex spasm in the direction either of flexion or extension, yet mobility in rotation will be found free. Herein lies a valuable diagnostic point in differentiating disease of the lower cervical from disease of the two upper cervical vertebræ, as rotation is in the latter markedly and invariably resisted. Pain is referred to the parts immediately below the diseased area. Pains radiating down the arms and in some cases to the sides of the neck, and even to the superior parts of the thorax, are most often complained of, the pains following the general rule and finding their expression at the periphery of the nerves. Jars and concussions are badly borne, and we are often enabled to observe a marked broadening of the neck. In the attempt to hold the head in such a position that concussion from jar is least liable to be felt, the spinal column below the point of disease assumes a compensatory curve, giving a hollow appearance to the dorsal part between the shoulders, with a projection in the lumbar region.

In cervical disease it is sometimes possible to feel the thickened vertebræ through the mouth, especially where the caries has advanced sufficiently to occasion some breaking down of the bodies and bulging forward of the post-pharyngeal wall, or, again, where an abscess points in this region. Paraplegia may be associated with disease of this part.

Less frequently than disease of the third, fourth, and fifth, we meet with disease of the first and second cervical vertebræ, or atlo-axoid disease. Here rigidity is quite expressive, and of itself furnishes a diagnosis. In disease between the atlas and axis all rotary movements are checked, and, while it is very rare that we have uncomplicated disease of these two vertebræ, a sufficient number of cases occur to make this limitation of motion strongly characteristic. It is in this region, although not exclusively, that we meet with the torticollis dependent on spinal caries, and this is sometimes difficult to distinguish from wry-neck due to causes independent of bone disease, but is always a valuable aid to diagnosis. The characteristic of this symptomatic torticollis is that in spinal caries the head is rotated toward the contracted muscles, whereas in the idiopathic form of wry-neck torsion takes place away from it. Again, there is a spasmodic feeling imparted to the muscles on movement, and the posterior group are more commonly involved than the sterno-mastoid in the contraction due to reflex spasm. Ether abolishes the contraction completely. With atlo-axoid disease pain is found early in the upper part of the neck and in the occipital region, or, again, is complained of in the ears, the sides of the neck, or the upper part of the chest, and is neuralgic in character. This pain is increased by pressure on the head or by any movements affecting the upper part of the spinal column. Hilton speaks of pain in atlo-axoid disease as being always unilateral, and seems to think that this indicates the side of the vertebræ affected. Swelling and broadening of the neck also occur; marked protrusion of the pharyngeal wall can sometimes be felt with the finger in the mouth, the patient being subject to attacks of dysphagia. Deformity appears at a variable period, the patient having adopted a peculiar attitude. The head may be flexed or extended markedly, with rotation, but usually it is projected forward, and supported in every possible position by the patient, recumbency being the favorite posture. It has been supposed that deformity in this region depends upon a forward luxation of the atlas upon the vertebræ beneath, and the spinous process of the axis can often be felt or seen.

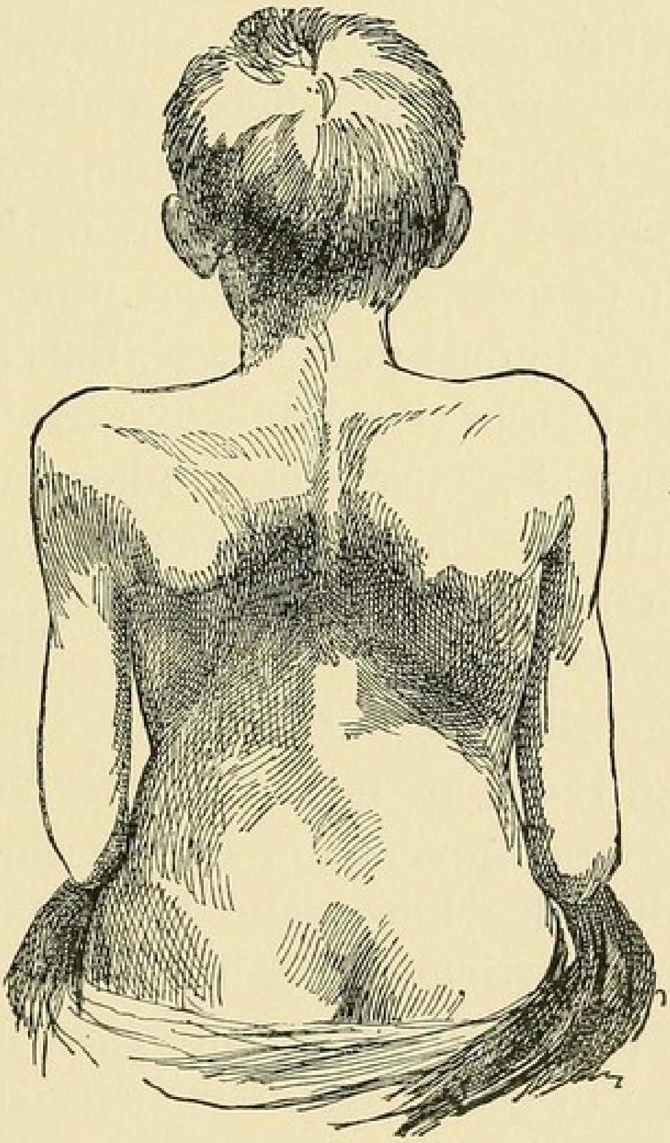
Abscesses are common in this region, and present frequently as "post-pharyngeal" collections of pus, giving rise to serious symptoms, which have received detailed description in works on surgery. Abscesses may appear also at the sides of the neck posteriorly, and follow the course of other deep-seated cervical abscesses. Nerve symptoms are very often associated with atlo-axoid disease, varying greatly in extent, from paralysis of one arm to a more general paralysis of the parts below the neck. This is usually of the motor type, but at times anæsthesia is noticed with loss of vesical and rectal control. Cerebral symptoms meningeal in character often occur, or sudden death may take place from crushing of the spinal cord.

Differential Diagnosis (Cervical Region). We have already spoken of torticollis as being at times a symptom of caries of the cervical region easily mistaken for idiopathic wry-neck, and have given a rule for its differentiation. Among other diseases liable to be mistaken for this serious malady are lateral curvature involving the upper part of the spine, muscular rheumatism, simple abscess, adenitis, acute traumatic lesions, and hysterical simulation of Pott's disease. Lateral curvature is rare in this region, and is usually accompanied by rotation and marked by absence of pain and reflex spasm. It should be borne in mind, however, that a lateral deviation of the spine may take place early in Pott's disease, and in any region, but this disappears, as a rule, rapidly with the advent of bony deformity and other pronounced symptoms, and is entirely modified by treatment. Muscular rheumatism is marked by tenderness of the muscles themselves and by the entire absence of bone deformity, and is more apt to take place at a later period of life. The movements of the neck, while stiff and painful, give no characteristic spastic sensation, and the transitory and shifting character of the affection should leave no doubt as to its nature. Simple abscesses are usually acute in character, attended by high temperature, and their history and superficial character leave little room for doubt. Acute traumatic lesions —dislocation and fracture—are diagnosticated by the history, the sudden deformity, and the usual signs of such injuries as met with in other parts of the body.

Hysterical simulation is at times exceedingly difficult to diagnosticate from true spondylitis, and may be encountered in all parts of the spinal column. In the simulated condition pain is the most prominent symptom, and is always complained of at the supposed seat of the disease, differing from that of true caries, which is generally reflected to the anterior part of the body. It has all the characteristics of an intense hyperæsthesia, and light pressure apparently gives rise to great suffering, such as is found in the so-called "spinal irritation." When attention is diverted, the pain on pressure either disappears or a new locality is complained of. There is no reflex spasm, voluntary efforts being made to keep the spine quiet, *and persistent gentle force* usually overcomes the resistance to motion. Care must be taken in estimating the amount of motion present, our diagnosis depending largely on the muscular expression accompanying the disease. Whatever bulging of the vertebræ occurs is immediately reduced by placing the patient in the prone position. Paralysis of hysterical origin is very common, and at times is difficult to distinguish from the paraplegia of Pott's disease. It is, as a rule, sudden, differing from the gradual loss of power found in the course of spondylitis, is more often unilateral or confined to one extremity, and frequently disappears as suddenly as it came.

Dorsal Caries. The attitude of a patient suffering with caries of the upper dorsal region suggests the attempt of one endeavoring to balance the head on the shoulders. (Fig. 35.) The chin is elevated, the spinal column below the seat of disease is straightened, and at times curved forward and held rigidly, and the gait and carriage of the patient are those of extreme apprehension. When the bony deformity is large, the head sinks between the elevated shoulders, giving a characteristic "turtle-head" appearance. Pain in disease of this region is referred to the chest and sides, and often there is disturbance of the respiratory function, as manifested by a peculiar "grunting," at times accom-

FIG. 35.



Dorsal caries.

panied by cough, dyspnœa, and partial cyanosis. Interference of motion at this portion is detected with some difficulty, owing to the fact that normally here is the most rigid and unyielding portion of the spinal column. This, however, is sufficiently well marked and appreciated, especially when the other symptoms present are taken into consideration. Paraplegia is most often found in connection with disease of the upper dorsal spine, and affects chiefly the lower extremities. Reference to this has already been made under the head of Symptomatology.

Mid-dorsal disease gives rise to the typical "hunchback," the most persistent deformity taking place in this region. The progressive character of the lesion is due to several reasons. It is in this locality, especially the superior dorsal, that we contend with the constant traumatism of respiration, and, having a fixed projection in the middle of a flexible column, the application of proper supports becomes a matter of great difficulty. The attitude assumed by patients with disease in this region is an exaggeration of the one described under disease of the upper dorsal spine. A marked rigidity in stooping or lifting articles from the floor is noticed. The patient in performing these movements lowers the body as a whole, bending his knees and hips, and gradually approaches the article he wishes to raise, resuming the upright position with infinite care, never allowing the spine to bend. Pain is marked, especially on motion, and is referred most frequently to the lower part of the thorax and stomach, giving the "initial gastralgia" so often complained of, and at times coming on very early in the course of the disease, antedating even the appearance of the deformity. It is of great importance to realize distinctly the connection of this pain with spinal caries, as many children are treated during long periods for many different diseases—indigestion, worms, and other disorders of the digestive tract being not infrequently assumed as the cause of the pain. The pain is frequently accompanied by the so-called "osteitic cry," and occurs most often at night, this cry being in character very much like that of acute hydrocephalus, and found in connection with disease of the bone in any part of the spine or of the articulations.

Disease of the lower dorsal spine is so intimately associated with lumbar caries that it will be best considered in the description of that region.

Differential Diagnosis (Dorsal Region). Before the appearance of deformity causing abnormal curves to appear in the spine, aneurism of the thoracic and abdominal aorta, eroding the vetebral bodies, as evinced in two autopsies the author had opportunities of making, may give rise to symptoms similar to those of spinal caries. Diagnosis by auscultation and the presence of other symptoms usually establish the nature of this lesion before the spine is much affected, and the extensive curve and localized pain are sufficient to demonstrate the existence of aneurism.

Malignant growths, cancer, etc., are rarely seen in children.

Chronic pleurisy, with effusion or empyema, and other inflammatory lung troubles, would be excluded by physical signs.

Rhachitic curves are very common in the dorsal region (Fig. 36), but are marked by their gradual character and extent, and are attended by the characteristic large head, flattened epiphyses, general tenderness, and inability to walk. Motion is rarely limited, the curvature mostly disappearing in the

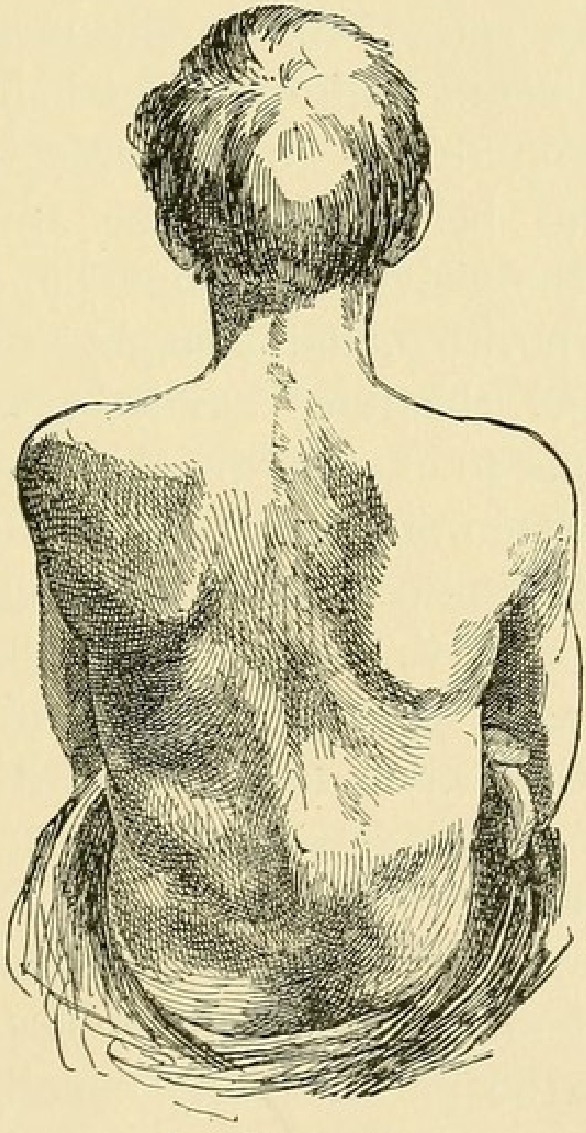
FIG. 36.

Functional spinal debility simulating caries.

prone position. Pain, when present, is local in character, and the general listless appearance of the patient serves to explain the functional curve.

DISEASE OF THE LUMBAR REGION. Disease of the lower segment of the vertebral column, which will here include the lower dorsal and lumbar vertebræ, presents some especially important features from the stand-point of diagnosis. It is here that we have to deal with a portion of the spine largely controlled by the psoas muscles, and the reflex limitation of motion at this point gives us most valuable indications concerning not only the condition of the vertebræ, but also the presence and progress of

FIG. 37.



Lumbar caries.

abscess, which is more often encountered here than in disease of any other part of the spine. Here, again, a special attitude is assumed by the patient, in most cases consisting of a "lordosis," or an anterior curvature of the spine. This is nature's mode of protecting the diseased parts, there being a conservative attempt made to throw the weight of the body from the diseased vertebral bodies on to the articulating facets. The reflex muscular spasm is best appreciated here by placing the patient in the prone position and making the movement already described in the general remarks on diagnosis. (See Fig. 37.) As stated, the condition of the psoas muscle furnishes us with excellent indications as to the presence or absence of abscess in its sheath. If, the patient being prone, the surgeon makes pressure on the pelvis with one hand, holding it firmly in one position, and, grasping the thigh with the other hand, the knee having previously been flexed, attempts to extend the thigh on the pelvis, should contraction of the psoas exist he will be met by a decided limitation in the extension of the thigh. The application of this test, one of the utmost importance, is easily learned, and, in conjunction with palpation of the pelvic fossæ and with the general symptoms of pain, temperature, etc., will usually show the presence or absence of an abscess. This limited extension is generally found unilaterally, but may be bilateral, and on the emergence of the abscess from the pelvic cavity usually disappears. Pain from caries of the dorso-lumbar spine is referred to the hypogastric region and the lower extremities.

Paraplegia with this form of spondylitis is among the rarest of complications, for well-known anatomical reasons. Deformity, as in the cervical region, rarely reaches the degree met with in the mid-dorsal spine, and in many cases where the disease is confined exclusively to the lumbar vertebræ little or no deformity is noticeable.

DIFFERENTIAL DIAGNOSIS (LUMBAR REGION). Many diseases may occur at or about this part of the vertebral column with spinal caries, and the knowledge and experience of the surgeon will often be severely tested in differentiating between them. Disease of the last lumbar vertebra is often mistaken for hip-joint disease, the converse being also true.

Sacro-iliac disease, perityphlitis and nephritis, sciatica, lumbago, and other diseases may also obscure the diagnosis; but space forbids a detailed account of the symptoms and methods used for differential diagnosis, the reader being referred to the articles on these subjects in other portions of this work.

GENERAL PROGNOSIS.

In general terms it may be stated that the prognosis of Pott's disease depends largely on that portion of the spinal column affected by the caries. Thus, the best results of treatment are usually obtained in the cervical and lumbar regions, at times lasting many years, although so-called acute cases have been reported. Much of the success achieved in later times in the treatment of spondylitis may be ascribed to a more correct interpretation of the symptoms, to a better knowledge of the etiology and of the mechanics of the parts, and, above all to a better adaptation of the various supports used in the treatment of the diseased areas. Prognosis will always be affected by the amount of personal attention given by the surgeon, by the home care of the patient, and by the detail with which the mechanical treatment is carried out. During the progress of a case the symptoms may be held in abeyance for a long time, and the inexperienced surgeon, judging from the cessation of pain, the apparent arrest of deformity, and the non-appearance of abscess, may remove the apparatus, thinking his patient cured. Very soon, however, he is undeceived; the symptoms become more acute in character and assume an alarming aspect, the patient having one of the exacerbations known to every one familiar with these cases. The earlier the diagnosis is made and the child placed under mechanical treatment and good hygienic conditions, the better the prognosis. Notwithstanding the fact that the strumous or tubercular diathesis usually underlies the lesion, many patients recover, with more or less deformity, and sometimes live to advanced age. The deformity when once present rarely disappears, although it may be diminished at times by treatment.

Abscess was formerly regarded as a symptom of the utmost gravity as affecting prognosis, but many patients recover, with strong, though sharply-deformed backs, who have had one or more abscesses. It is an undoubted fact that many abscesses form and entirely disappear, protective treatment modifying their course to a very large extent. Abscesses which suppurate and discharge by fistulous openings for a long time are necessarily of grave import in making a prognosis, owing to the ultimate involvement of internal organs, amyloid degenerations oftentimes causing death from kidney and liver complications.

Paraplegia, while a distressing complication and alarming alike to the parents and the attendants, is, as a rule, recovered from, often spontaneously, although usually it lasts for a long time. An exception to this is found in the paralysis attending upper cervical disease, where sudden death may take place from crushing of the cord or involvement of the respiratory centre, or, again, where motion and sensation are both involved, incurable paralysis often remains. We have discussed this complication at some length in a former section.

Death often occurs from rupture of an abscess internally, from intercurrent inflammations, such as pneumonia and tubercular meningitis, or from exhaustion following long-continued discharges. The acute exanthemata have a deleterious effect on the progress of caries, and pertussis is a particularly dangerous complication, especially in disease of the thoracic vertebræ, the affection of the spine advancing rapidly, the patient often dying in a paroxysm. Hemorrhage from perforation of large bloodvessels, and suffocation from discharge of abscesses into the lungs, have also been reported as complications with a fatal termination.

TREATMENT.

The modern treatment of Pott's disease has attained a measure of excellence attested in a high degree by the much less frequent sight of those distressing deformities which were at one time so common. Much of this is due to the improved means not only of treatment but also of early diagnosis, and to American surgery is largely due the advance in this formerly much neglected branch of medicine. In commencing the treatment of caries of the spine a consideration of the pathological state that we have to deal with is of the utmost importance. It must be remembered that there exists in this condition a retrograde rather than a reparative process, one which in its course is entirely different from the process that follows an acute traumatic lesion. Instead of its being a question of days or weeks, months and sometimes even years are necessary to effect a cure.

There being this long-continued drain on the system, it is obvious that the care of the general health should receive as much attention at our hands as the local condition, which in most instances is but the expression of a general constitutional state.

The principles of treatment to be constantly held in view should be those which aim at (1) improvement of the general health and (2) proper rest to the diseased parts, which embraces the question of correct mechanical support.

Before mentioning those remedies which have been found of service as general reconstructive agents, we would insist, in every case where it is possible, on the importance of fresh air and sunlight, the influence of which has been recognized and has largely aided in bringing about the good results of modern treatment. We have ventured to speak of these agents before mentioning the more generally used medicines, feeling, as we do, that if restricted to a choice, we should select these hygienic means as against internal medication. All such medicines as tend to "bone-building" are of value in this disease, and the selection of one—whether it be cod-liver oil, the compound syrup of the hypophosphites, phosphorus, or any of the tonics, mineral or vegetable—depends largely on the condition of the individual case and the judgment of the practitioner.

Under the second division all those means which have for their object proper rest of the diseased parts, and which include recumbency and splints or braces, will be considered. The question of rest encounters at present no dissent except from those whose experience and clinical opportunities hardly entitle them to speak with authority. On the mode of giving proper support there is still much difference of opinion.

The treatment by recumbency has had and still has its advocates; its chief merit consists in the fact that in the recumbent position, whether prone or supine, there is no superincumbent weight pressing upon the spine. Where other means are not at hand, it is well that the recumbent posture should be advised; but the utter failure of simple recumbency is easily explained by the difficulty of keeping a patient in bed, in one position, without other means. It is often necessary, even with good mechanical support, that a patient should be confined to bed, especially where exacerbations occur or a paraplegia is in progress. Thus recumbency becomes an aid rather than a mode of treatment, and in this way has a legitimate place in our therapeutics of Pott's disease. The effect of recumbency on the general health, especially in strumous cases, has been variously estimated. Many believe that, by lessening the pain and irritation, the general health has improved. Personally the results obtained by us with other means have been, as a rule, so favorable that we have not had occasion to test its merits from this stand-point.

Extension and suspension are modes of treatment which have been used for a long time, and which have recently been brought into prominence. The former has been used with advantage in cervical disease, but here again the treatment by this method necessitates the recumbent posture, and, unless under exceptional circumstances, we prefer the use of apparatus which allows fresh air and sunlight, while the patient receives proper support at the same time.

Suspension as a mode of treatment in caries of the spine is now generally used simply to allow of the application of plastic supports. As a remedial agent it is of no value independent of support. The idea formerly entertained, that by suspension pathological curves could be obliterated, no longer prevails, it having been demonstrated that, while the physiological curves may be altered or even obliterated, the gibbous curve does not change its character.

Suspension should always be practised with the greatest care, and always under the direction and in the presence of the surgeon or an assistant.

MECHANICAL TREATMENT. The plan pursued in the section on diagnosis—namely, the regional one—will be continued in the consideration of treatment. No attempt will be made to consider the numberless mechanical devices used in the treatment of Pott's disease, only those receiving attention which in the hands of the author have been found to be most easy of adjustment and modification, and which mechanically are capable of meeting the indications in the greatest number of cases. The principles underlying the question of all such apparatus as are used in the treatment of Pott's disease ought to be such as will enable us to secure certain objects. Chief among these are, first, the prevention of undue traumatism; second, the avoidance, as far as is practicable, of any movement of the diseased parts; and, last, the prevention, where possible, of increase of pain and deformity. In the present state of our knowledge, there is no apparatus that will satisfactorily accomplish all these indications, and we have already stated why this lesion presents difficulties in the way of treatment, from a pathological stand-point, entirely different from those which present themselves in the treatment of an acute traumatic trouble. Were the anatomical opportunities present, as they are in other articulations, for making proper traction on the diseased parts, there could be no doubt as to the superiority of this method; but the application of continuous traction to certain localities of the spine, the subject of carious inflammation, and the limitation of such traction force, are not, in our opinion, possible.

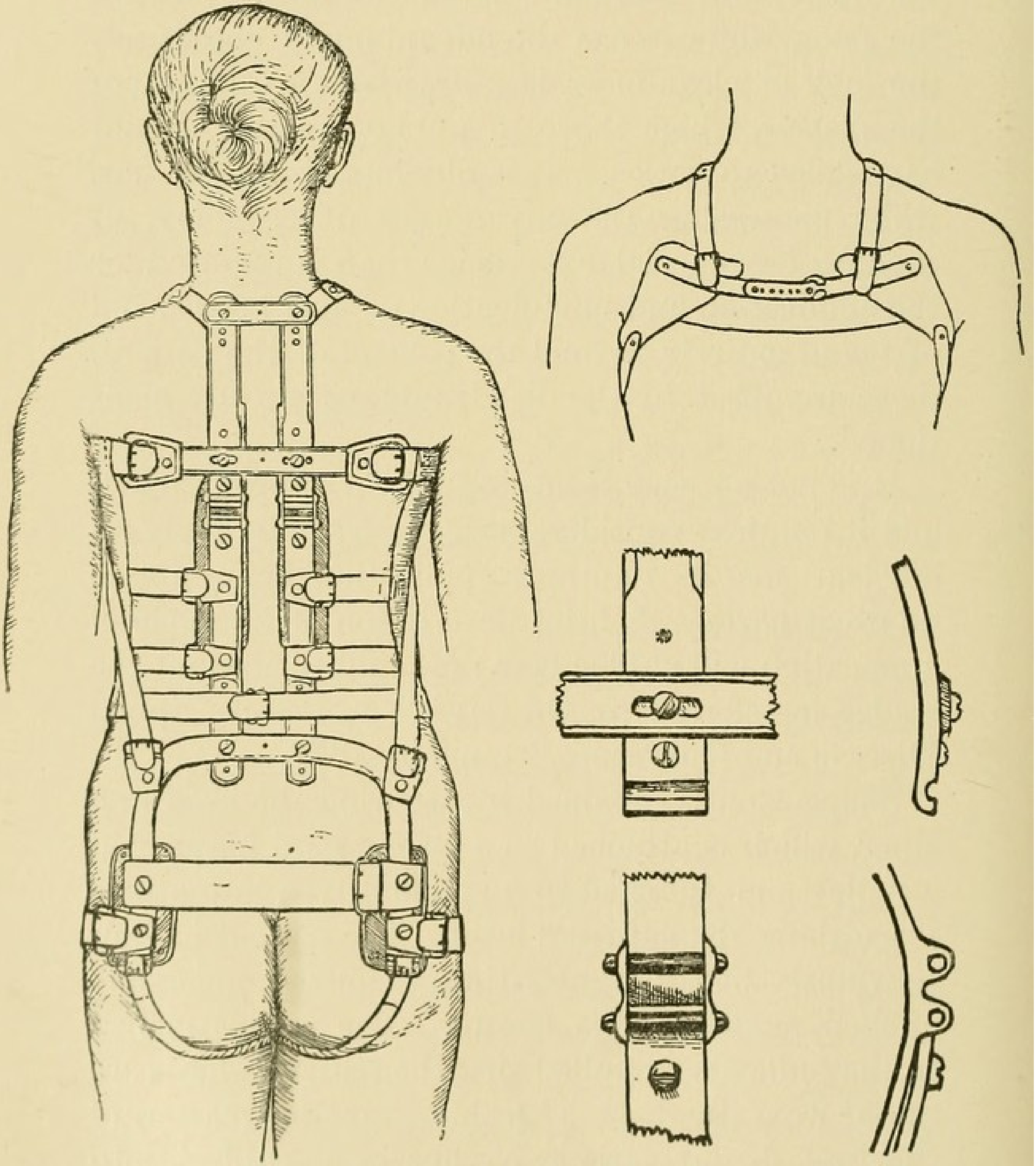
The treatment of Pott's disease by the plaster-of-Paris jacket, as popularized by Prof. Sayre, has of late years received so many adherents and been so universally accepted as an easy mode of treating this disease that a few words concerning it and similar plastic supports will not be out of place. It is an undeniable fact that any apparatus which gives protection from undue motion and traumatism to certain diseased areas will afford relief, and for giving us a ready means of treating such localities Prof. Sayre's method is of the greatest value. This is particularly true of the dorso-lumbar region, which is the most easily controlled of any portion of the spine.

There are, however, certain disadvantages connected with the use of any plastic material, which are of sufficient importance to receive attention. The encircling the body in any solid support prevents the surgeon from having the opportunity of carefully watching the progress of the disease, and of estimating the condition of the skin, so that it shall receive proper care. Ulcerations or abscesses may form without his knowledge, and no modification of the apparatus is possible without removal and renewal. The improvement which ensues on the application of any apparatus giving immobility is such that patients, as well as surgeons, are apt to be deceived by the amelioration of the symptoms, and hence escape the strict watch necessary in these cases. Thus the plastic envelope may be borne for months, the disease constantly advancing, and the patient returning only at rare intervals, owing to the absence of the acute manifestations. Among the poor, while it has the advantage of cheapness, the lack of cleanliness is a drawback to the use of the plaster, which those in public practice cannot have failed to notice. It is obvious, therefore, that, while possessing the advantages of economy, of needing less special experience than is required for the application and modification of steel braces, and of being entirely beyond the control of the patient, these are offset by the disadvantages already mentioned.

It is not an easy thing to apply a proper jacket, and it requires considerable experience to apply an efficient one, its improper application being apt to do great harm. A brief description of its mode of application will suffice here; for a fuller account the reader is referred to Dr. Sayre's work on "Spinal Disease and Curvature," London, 1877.

Suspension is obtained by securing the head in a sling, which is attached to a strong cord playing in a pulley and fastened to a staple driven into a firm place above the patient's head. The patient having previously had a tight-fitting, seamless undershirt applied, suspension is begun. The cord attached to the pulley is so pulled that the patient's heels are raised from the floor. Freshly-prepared plaster, of the best dental variety, having been rubbed into cross-barred crinoline or other loose-meshed cloth, and rolled into bandages, is then applied. These bandages should before application be placed in water until bubbles cease to appear. The parts

FIG. 38.



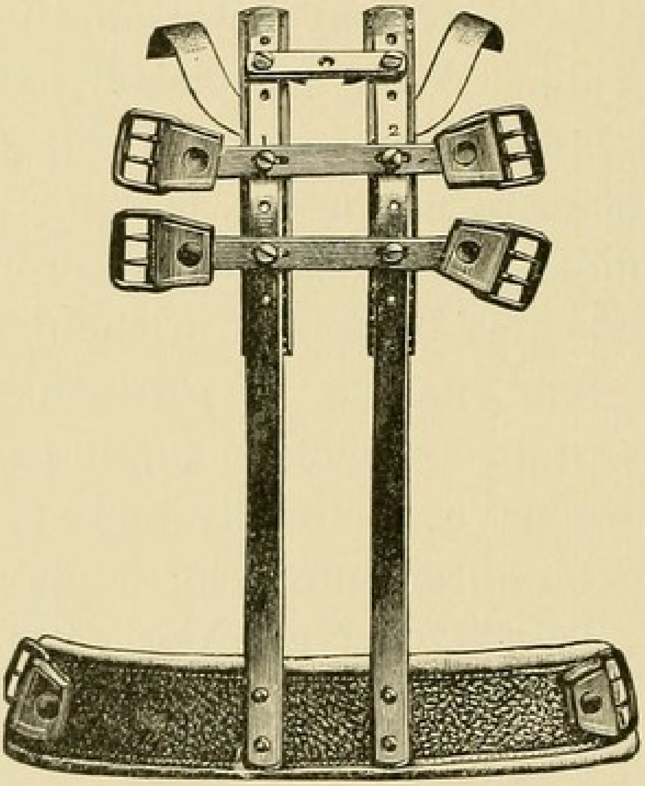
Taylor's modification of Davis's spinal assistant. (From Transactions of the American Orthopædic Association, vol. i., 1889.)

most liable to excoriation are carefully padded, and over the abdomen a "dinner-pad" is applied, which is afterward removed, in order to prevent too great pressure. In females the mammæ are also padded. The bandages should be put on smoothly, and as high as possible, and there should be no inequalities or differences in thickness between the front and the back portion. After the plaster has hardened, the patient is placed on a smooth soft surface, and all rough edges are cut away, making the support as comfortable as possible. Plastic supports of different materials may be applied without suspension.

Fixative Apparatus. Apparatus of different constructions, and representing many principles, are in use; but we have personally had such excellent results from the antero-posterior support as modified by C. F. Taylor, of New York, that in closing the account of treatment we shall speak of this alone. (Fig. 38.)

The antero-posterior splint acts upon the principle of a lever, with its fulcrum at the point of deformity. The apparatus is constructed as follows: Two uprights made of the best annealed steel, allowing of easy bending and modification of shape, are connected above by a transverse bar, giving attachment for the shoulder-pieces, and below by a pelvic band. (Fig. 39.) At the location of deformity, and where we wish them to serve as a fulcrum, are placed the pad-plates, which extend for some distance above and below the deformity, and should always be sufficiently long to include the entire area of disease. These are pieces of steel slightly wider than the uprights, and are fastened to the uprights by hinges allowing of easy removal and modification. In some cases they may be screwed to the upright without hinges. They are

Fig. 39.



Davis's spinal assistant.

padded with various materials, ground cork being the best. The uprights should be so widely separated that the pressure of the pad-plates will come on the transverse process, and never on the spinous ones. The uprights should extend high enough to give sufficient leverage, and below to the anal commissure, and the pelvic band should be broad and strong, extending from trochanter to trochanter. Cross-pieces for the insertion of buckles which are attached to the anterior support or apron are placed at points corresponding to the upper border of the axillæ and the lower angle of the scapulæ, and are attached to the uprights by screws. The anterior part of the support consists of an apron made of strong jean or other similar material, and this serves to fasten the trunk to the apparatus. It reaches from the upper border of the axillæ in front to a point just above the symphysis pubis. Webbing straps are attached at different points for attachment into the buckles of the cross-pieces and pelvic band, and to the shoulder-pieces are attached padded axillary straps.

The apparatus is applied as follows: The patient is placed in the recumbent posture on a hard even couch, with the apron applied to the anterior part of the trunk. The brace, previously fitted to the contour of the spine, is first secured by the pelvic band and by axillary straps which pass to the lower cross-piece. The upper strap of the apron is then attached to the upper cross-piece. These are the important and essential points of attachment, and should always be made firm. Supplementary webbing straps and buckles may be attached to the apron to give more firmness to the support.

Principles of the Antero-posterior Support. The antero-posterior support acts, as has already been stated, on the principle of a lever with a fulcrum at the location of the deformity (Fig. 40) and acting through the transverse processes. The pelvis is another point of pressure, forming the base of the support, and the resistance is furnished anteriorly by the superior thoracic wall and the traction of the shoulder straps passing under the axillæ. The power is maintained by the two uprights to support the spine in the same position as is gained by the recumbent posture.

FIG. 40.

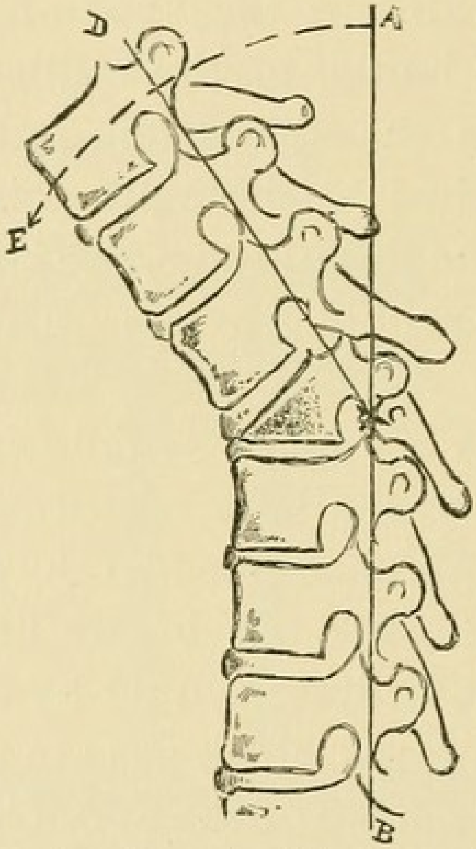


Diagram showing the principle of Davis's support.

There are certain rules concerning the application of the antero-posterior brace which should be carefully followed. It should always be put on in the recumbent posture. The pressure should be entirely equable over the transverse processes, as made by the pad-plates, and the shoulder-pieces should never press on the shoulders, it being well to leave a small space between the lower surface of the shoulder-pieces and the shoulders. The axillary pads should run in such a direction that no constriction will occur on the axillary vessels and nerves. The brace should be worn day and night, unless removed for some special reason or complication, and in no case should a patient with a carious spine be allowed to assume the upright position without support. Bathing should be done by sponging the body, the patient being recumbent.

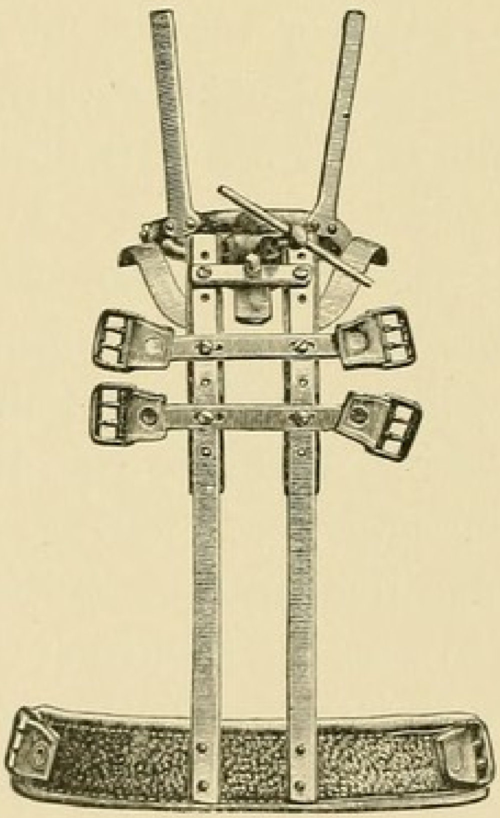
For ease of application, for convenience of modification and inspection, for comfort and cleanliness to the wearer, and for maintaining the proper pressure, we know of no apparatus which will compare with the antero-posterior brace. With a little care in adjusting the apparatus, it is within the province of every surgeon to secure with it the most satisfactory results.

Measurements for Apparatus. It is important that the surgeon should be fully equipped not only to measure for his apparatus, but also, when it is sent to him in crude form, to be able to fit it and modify it, so that nothing is left to the instrument-maker but its manufacture.

It is measured for as follows: The patient is placed on a hard surface in the prone position. A strip of flexible lead or block-tin, which retains its form, is laid over the spinous processes from the neck to the anal commissure, and all the inequalities are carefully moulded with the lead. This is then placed on a stencil-board or ordinary pasteboard, and the inner outline traced with great care. This outline is then cut out with scissors, and marks places on the pattern for the position of the pad-plates, cross-pieces, and shoulder-pieces. The pelvic measurement is taken from trochanter to trochanter. The pattern serves a double purpose, being the guide for the instrument-maker, and also a record of the deformity at the time of measurement, and should be kept for future observation.

TREATMENT OF CERVICAL CARIES. Under this head will be included the treatment of caries extending to the seventh dorsal vertebræ, as above this point we have, in order to get efficient support, to

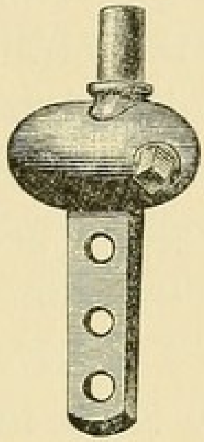
FIG. 41.



Spinal support, with chin-rest, for treatment of upper dorsal and cervical caries.

extend the arm of the lever superiorly. This is best done by means of Taylor's chin-piece, which is secured to the uprights by means of a "keeper and pivot." (Fig. 41.) A modification of this has been devised by Dr. Shaffer, in the form of a ball-and-socket joint (Fig. 42), which allows of motion in all directions, which can be locked at any point, and in which the head can be treated in the position of deformity, and so held and modified from time to time. It is important that the chin-piece (Fig. 43) surmounting the apparatus should not be too large, and its measurement represents only the occipito-mental diameter.

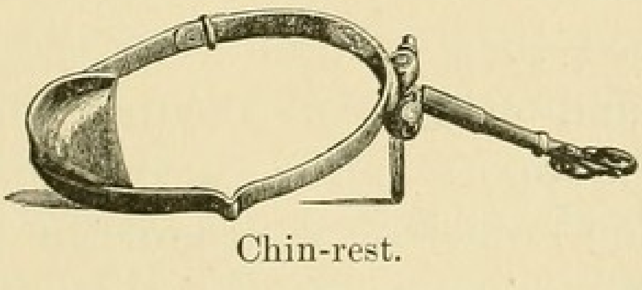
Fig. 42.



Ball-and-socket joint for accurate adaptation of chin-rest.

In this region, it must be remembered, we are dealing with a rigid projection in the middle of a flexible column. It is thus not easy to secure adequate support, especially in the upper dorsal region, and the addition of the superior lever by means of the chin-piece is of great importance.

Fig. 43.



Chin-rest.

In the cervical region above the second dorsal vertebræ, treatment, as a rule, is attended by excellent results. It is sometimes necessary still further to supplement our chin-piece by the addition of occipital uprights (Fig. 41), which increase the support. Traction-force is not attempted with the chin-piece, immobility being the object primarily in view. In some cases where the expense of a steel brace is of moment, disease in this region may be treated by means of a pedestal of plaster encircling the trunk, into which the chin-piece with ball-and-socket pivot can be adjusted. The advantages of the chin-piece in the treatment of disease of the upper portion of the spine are its lightness, firmness, and inconspicuous appearance as compared with the "jury mast" used in the treatment by plaster-of-Paris for the same affection.

TREATMENT OF DORSAL DISEASE. Disease of the dorsal vertebræ extending from the seventh to the twelfth is very common. The mechanical difficulties here, as well as in the lumbar region, are much more simple than those involved in the treatment of the upper part of the spine. We have here as a firm basis for our support the pelvis below, while the thorax and axillæ afford excellent locations for securing fixation. It is in dorsal disease that the best results are often obtained, traumatism being reduced to a minimum by the absence of respiratory and other movements, which conflict with proper support in the cervico-dorsal region. In this region sufficient leverage can be obtained by the use of the antero-posterior support without the use of a chin-piece. It is necessary, however, that the anterior support or apron should be firm, and it is often beneficial to reinforce this by the supplementary means of corsets, etc.

TREATMENT OF LUMBAR DISEASE. Here the difficulties of treatment are reduced to a minimum, for the same reasons as stated in speaking of lower dorsal caries. The results in this region are usually good, exception sometimes taking place in disease of the last lumbar vertebra. At times, owing to the form of the deformity, it is difficult to prevent the apparatus from pushing or slipping upward. This may be prevented by attaching perineal straps to the apron, which pass between and are fastened to buckles inserted in the pelvic band. It is especially in the lower region of the spine that any apparatus, whether of steel or plaster, providing proper fixation and support, gives real and at times instantaneous relief to the symptoms. Care must be taken here, as well as in the other localities afflicted with caries, not to remove the splint too early.

TREATMENT OF COMPLICATIONS. Abscess and paraplegia are the two most common complications of caries of the spine. Of the former, we would simply say that for the surgical procedures necessary for their relief the reader is referred to works on surgery. There is, however, one point to which we wish to call attention. Clinical experience has taught orthopedic surgeons that the course, progress, and treatment of cold abscesses connected with Pott's disease are materially affected by mechanical treatment. Where good support of the diseased parts is given we are sure that the development of abscesses is less common, their course is more benign, and in many instances they are entirely absorbed. Abscesses of this nature should not be opened too early, and, when opened, it is well to do so in a position suitable for thorough drainage, and under rigid antisepsis.

Paraplegia, as has been already stated, has, when caused by caries of the spine, a spontaneous disposition to recover. Its treatment is still somewhat a vexed question. Absolute rest in the recumbent posture, with efficient support, has seemed to us to have been of most benefit. The affection being spastic in its nature, the result usually of a direct irritation of the cord, electricity in any form would be strongly contraindicated. Suspension as a means of treating the paraplegia of Pott's disease has not, up to this date, been sufficiently tried or recorded to give any idea of its status as a treatment for this form of paralysis.

In conclusion, the question of cessation of treatment is of practical importance. With the disappearance of pain and the non-increase of deformity, as evidenced by repeated measurement and comparison of the patterns, with the disappearance of reflex spasm, allowing of free motion above and below the deformity, and lastly with the general improvement in the condition of the patient, it may be considered that solidification has taken place and that the carious process has been arrested. Relapses may occur, or disease may appear in other parts of the spine, and a careful watch should for a long period of time be kept on patients who have been the subjects of Pott's disease.

THE SPINAL ARTHROPATHIES.

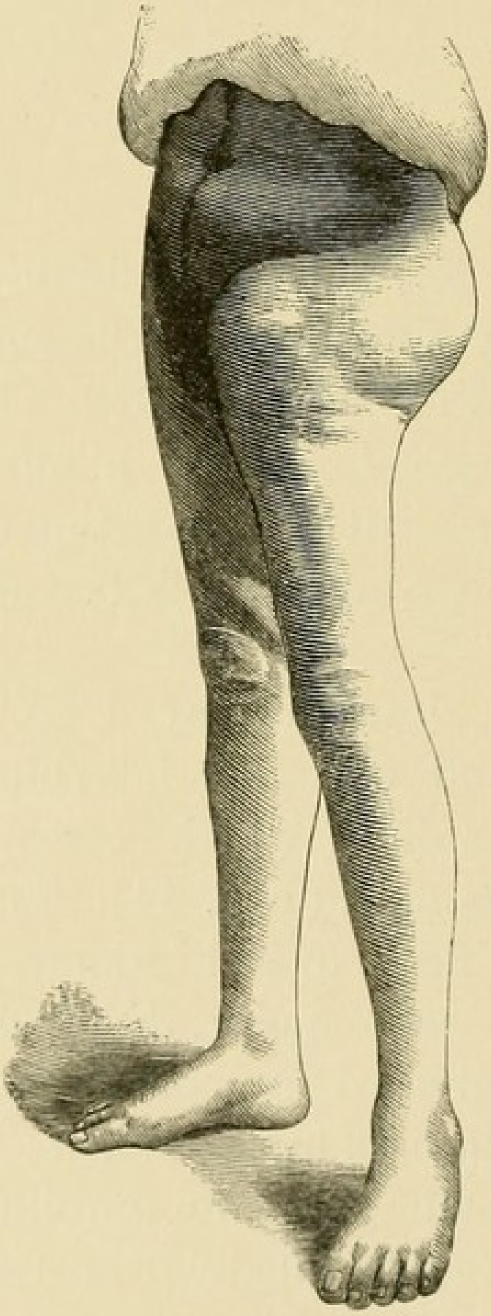
THE SPINAL ARTHROPATHIES.

A CLINICAL REPORT OF SIX CASES OF CHARCOT'S JOINTS.

CASE I.—M. K., male, aged forty-one, referred to the New York Orthopedic Dispensary from St. Luke's Hospital on May 5, 1879. Hereditary history unusually good. He is a moderate drinker. Health excellent until manifestation of present joint trouble. Married, and the father of five healthy children.

Condition at date of entry: A large nodular tumor was found over the left hip-joint, oval in shape, the long axis of which corresponds with line of Poupart's ligament (Fig. 44). Transverse diameter of normal limb over hip-joint, 22 inches; of affected limb at same point, $30\frac{1}{4}$ inches. No muscular atrophy detected by measurements of circumference. Left limb $1\frac{3}{8}$ inches shorter than its fellow; measurements made from the umbilicus. External iliac fossa of left side filled with osteophytes, which add to bulk of tumor. The ligamentous structures about the joint seem entirely destroyed; motion of the limb abnormally free in all directions. Head of femur probably absorbed or greatly atrophied. Limb abducted and rotated outward. What appears as the head of the femur is anterior to its normal position, lying under a "shed" of bone, built out from the pelvis, which covers its atrophied extremity like an umbrella. When the patient

FIG. 44.



flexes the limb, the upper extremity of the femur glides forward until it catches under this "shed" of provisional bone, which, acting as a fulcrum, allows the patient to flex and rotate the limb with ease.

A thorough examination of the patient for evidence of a central lesion, revealed the absence of numbness of limbs, of pain, or of constricting bands; sensation slightly impaired on left side. On right side, reflex action increased on titillation of soles; none on left. No tendon reflex in either limb. Sways with "closed eyes test."

Condition eighteen months later: The patient presented all the marked symptoms of locomotor ataxia. Two years from date upon which the above notes were recorded (May 5, 1879), he is confined to bed, with complete loss of muscular coördination.

Remarks. The case exhibits an arthropathy existing four and a half years prior to the development of active tabetic symptoms, and shows a tendency, from early stages, to the formation of osteophytes about the joint, with early atrophy of the upper epiphysis of the femur.

At no time during the progress of the lesion were there developed reflex neural symptoms that would point to joint inflammation.

The joint lesion (swelling and tumefaction) diminished as the active symptoms of ataxia advanced. Provisional callus was thrown out about the atrophied extremity of the femur as a substitute for the destroyed acetabulum.

Case II.—O. P., male, aged forty-four. Registered as an out-patient in the New York Orthopedic Dispensary on January 29, 1879. The following notes were recorded:

Hereditary History. Parents living and healthy; one brother died of phthisis. Patient is married; has three children, two in excellent health, the third has an intrapelvic abscess (subsequently died of amyloid degeneration of the kidneys). Patient has had to work very hard, with considerable mental anxiety; no other known cause for present disease.

FIG. 45.

The left knee and ankle (Fig. 45) are enlarged, the latter more so relatively than the knee. The patient states that seven years ago, while working, a heavy box fell upon him, injuring the ankle. The joint became swollen, and he was "laid up for two months." He recovered, and suffered no inconvenience for one year; the swelling again returned in the same ankle and involved the entire leg. At this time he was incapacitated from work for three months; recovered, and has had no active joint symptoms since. Has never had an abscess about the joint.

The urgent symptoms at present examination are those of locomotor ataxia. He cannot walk without staggering, and when attempting to do so in the dark, or with closed eyes, falls. Suffers from ataxic pains in the right leg and arm. Is uncertain in guiding his finger to the tip of his nose, with eyes closed, or in putting his heel on a designated spot. Sensation impaired in right hand and arm; has difficulty in buttoning his coat with that hand. When standing or walking in his bare feet, he feels as though he were on cushions; vision unimpaired (eye-ground not examined).

On February 4, 1879, Dr. Cloves Adams saw the patient in consultation, and thought him to be suffering from locomotor ataxia in the third stage, with osseous changes in left ankle and synovitis of both knees.

The patient returned to the dispensary in September of the same year, with a marked elastic swelling of the right elbow-joint (Fig. 46).

A year later (November, 1880), he was referred to the clinic of Dr. E. C. Seguin. He again applied to the Orthopedic Dispensary on February 14, 1881. The ataxic symptoms had advanced; he walked with extreme difficulty. The condition of the joints remained about the same as when last examined, now four months ago.

During November (1881) the patient was critically examined by Dr. S. Weir Mitchell, and pronounced to be in the third stage of locomotor ataxia,

Fig. 46.

with spinal arthropathies of the right elbow and left ankle-joints. It was noted that the circumference of the elbow tumor had materially diminished since the last measurements were recorded (decrease of two and a half inches).

REMARKS. The joint enlargements in this patient presented three characteristic peripheral ataxic conditions:

1. At the knee-joint synovial irritation, indicated by the physical signs of a chronic synovitis, although at no time during its course was there evidence of inflammation.

2. A characteristic doughy, nodular, ataxic joint tumor of the elbow, largely composed of osteophytes and excessive synovial secretion.

3. Hypertrophy of the lower epiphyses of the tibia and fibula, with but slight synovial irritation.

The peripheral manifestations at the knee and ankle accompanied the earlier symptoms of ataxia; the elbow tumor entered abruptly upon the second stage of the sclerosis. I am indebted to my friend Dr. Newton M. Shaffer, of New York, for the privilege of reporting the above notes.

CASE III.—J. H., male, aged forty-five; was admitted to my wards in the Philadelphia Hospital on April 3, 1883. The following notes were recorded: A vigorous, well-nourished man, with little personal knowledge of his family or their history. Knew his parents lived to advanced age, but thought both of his brothers had died, and likewise two sisters. Acknowledged to being strongly addicted to the use of alcohol. He thought that his present trouble arose from a "dissipated life and constitutional syphilis."

Two years ago, after a debauch, his attention was directed to painful swelling of his right great toe. This lasted a few days, and as the pain and swelling of the toe subsided, the right ankle-joint enlarged. This swelling slowly and painlessly increased, and three months from its onset, the same condition appeared in the left ankle-joint. Without especial discomfort to the patient, this joint enlarged. He continued drinking to excess, and was admitted to the hospital in a state of chronic alcoholism.

An examination two weeks after admission, when all traces of alcoholism had subsided, gave evidence by the following facts of a central lesion: He had suffered from constricting pains about the abdomen, and occasional darting pain in the region of the hips and thighs for the past year. He also experiences considerable difficulty in walking, especially at night. At present he has a staggering gait. Absence of patellar reflex in both limbs; sways and falls with "closed eyes test," and has difficulty in finding tip of nose with forefinger when eyes are closed.

The metatarso-phalangeal articulation of the right great toe is anchylosed. Both ankle-joints are enlarged, apparently by a diffuse hypertrophy of the epiphyses of tibia and fibula. This increase has almost doubled their normal circumference. The subcutaneous tissues are slightly œdematous. The capsules of ankle-joints are distended and elastic.

When first admitted, the tissues about the ankles and legs were swollen, presenting the appearance of diffuse cellulitis. This subsided in a few days from rest and local treatment.

My colleague, Dr. C. K. Mills, saw the patient with me in consultation, and confirmed the diagnosis I had made—of posterior spinal sclerosis, with accompanying arthropathies at ankle-joint.

REMARKS. The joint hypertrophy had preceded any active symptoms of ataxia. The character of the joint enlargement was that of bony hypertrophy, without a tendency to the formation of osteophytes or to nodular irregularity of contour.

The possibility of rheumatism or malignant disease was considered and dismissed. A thorough physical examination failed to detect any of the characteristic reflex neural symptoms of epiphyseal osteitis.

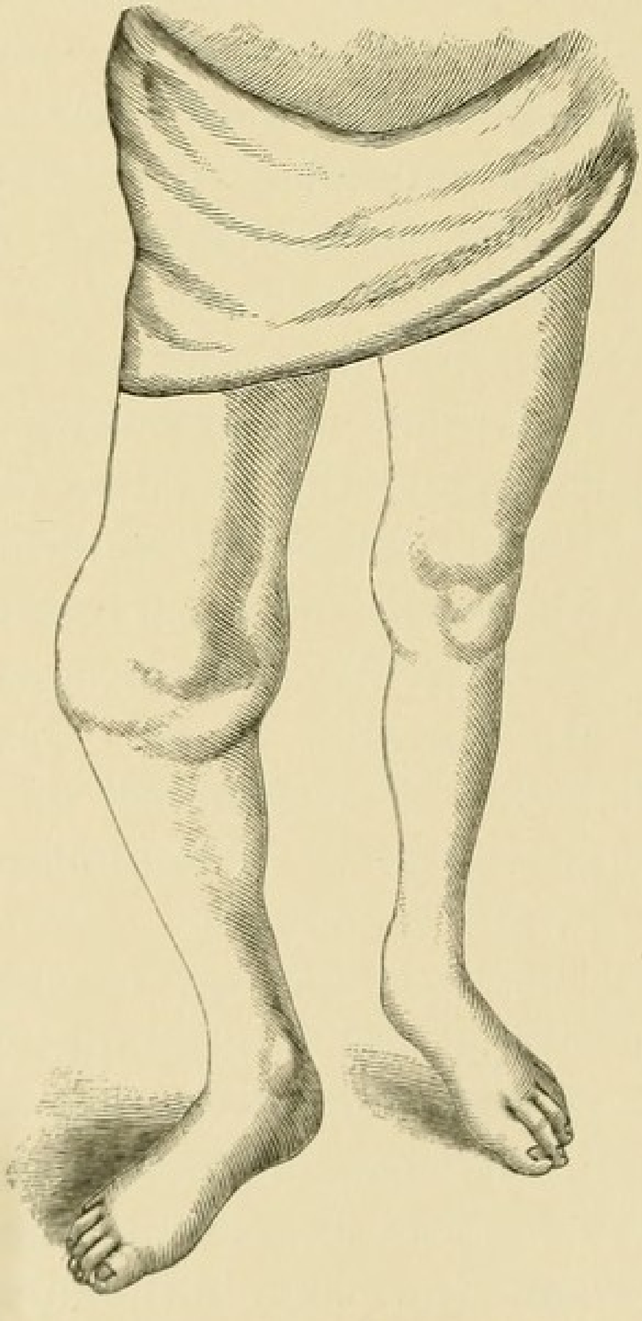
The history of the progress and course of the ankle-joint hypertrophy, together with the evidence of a central lesion and the negative physical signs of local joint inflammation, all confirmed the diagnosis of an arthropathy of spinal origin.

CASE IV.—Dr. A. A. Y., male, aged sixty-five, resident of Hammonton, N. J. Examined the patient with Dr. S. Weir Mitchell on January 16, 1885. For the substance of the following notes I am indebted to Dr. Woodnut:

Hereditary history of patient excellent. He had always been strong and healthy during youth and up to 1865, though a hard-working farmer. An army life, and three years of extreme exposure prior to the close of the war, found him suffering in 1865 from sharp, wandering pains in the upper and lower extremities; never noticed, however, in the articulations. Loss of power followed in the right leg. Three years later suppurative arthritis attacked the metatarso-phalangeal articulation of the right great toe, and last phalanx of left ring finger, sequestra coming away in each instance.

During 1870 the patient first noticed an œdematous swelling of the right elbow; following shortly upon this, the wrist-joint of the same arm gradually

Fig. 47.



and painlessly enlarged. Then a distention of the capsule of the right knee-joint succeeded. The enlargement of the latter articulation was more rapid than either the wrist or elbow. Rheumatic pains in the joints accompanied the swelling and deformity.

The left limb has been comparatively exempt from pain. Recently, however, the capsule of the knee-joint has become distended and elastic. The elbow-tumor has diminished somewhat in circumference during the past four years.

During the past year the distal phalanx of the right index finger has gradually atrophied without inflammation, and is now entirely wanting. The nail and finger end are normal, though somewhat shortened. Pain at present is chiefly in both feet, paroxysmal and erratic, often attacking corresponding points on the legs.

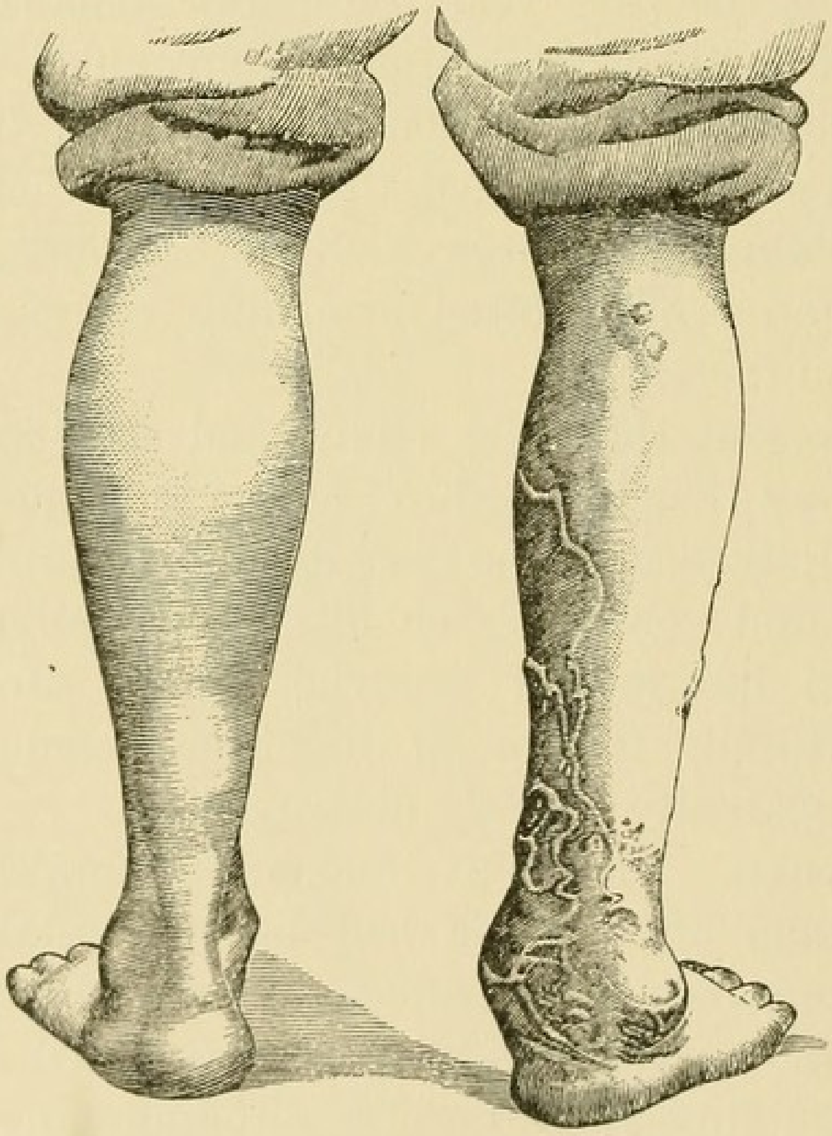
At present the right elbow and knee-joint enlargements (Fig. 47) exhibit an irregular nodulated hypertrophy, bearing no resemblance to normal joint outline, and consisting chiefly of osteophytes and abnormal increase of synovial fluid. Motion is preternaturally free in all directions; structure of joints apparently entirely destroyed.

Remarks. The joint lesions first appeared in this patient after ataxia had become established. The appearance of the affected elbow and knee is that of an enormous nodular hypertrophied mass of bone, doubling their normal circumference, associated with synovial distention of the capsule. Osteophytes readily movable within the capsule, and varying in size from a pigeon's egg to that of a turkey.

The atrophy of the distal phalanx of the right index finger is especially to be noted. It is the first instance of complete absorption of the diaphysis of bone that I have had an opportunity of observing.

Case V.—W. H. McC., male, aged thirty-eight, married. Admitted to the Orthopedic Dispensary of the University Hospital in July, 1883.

Fig. 48.



Hereditary history excellent; no evidence could be obtained of articular disease, rheumatism, or phthisis in any member of his family. He presented at the date of examination the appearance of a healthy well-nourished man. Has always worked industriously at his trade of plumber. A moderate drinker. He had constitutional evidence of syphilis, following a chancre contracted in 1863.

The patient attributes the present enlargement of the right ankle-joint to an injury received while working in a cramped position. Following this strain the ankle became suddenly discolored and swollen, bursting the buttons from his shoes. He was incapacitated for work during the succeeding four days; at the end of a week the discoloration and swelling had about disappeared. His attention was then first directed to a bony enlargement of the right ankle-joint. This slowly and painlessly increased in size without any appreciable interference in locomotion. At present examination the enlargement resembles a simple hypertrophy of the lower epiphyses of the tibia and fibula (Fig. 48). The outline of the joint is globular, with slight elasticity of capsule. No pain or reflex muscular spasm.

Record of Spinal Symptoms. Complains of darting pains about hips. Has difficulty in walking at night. Sways with closed eyes. Complete absence of patellar reflex on both sides. Dr. Horatio C. Wood saw him with me in October of 1833, and pronounced him ataxic.

Remarks. This case presents an arthropathy that apparently followed a direct traumatism to the affected joint. From careful interrogation, I determined that the acute swelling and ecchymosis resulted from the rupture of a varicose vein, inasmuch as these were numerous and greatly engorged about the affected ankle. This first attracted his attention to the ankle, the deeper bony growth being detected when the active symptoms of subcutaneous swelling had subsided.

The hypertrophy of the joint has increased the circumference four and a half inches over its fellow.

CASE VI.—A specimen of shoulder-joint arthropathy, lately removed at an autopsy held upon the body of a well-marked ataxic, has been referred to me by Dr. S. Weir Mitchell, to embody in this report. The joint had become suddenly and painlessly enlarged in the later stages of the central lesion. It presented ante mortem all the characteristic symptoms of a tabetic arthropathy: distention of the capsule, abnormal mobility, and the presence of osteophytes. The joint, upon examination, presented the following structural changes:

1. Cartilage covering head of humerus eroded; that upon glenoid cavity irregularly thickened.

2. Anterior margin of glenoid cavity worn away, allowing the head of bone to rest in position of forward dislocation.

3. Osteophytes abundant about junction of capsule with anatomical neck. Marked relaxation of ligamentous structures, and distention of capsule.

4. General hypertrophy of epiphysis, somewhat nodular at margins. Evidences of hydrarthrosis.

The practical deductions to be drawn from a clinical study of the above somewhat anomalous cases, may be briefly summarized as follows:

Period of Development. 1. The tabetic arthropathies may occur independently, or precede the active symptoms of locomotor ataxia.

2. They occasionally develop suddenly, late in the course of a posterior spinal sclerosis.

Nature of Lesions. The peripheral expression of central nerve irritation is characterized by the following changes found in the structure of the various articulations.

1. A chronic asthenic hyperæmia of the synovial membranes; a hydrarthrosis.
2. An interstitial atrophy of the epiphyses.
3. A fungous or rarefying epiphyseal hypertrophy.
4. The formation of osteophytes and bony stalactites.

These various joint lesions characteristic of the spinal arthropathies may exist separately; but are usually combined in the same subject.

Differential Diagnosis. They may be readily distinguished from the common inflammatory diseases of the epiphyses by the total absence of the reflex neural phenomena—*i. e.*, of pain, both reflex and local, the apprehensive state regarding joint movements, and the reflex or tetanic spasm of the muscles, always associated with joint osteitis. Abscess is never directly associated with the arthropathies, unless incident upon direct traumatism.

They are more difficult to differentiate from malignant affections of the articulations; but a careful inquiry into the history and course of the lesion, and the presence or absence of central disturbance, are our most reliable guides.

Course. The progress of the arthropathies is essentially chronic. Occurring, not infrequently, early in the history of the tabetic lesion, they slowly increase, with occasional exacerbations, and years elapse before fully matured. Their course is self-limiting, though never reparative.

THE ETIOLOGY, MORBID ANATOMY, VARIETIES, AND TREATMENT

OF

CLUB-FOOT.

CLUB-FOOT.[1]

LECTURE I.

Gentlemen: Every observant person, whether within or without the profession of medicine, must be impressed with the prevalence of various deformities in individuals of the human family, and their very existence must cause him to reflect upon the nature of their being, their chronic and progressive character, and the apparent difficulty of arresting them. Much of this has been due to lack of knowledge of the mechanical factors which enter into their etiology, and the very general neglect the subject of malformations has received, from an educational stand-point, in our medical schools. Though twenty-five years have elapsed since the establishment of orthopedic surgery as a legitimate special branch of surgical art, its science and practice, noticeably in this city, are permitted to occupy a very subordinate position, and its principles practically are untaught. In this clinic, which will initiate the course of lectures upon orthopedic surgery in the Philadelphia Hospital, which it will be my privilege to deliver before you this spring, no better subject

[1] Clinical Lectures on Orthopedic Surgery, delivered at the Philadelphia Hospital.

could be chosen than one descriptive of *club-foot*, a condition which you will frequently meet in practice, and of which many examples may be constantly observed in the nervous, obstetrical, and surgical wards of this hospital.

We may define club-foot, or talipes, which latter designation was first employed, about thirty years ago, by William J. Little, of London, as a deformity of the foot, caused by paralysis, permanent spasm, or structural shortening of the muscles, contractions of fasciæ or ligaments, and resulting in an alteration of the normal relations of the tibio-astragaloid articulation, or between the bones of the tarsus proper. Under the generic term club-foot, or talipes, we include all deformities of the foot which occur on an antero-posterior or transverse plane, and which are characterized by flexion, extension, inversion or eversion.

To obtain a clear conception of the deformities under consideration, it is best to divide the foot into an anterior and a posterior portion, the former, the "*pes*," or foot proper, and the latter, the "*talus*," or ankle. These portions articulate at Chopart's joint, which is formed by the astragalus and os calcis behind, and the scaphoid and cuboid in front. For purposes of clinical study, club-foot is conveniently separated into two classes, composed of the simple and the compound forms. Of the former there are four varieties, two between the tibia and foot, namely, *equinus*, in which the heel is raised, the foot being held in the extended position, the patient walking upon the ball of the foot;

and *calcaneus*, its opposite, in which the patient walks upon the heel, the foot being drawn into the position of flexion. There are also two lateral deformities: *varus*, in which the internal border of the foot is elevated, the sole directed inward, and the anterior portion of the foot adducted; and *valgus*, its opposite, in which the outer side of the foot is raised and the sole everted. Any combination of these simple varieties will present compound forms, such as *talipes equino-varus*, *equino-valgus*, *calcaneo-valgus*, etc.; some authors have added others: for instance, *talipes cavus*, in which the arch of the foot is increased, and *talipes planus*, or spurious valgus, in which the foot is flattened, the arch resting upon the ground. Recently, Shaffer, of New York, under the title *non-deforming club-foot*, has described a class of cases in which there is little or no deformity, but which are very important on account of the inconvenience they occasion the sufferer, and the results to which they give rise, coupled with the liability of being overlooked, unless care be taken in the examination of the patient.

The varieties of club-foot may be classified as follows:

TABLE No. I.

VARIETIES .	Simple. .	Antero-posterior .	Equinus.
			Calcaneus.
		Lateral . . .	Varus.
			Valgus.
	Compound .	Equino- . . .	Varus.
			Valgus.
		Calcaneo- . . .	Varus.
			Valgus.
	Other forms.	Cavus.	
		Planus.	
		Non-deforming.	

As previously mentioned, these simple forms, or their combinations, constitute the deformities which you will meet with, and a knowledge of their relative frequency is of interest and importance. Much difficulty is experienced in the investigation of this subject, owing to the difference in nomenclature employed by various authors, similar conditions being spoken of under different names. Duval has recorded 1000 cases, of which 574 were congenital; 364 of these were in males, and 210 in females. His statistics as to relative frequency are valuable, and are as follows:

TABLE No. II.

	Cases.	Boys.	Girls.
Equinus and equino-varus	417	215	202
Varus	532	302	230
Valgus	22	14	8
Calcaneus	9	6	3
Extreme calcaneus	20	13	7
Totals	1000	550	450

I have compiled the following statistics, shown in Table No. III., from the records of the New York Orthopedic Hospital, and the Orthopedic Dispensary of the University of Pennsylvania:

TABLE No. III.

	Congenital.	Acquired.
Equinus	5	87
Calcaneus	3	31
Varus	73	66
Valgus	29	236
Equino-varus	95	68
Equino-valgus	3	9
Calcaneo-varus	0	2
Calcaneo-valgus	5	34
Totals	213	533

Lannelongue has collected the statistics of the Maternity Hospital (Paris), covering a period of ten years, from 1858 to 1867, inclusive. In 15,229 births, 8 children were born with club-foot, a proportion of about 1 case in 1963 births.

The condition may be present as a congenital or an acquired deformity, and the relative frequency of the two forms may be seen by reference to Table No. III., from the cases treated in the New York Orthopedic Hospital, and the Orthopedic Dispensary of the University of Pennsylvania, in which are recorded 746 cases, of which 213 were congenital, and 533 acquired. Tamplin's deductions, shown in Table No. IV., covering 764 cases of congenital talipes, show the relative frequency to be as follows:

TABLE NO. IV.

Congenital.

Talipes varus	688	cases.
" valgus	42	"
" calcaneus	19	"
" varus of one foot and valgus of the other	15	"
Total	764	"

Acquired.

Talipes equinus	401	cases.
" valgus	181	"
" equino-varus	162	"
" calcaneus and calcaneo-valgus	110	"
" equino-valgus	80	"
" varus	60	"
" varus of one foot and valgus of the other	5	"
Total	999	"

Adams states the proportion between the congenital and acquired forms to be as 2 : 3, and the tables already referred to show the large preponderance of cases in which the deformity has been acquired. Giving due weight to the statistics which have been alluded to, we may conclude that club-foot occurs more frequently in males than in females; that cases in which inversion and adduction of the foot, either accompanied or not by elevation of the heel, or the varus types, are oftener met with, and that the right foot is more frequently deformed than the left, but that many more cases of double club-foot occur than of single; and that the primitive forms, pure equinus, calcaneus, varus or valgus, are rare.

The etiology of congenital talipes is veiled in obscurity. The difficulty of studying pathological changes occurring during intra-uterine life is self-evident, as the fœtus cannot be subjected to any direct scientific method of investigation. Comparative physiology, embryology, and the changes and diseases which occur subsequently to birth, give us data of comparative value, but all such investigations have resulted in much speculation, many theories, and but few facts. The theory that diseases which produce the acquired forms have their prototypes during intra-uterine existence has its supporters, notably Little. But microscopical research has not yet shown the existence of changes in the fœtal brain and spinal cord analogous to those found in cases of the acquired paralytic forms. Voluntary muscular control is retained in congenital cases, while it is lost in the acquired varieties referred to, and the electrical reactions are markedly different; so that this theory has no foundation to rest upon, except the similarity in the appearance of the deformities.

Hereditary influence, with its transmission of peculiarities of face and form, of various tendencies, of traits of character, etc., has some weight as an etiological factor.

Another theory of causation is that of arrest of development, and, although cases occur in which coexisting deformities, such as spina bifida, hare-lip, cleft palate, etc., are also present, the feet show no evidence of arrest of development, the only alteration being that of the direction of the planes of the feet which is characteristic of the deformity. Adams and Hüter, it is true, have described changes in the bones involved, consisting of alteration of form and relative position of articulating facets, but these changes are by no means constant, and whether they be causative or secondary to the altered relation of the bones is a matter regarding which there is much difference of opinion. Personally, I incline to the latter view, although the theory has many eminent supporters, including A. Lücke.

The theory which has, perhaps, the greatest number of votaries is that which ascribes to abnormal intra-uterine pressure, and deficiency of amniotic fluid, the influence productive of club-foot, the foot being permanently fixed in the abnormal position during intra-uterine life. Although numbering among its supporters such names as Volkmann, Kocher, Bauga, and Parker, I do not think the assumption tenable, for the following reasons: Were this deformity the result of pressure, it is reasonable to believe that in many cases deformity of other members would coexist, having been exposed to the same pressure-influence; such, however, is not the case, combinations of this kind being of rare occurrence. Again, in children who have been born with club-foot, and in which the mother had previously given birth to several healthy children, no appreciable difference in the quantity of amniotic fluid discharged during the various labors can be made out. Further, I have recently seen a case of double equino-varus in a twin, the other child showing no deformity whatever.

Dr. H. W. Berg, of New York, in a series of investigations which are commendable for their originality, ascribes congenital equino-varus to a failure of rotation during intra-uterine existence. In his studies at the New York Hospital and Wood's Museum at Bellevue Hospital, he has followed the changes which occur in the position of the lower extremities at different periods of fœtal life. At first, the entire leg is rotated outward, and the feet are in a position of marked varus, and, subsequently, of equino-varus. Later, rotation inward takes place, gradually diminishing the amount of varus; but even after this rotation has been completed some varus remains, and, in a very slight degree, is the normal position of the foot in the new-born. Dr. Berg found, in some instances, equinus to be present in fœtuses of two, three, and four months, the condition disappearing in the process of normal growth, and he reaches the conclusion that in early fœtal life equino-varus or varus is physiological, and that its disappearance is coincident and keeps pace with the normal rotation of the limb. When, from any cause, rotation is retarded or arrested, club-foot results.

To summarize the theories to which I have alluded, and which constitute the principal ones advanced in explanation of the causes of congenital talipes, I have reduced them to the following: that which would ascribe club-foot to pathological changes occurring in the fœtus, similar to post-natal diseases; that which assumes, as a cause, the action of mechanical forces upon the child in utero; then the theory of heredity, with its influences but little understood; the theory of arrest of development; and, lastly, the theory promulgated by Dr. Berg, which would make club-foot dependent upon the absence or retardation of rotation. The last mentioned possesses the merit of being demonstrable by embryological research, and in the present state of our knowledge it has, in my opinion, greater claims to recognition than those which are based upon similarity of post-natal conditions, or those which rest upon even a more fanciful basis.

Turning our attention now to the consideration of the etiology of acquired talipes, we do not find the path of investigation beset with the difficulties we met with in the study of the causation of the congenital types. We may divide the causes into six groups: 1. Infantile spinal paralysis. 2. Spastic contractions due to an irritative lesion of the spinal cord. 3. Contraction of aponeuroses. 4. Traumatism. 5. Rhachitis. 6. Hysteria.

By far the greater number of cases of acquired talipes are due to infantile spinal paralysis—"poliomyelitis anterior." This is essentially a disease of childhood, usually occurring at the period of dentition, its invasion being, as a rule, sudden, marked by fever, gastro-intestinal disturbance, sometimes ushered in by a convulsion, and immediately followed by muscular paralysis, more or less extensive. Recovery follows rapidly in many of the muscles affected, but is rarely, if ever, complete, a certain amount of residual paralysis remaining permanently, in one or both of the lower extremities. Atrophic changes now take place, and are characterized by wasting of the muscles of the limb, loss of electro-contractility, especially to the faradic current; later by reaction, when stimulated by galvanism, characteristic of degenerative change, and deformity, of which the most frequent is club-foot.

It has been thought that the deformity in these cases was due to the loss of equilibrium between the muscles of the limb; one set being paralyzed, their antagonists drawing the foot into the deformed position; but Hüter has shown that the weight of the limb, in the position assumed in paralysis, is the cause of contractions, and that these were due to atrophy and arrest of growth, and were not in any sense muscular. In some cases, resulting from poliomyelitis, the deformity is due entirely to the force of gravity, the foot dropping into the position of equinus, and the anterior portion being adducted by its own weight. In these cases there is little, if any, contraction, and the deformity is readily reduced by manual pressure, but, of course, returns immediately upon the removal of the hand. Volkmann, also, has directed attention to the fact that, owing to the weight of the body, the limb assumes an abnormal position, which eventually becomes permanent, being due, not to contraction, but to abnormal growth.

The "spastic paralysis" of Erb is also productive of club-foot. This condition has been called by Adams, "paralysis with rigid muscles," and by Seguin, "tetanoid paraplegia." It is well illustrated by the case I now present.

CASE I. *Tetanoid paraplegia, producing double talipes equino-varus.*—Barney, aged six years. No record or information could be obtained regarding previous history. Having stripped him, it will be noticed that the thighs are adducted and slightly flexed upon the pelvis. The legs are held firmly at a moderate degree of flexion at the knee-joint. The feet are extended and inverted in the position of pronounced equino-varus. All muscular groups of the lower limbs are in a condition of spasmodic rigidity. You will notice these contractions may be temporarily overcome by firm and continuous pressure, but immediately reappear upon the removal of the opposing force. Locomotion, with assistance, is accomplished, with difficulty, by a swinging, discordant gait, typical of the disease, the patient walking only upon the ball of the feet and toes, the weight of his body not being sufficient to overcome the contraction and bring the heels to the floor. The other symptoms characteristic of the central lesion—deficient intelligence, strabismus, exaggerated muscular reflexes, and general rigidity and spasm of the muscular system, are all present. As I propose to operate upon this patient, I will defer a further consideration of his *feet* until my next clinic. The condition appears to be due, in some instances, to retarded development in the motor tract of the brain; in others, to a lesion in the same position, followed by secondary changes in the lateral columns of the cord. The researches of Rupprecht, of Dresden, not only show that tenotomy is followed in some of these cases by improvement in the position of the feet, but that the mental state is also appreciably benefited by the operation. His article has been published in Volkmann's series of clinical lectures, and constitutes an important and valuable contribution to our knowledge of this interesting class of cases. Various spinal diseases, acute compression, syphilis, tumors, caries, etc., are frequently productive of a similar condition. Other diseases of the nervous system should be mentioned as causes of club-foot. In rare cases, pseudo-hypertrophic muscular paralysis and post-hemiplegic contractions produce the deformity, but neuromimetic conditions, which of late years have attracted much attention, are more frequently the cause of it. A careful elimination of other possible etiological factors in a given case, coupled with a proper appreciation of the general condition, will usually lead to correct conclusions in the cases of the latter kind.

Sayre has advocated the view that paralysis due to reflex irritation is, in many instances, productive of talipes, and has reported cases in which he claims that functional disturbance of the nervous system can cause spasm of muscles, which, if sufficiently prolonged, while healthy growth continues in their antagonists, becomes the cause of a permanent deformity. Much discussion has taken place concerning this condition as a cause of club-foot, but I do not consider Dr. Sayre's theory as in any way tenable.

Talipes equinus sometimes occurs as a concomitant of the paraplegia of Pott's disease of the spine, but disappears upon recovery from the paralysis; joint diseases of the lower extremity are also potent factors in the production of club-foot. In ankle-joint disease the deformity may follow osteitis of the articulation, and remain as a permanent condition, due to anchylosis of the joint in the position of extension. In hip-joint disease, it would be due to prolonged malposition during the period of growth. I have lately seen a case of this disease in which the limb upon the affected side was shortened but one inch, and in which there was a marked equinus accompanied by contraction of the plantar fascia. Occupations requiring long-continued standing in one position can be also considered causative agents; printers, bakers, blacksmiths, and those engaged in kindred trades may be mentioned as the principal sufferers. The enforced position and the weight of the body are the factors in the production of this variety of the deformity, which is most commonly a valgus. The same remarks will apply to the valgus of adolescence, due probably to rapid growth and increased weight of the body, without, however, a corresponding development of the muscles, aponeuroses, and ligaments of the feet. The influence of long-continued decubitus is further shown by the case reported by Volkmann, in which an equinus was found, after prolonged typhoid fever, so resistant that it required a year's treatment to restore the feet to their normal position. As to traumatism, it will be only necessary to allude to the possibility of wounds, burns, rupture of tendons, etc. The former may result in the production of deep cicatrices, which, by their contraction, tend to draw the foot into a deformed position. Spurious valgus, or splay-foot, is frequently the result of rhachitis, although, as before mentioned, occupation is often an important factor in its causation. All these forms may be simulated by hysteria, and this class of cases frequently taxes the knowledge and ingenuity of the surgeon; their recognition lies in a thorough understanding of general morbid conditions and a careful diagnosis by exclusion.

Before closing, I desire to call your attention to the morbid anatomy of club-foot. I shall, however, touch upon it only sufficiently to give you an idea of the muscles involved in the production of the various deformities, and will illustrate my remarks by reference to the following classification:

TABLE NO. V.

Extension (equinus) . .	Gastrocnemius. Soleus. Plantaris. Peroneus longus.
Flexion (calcaneus) . .	Tibialis anticus. Peroneus tertius. Extensor longus digitorum.
Adduction (varus) . .	Tibialis anticus. Tibialis posticus. Flexor longus digitorum.
Abduction (valgus) . .	Peroneus longus. Peroneus brevis. Peroneus tertius.

Dividing the muscles into three groups, which move the foot in four directions, as shown in Table No. V., we have a posterior group, the calf muscles, the gastrocnemius, and the soleus, and two anterior groups, the tibial and the peroneal. In the normal condition, an equilibrium is maintained between these muscles, and the correct anatomical relation of the parts is preserved; but should spasmodic contraction or paralysis of one or more of these groups occur, the balance is destroyed, and deformity takes places. As has been remarked, the purely primitive forms of club-foot are extremely rare, and this statement will apply to these deformities, whether they be congenital or acquired. A brief consideration of them, however, is necessary in order that a clear understanding of the compound forms which are encountered most frequently in practice may be obtained. They are *equinus*, *calcaneus*, *varus*, and *valgus;* the two former being antero-posterior deformities; the two latter occurring upon a transverse plane.

In *talipes equinus* the heel is raised, the patient walking upon the ball of the foot. Here we find the posterior group of muscles, consisting of the gastrocnemius and soleus, contracted and shortened, the tendo Achillis being felt as a tense band. In the opposite condition, *talipes calcaneus*, the anterior groups of muscles, tibialis anticus, posticus, and peronei, are at fault, and, being shortened, maintain the foot in the position of flexion, the patient walking upon the heel. *Talipes varus* manifests itself by inversion and adduction of the foot, the deformity taking place anterior to Chopart's joint; in it the sole is turned inward and raised, and the anterior portion of the foot adducted, the tibailis anticus and posticus and flexor longus digitorum being contracted. In *valgus*, on the contrary, the sole is turned outward, and its outer border raised, the peronei being the muscles at fault. In this deformity, however, the plantar fascia is involved, the arch of the foot being diminished by its relaxation.

In all these varieties, changes occur, not only in the muscles, but also in the ligaments, fasciæ, and in the bones themselves, whether as causes or effects; but we shall defer the study of them until our next meeting, my object in briefly mentioning the primitive deformities now being merely to impress upon you the character of the changed relation of the parts from an anatomical rather than a pathological stand-point, which latter condition can be best considered when we come to speak of the most frequent of all the forms of club-foot, namely, *talipes equino-varus.*

LECTURE II.

Gentlemen: Our last meeting closed with a brief description of the primitive forms of club-foot. We now pass to the consideration of the treatment of talipes in general, such modifications as may be necessary to correct the deformity in any special case which may come before us being deferred until we discuss the compound forms. Properly to cope with these conditions, it is essential that you should thoroughly comprehend the factors, pathological and mechanical, which produce them. Because of the lack of exact knowledge upon the subject by the profession, many cases of deformity remain uncured, and scores of children who could otherwise be relieved are left to the care of inconsiderate instrument makers. It is only by the intelligent application of measures fitted exactly to the case that success can be achieved; and the knowledge requisite to do this is not possessed by the mechanician in any greater degree than is the knowledge necessary properly to care for a medical case a part of the education of the apothecary. Nor has the training of the general practitioner been such as to make him an adept in this branch of surgery, and when it is considered how few are his opportunities of seeing many such cases, it is not strange that extreme deformities are frequent, and that their existence and progression should be an opprobrium. It is only by the dissemination of knowledge by clinical teaching, and the establishment of institutions dedicated to the care of these special cases, that a better state of things may be hoped for, and the importance of such measures cannot be overestimated.

The object of treatment in club-foot is not only to remove the existing deformity, but to restore to the foot its functions; and to do this many procedures have been resorted to which have been in turn discarded. We may consider the methods now in use as *mechanical* and *operative*. First among the former is manipulation, applied so as to stretch the contracted tissues, passive motion, massage, shampooing, and electricity being used the while, to aid in the restoration of function. The hand, if pressure and traction to the contracted tissues could be continuously applied by it, would, no doubt, constitute the best instrument for the relief of club-foot; the apparatus which is best adapted to take its place is that which should be relied upon in the mechanical treatment of the deformity.

Massage and electricity serve, in paralytic cases, to restore, as far as possible, the functional activity of the paretic muscles, and should always be employed as adjuvants in such cases.

Tenotomy, for the division of contracted tendons, called aponeurotomy when performed upon fasciæ and aponeuroses, was resorted to first by Delpech, of Montpellier, France. It was not, however, generally employed until Stromeyer, of Hanover, rendered it popular. Little introduced the operation into England, and Dickson, of South Carolina, first performed it in America. To Deltmold, of New York, and Mütter, of this city, however, is due much of the credit of making the operation popular in this country. Opinions differ as to the indications for tenotomy and the proper time for its performance; whether, for instance, in cases of congenital talipes, it should be done prior to the time at which the child is able to walk, or subsequently. No difference of opinion can exist as to the advisability of early operation in cases in which the nature or extent of the deformity renders correction by mechanical means alone impossible; but as experience is the only guide to discrimination, mechanical appliances should always be granted a fair trial before resorting to operation. Rigidity, or the reflex spasm caused by point pressure mentioned by Sayre, is not in itself a safe criterion, nor does excessive deformity, taken alone, furnish a reliable indication.

Retentive dressings, such as splints of silicate of soda or plaster of Paris, are used, either alone or after tenotomy, serving to retain the foot in the position acquired after manipulation or operation. The rubber muscle advocated by Richard Barwell, of London, and extensively used by Sayre, may be employed to take the place of paralyzed muscles; or Scarpa's shoe, as variously modified, may be applied to fix the foot and exert traction.

As I mentioned to you at our last meeting, the type of club-foot with which you will most frequently meet is talipes equino-varus. The principles of treatment appropriate to the mechanical conditions present can be applied to any of the other forms. This deformity is well illustrated by the case I now show you.

CASE II. *Congenital double talipes equino-varus; mechanical extension; recovery.*—Richard C., aged four months, referred to my care from the Obstetrical Department of this hospital. The deformity, which in this case affects both feet, takes place upon an antero-posterior and a transverse plane, combining elevation of the heel, *equinus,* and inversion of the foot, with elevation of the internal border of the sole, *varus.* The os calcis is drawn upward by the contraction of the gastrocnemius and soleus, and rotated in such a manner that its posterior border is turned outward and its anterior border inward. The bones of the tarsus, following the direction of the os calcis, are inverted, and the inner sole raised by the action of the tibialis anticus. The altered relation of the bones of the tarsus leads to change in form, especially of the articular facets; and some have considered these alterations as causative. This is by far the most frequent of the congenital forms of club-foot, and it has been argued that arrest of development in bones and muscles is the principal etiological factor. As the various theories on the subject were discussed in our former clinic, they need not detain us here.

The lateral deflection of the anterior portion of the foot, as compared to that of the normal imprint, is well shown in the following cuts. The outline tracings are from impressions of the feet of patients suffering from various deformities, obtained after the method advocated by Rohmer ("Les Variations de Forme Normales et Pathologiques de la Plante du Pied," Thèse, Nancy, 1879), consisting of first

FIG. 49.

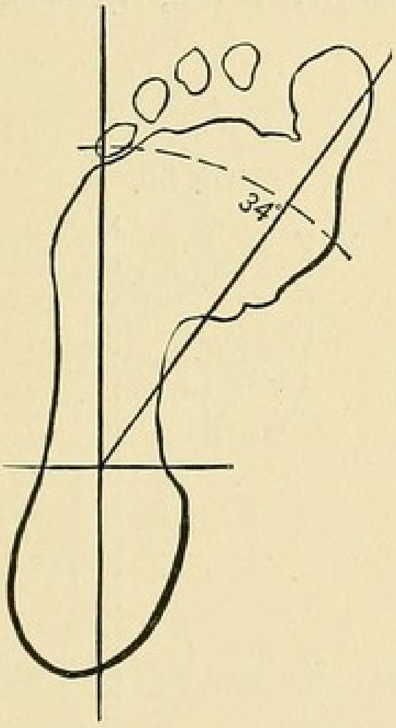
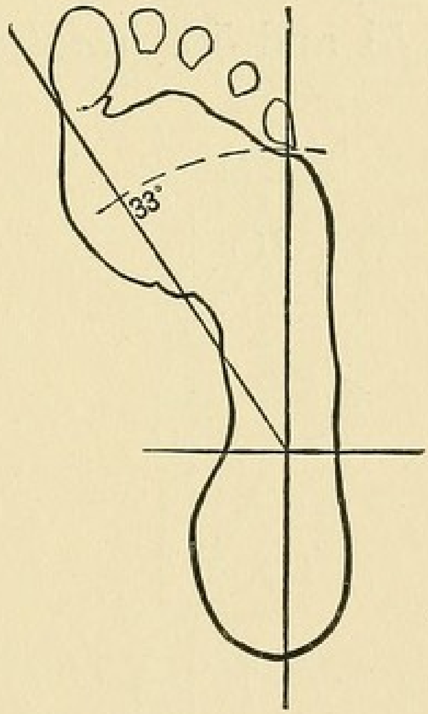


FIG. 50.



covering the plantar surface of the foot with lamp-black, which leaves a correct impression of the sole upon white paper, on which the patients are then requested to walk. To obtain a correct basis of measurement, and still further to carry out Rohmer's researches as a guide to treatment, I selected the medio-tarsal joint as a base line of measurement; erecting upon it a perpendicular corresponding to the long axis of the os calcis. As they are comparatively stable structures in all deflections from the normal condition of the foot, the *position* and character of deformity could be readily determined by a comparison of the degrees of variation.

In the thirty-two normal feet measured, I have found the angle of deflection, which is represented by an imaginary line passing through the head of the metatarsal bone of the great toe, to range between 26 and 37 degrees (*average*, 20 males, 34.8 degrees; 12 females, 31.5 degrees); typical examples may be seen in Figs. 49 and 50, *males*, and Figs. 51 and 52, *females*.

FIG. 51.

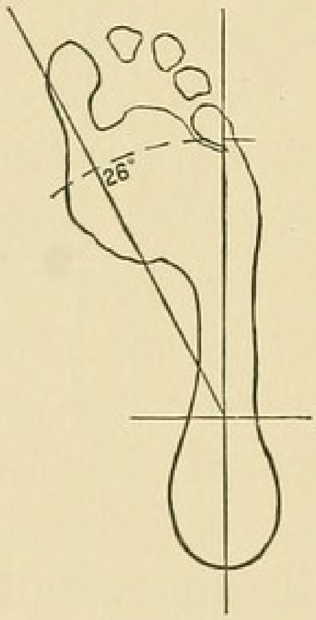
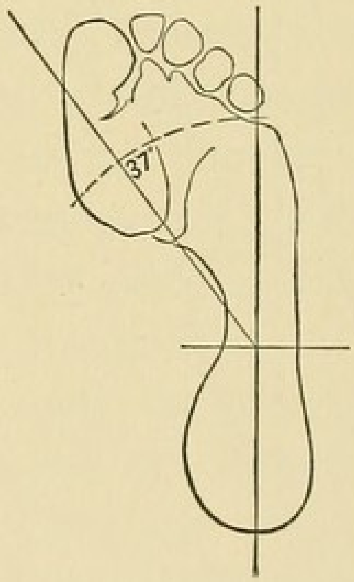


FIG. 52.



In valgus, on the contrary, the angle of internal deflection is reduced to from 12 degrees in moderate cases, to 5 degrees in extreme ones, illustrated by Figs. 53 and 54, which represent the imprint of patient's feet suffering from acquired "flat-foot," of rhachitic origin. From an examination of seven cases I have ascertained the average deviation from the perpendicular to be about 8.2 degrees.

The adduction of varus has in two instances reached an internal rotation of 63 degrees. I consider all feet that have an internal deviation in excess of 40 degrees as abnormal. An examination of fourteen cases of varus yields an average of 51 degrees.

FIG. 53.

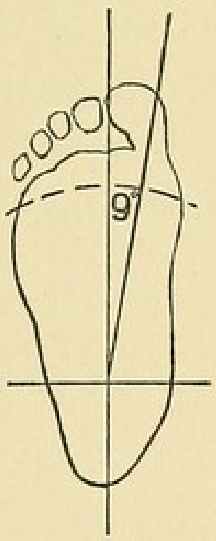
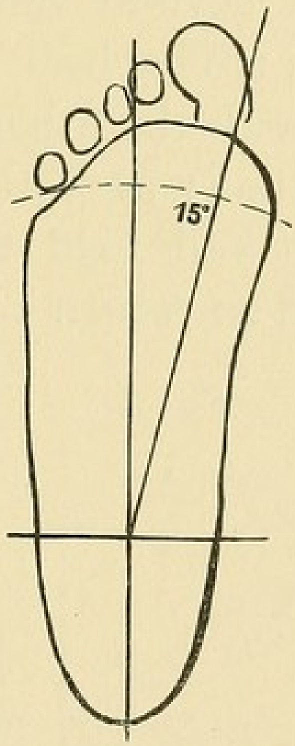


FIG. 54.



This method of measurement I believe to be of importance, as furnishing us with an excellent and accurate guide to the amount of deformity, as well as affording an opportunity of determining the improvement that may follow any plan of treatment instituted.

In the correction of equino-varus, as in that of the other compound forms, it is best to divide the process of rectification into two stages, the object being to overcome one of the factors of the deformity before attacking the other. The reason for this will be sufficiently obvious when it is considered that the altered relations of the tissues of the foot take place upon two planes at right angles to each other. Our endeavor, then, should be directed first to the lateral or varus element of the deformity. Manipulation should be systematically used, and, while sufficient in very mild cases, is of great service as an adjuvant in severe ones. It should be applied several times daily, and in the following manner: The heel is firmly grasped by one hand, while with the other the anterior portion of the foot is gradually and steadily brought into a position of valgus, and held there for a few moments, then allowed to return to its abnormal position. After

FIG. 55.

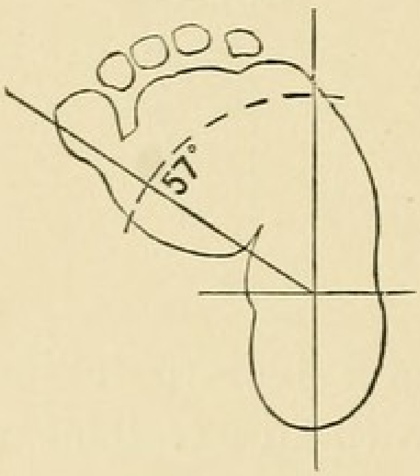
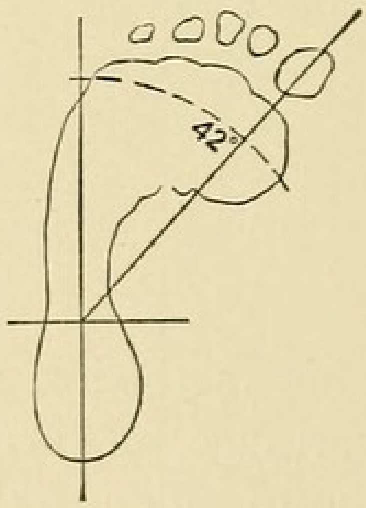
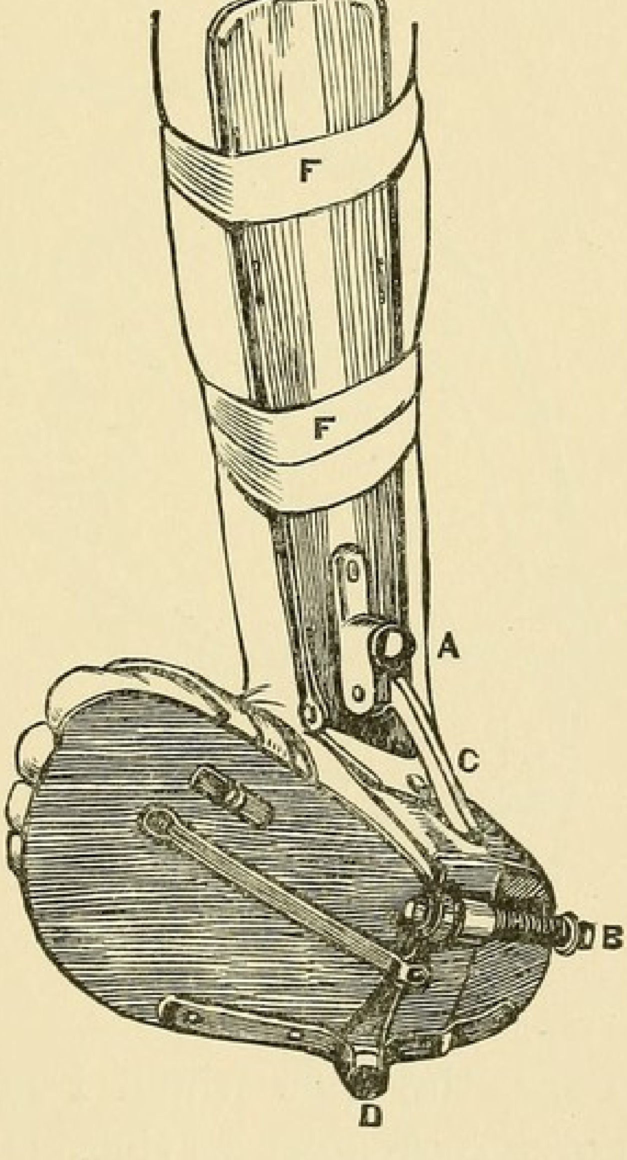


FIG. 56.



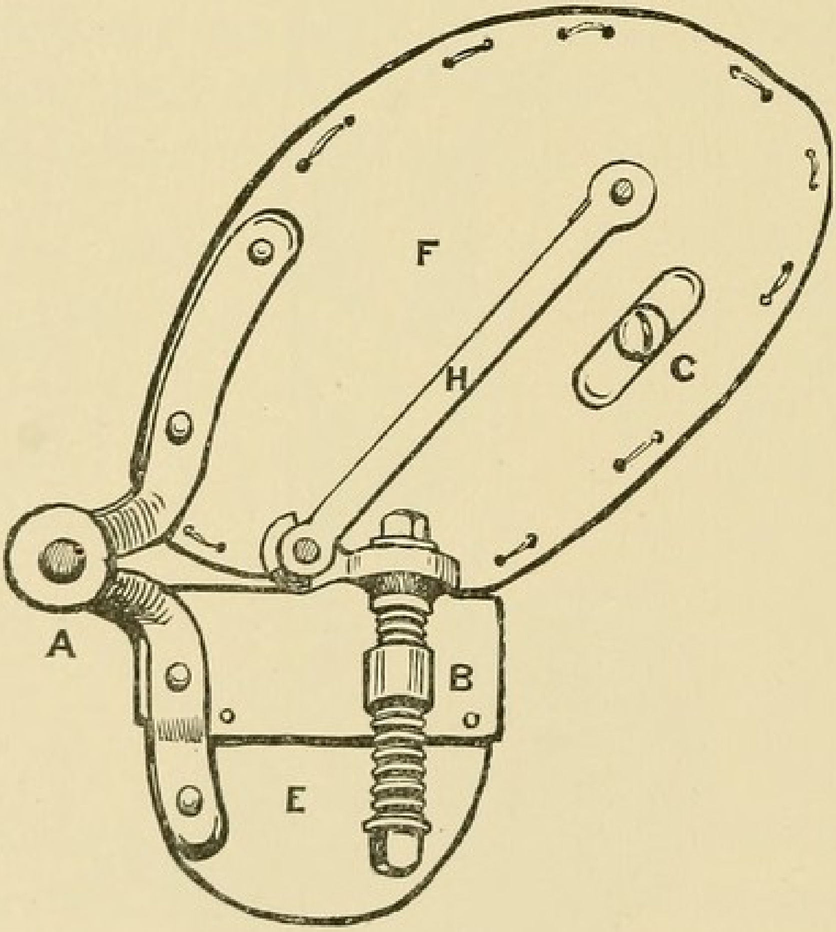
the manipulation has been repeated several times at short intervals the foot may be placed in any light dressing. This splint will retain the foot in its corrected position, and may be modified from time to time to suit the lessened amount of varus. It may consist of material suited to the case. In the milder degrees of the deformity, adhesive plaster wound around the foot and attached to the fibular aspect of the leg answers the purpose, but when greater strength is required splints made of leather, gutta percha, or hatters' felt may be moulded to the parts, and secured by a roller bandage. These have the advantage over fixed dressings of plaster of Paris in allowing inspection as frequently as may be desired, together with the application of massage, electricity, etc.

FIG. 57.



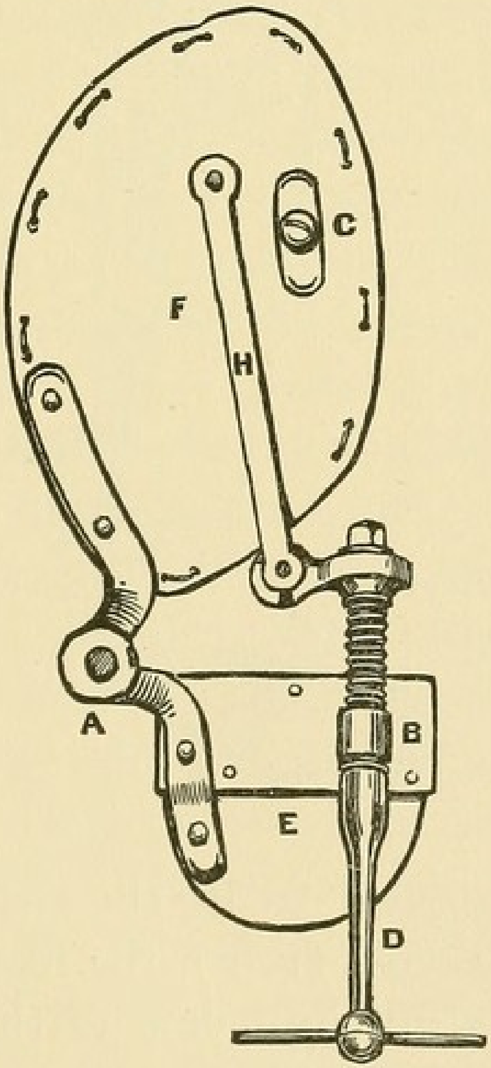
But the majority of cases of varus cannot be cured by such simple means. As in this case, which is typical of congenital equino-varus, we have absolute deformity to overcome; tendons and muscles are shortened, and the tissues structurally altered. The so-called "mild measures" will not avail, and time occupied in their trial is wasted. Nothing will be of benefit except the application of instruments which by their accuracy of construction and power will appropriately stretch the tissues involved, or, after a fair trial of these, operations which will divide the resisting structures.

Fig. 58.



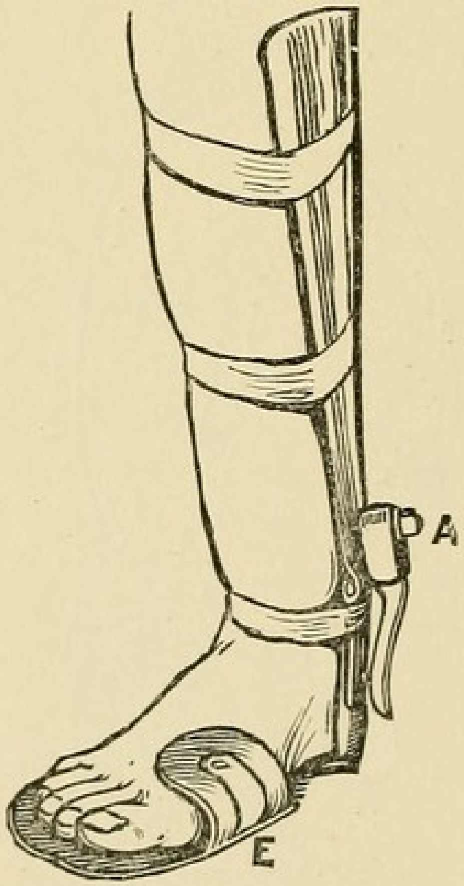
In such cases the shoe which I now show you (Fig. 57) is of the greatest service. It is a modification of Taylor's ankle support, and in its original form was devised by Shaffer, of New York. To this brace I have given more power by substituting in the sole plate, for his extension bar a triple thread screw worked by a key at B, and by throwing the centre of motion further to the outer side of the sole at A (Fig. 58). The instrument consists of a steel trough fitted to the inner side of the leg, extending from the upper part of the tibia to the internal malleolus. A hinge at C (Fig. 57), the direction of which is such as to allow pressure exerted upon it at right angles to operate upon the anterior or lateral deformity, connects this trough with a con-

Fig. 59.



tinuation, or foot portion, which is joined by a plate to receive the foot by an antero-posterior joint, so that the shoe may be accurately adjusted to the "equinus" element of the deformity. The endless screw which I show you at A (Fig. 57) is operated by a key, and acts through this hinge upon the anterior portion of the foot. The sole is divided opposite the medio-tarsal joint, and by means of the screw B (Figs. 58, 59) acting upon the centre of motion at A allows of extreme and powerful abduction of the anterior part of the foot. The apparatus

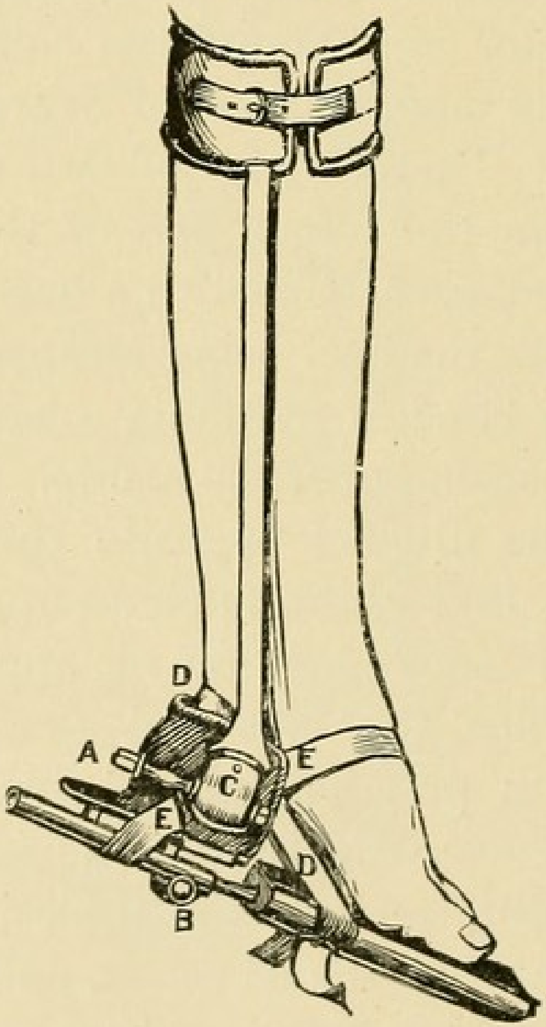
FIG. 60.



having been applied to fit the deformity, and secured by a bandage (F, F), the foot is thrown into a position of valgus by means of the screw A (Fig. 57) acting upon the hinge C, and this is supplemented by applying the force of the screw in the sole plate B (Fig. 58), which still further acts upon the anterior deformity. It is better to use the apparatus by stretching the tissues several times in succession, and, after allowing them to relax, to adjust the brace to the corrected position. Having by this method overcome the lateral deformity, as illustrated in Fig. 60, our attention must be directed to the antero-posterior or equinus element.

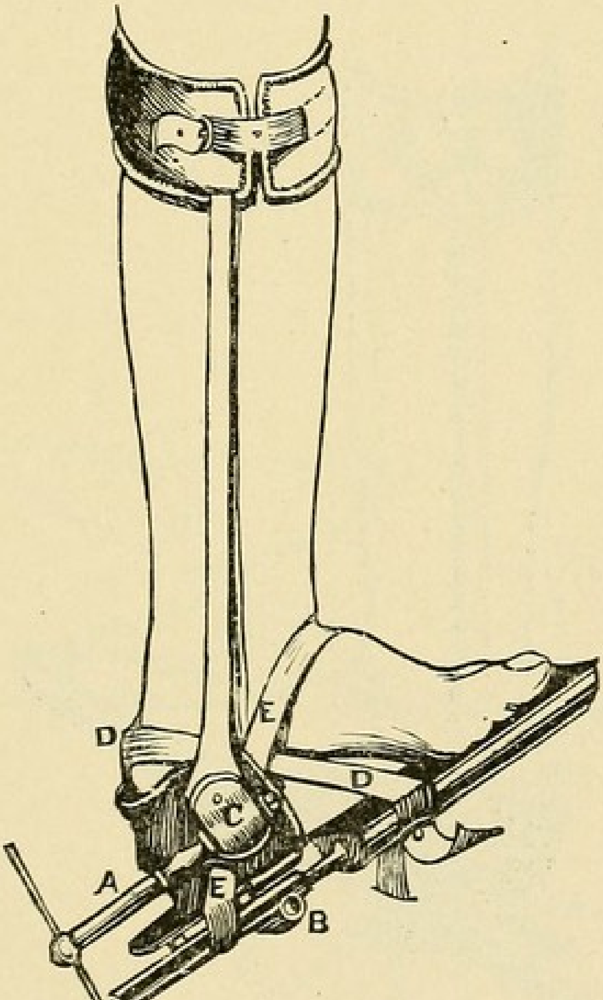
To correct this deformity by mechanical means it is necessary to apply an instrument which, through the tendo Achillis, will elongate the contracted posterior muscles of the calf. To accomplish this many modifications of Scarpa's shoe have been devised. They consist of two steel uprights extending from the upper part of the tibia to the ankle-joint, and are attached to a heel-cup and sole, to hold the foot, the heel being strapped in its place by means of a band of webbing, a bandage, or similar material passing over the instep. The sole may, or may not, be divided opposite the medio-tarsal junction. At first sight, such an apparatus would seem to fulfil the indication of applying a force sufficient to flex the foot and stretch the tendo Achillis, but in practice we find that as the necessary power is exerted, the centre of motion in the instrument being opposite the ankle-joint, the heel-cup slips away from the os calcis, and the posterior border of the foot is found resting upon the top of the heel-cup. To obviate this, Shaffer has in his extension shoe, which I now proceed to apply to this patient (Fig. 61), divided the sole of the brace opposite Chopart's joint, and attached to the anterior portion or sole an extension bar which is worked by a key which is introduced beneath the heel-cup at B. The shoe having been applied *extended to an* *angle corresponding to the angle of deformity,* and the heel secured in its place by a strap passing over the instep, E, the os calcis is further secured by a strap, D, passing around it posteriorly and attached to the buckles upon either side of the anterior portion of the sole plate. When flexion is made by the

Fig. 61.



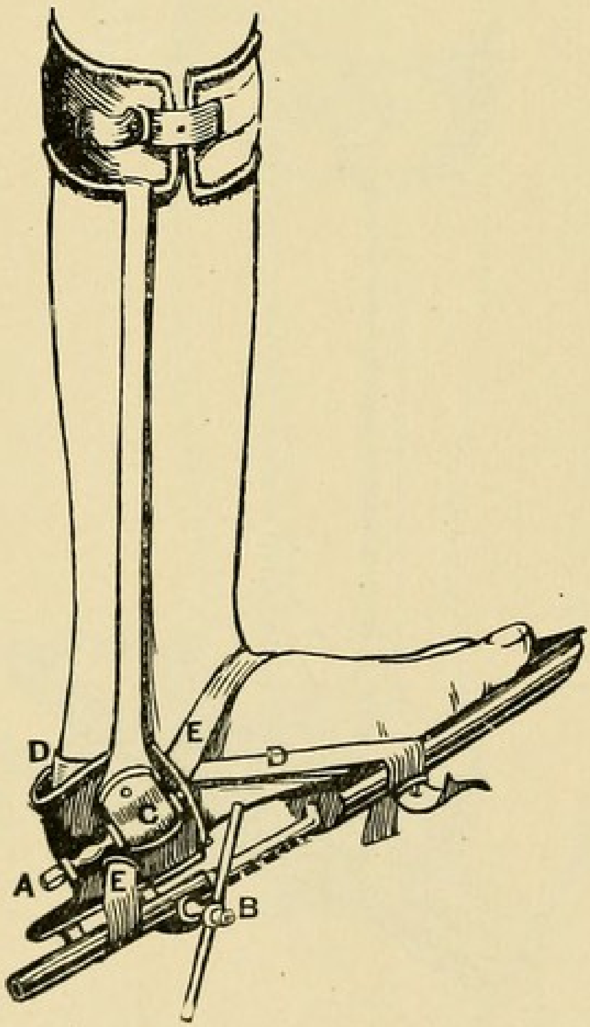
key at A, which acts upon the endless screw opposite the ankle-joint, C, the tendency of the heel, as you see in Fig. 62, is to slip away and rest upon the upper border of the heel-cup, and the degree of flexion of the foot does not correspond to that of the brace. If now we insert the key below the heel-cup at B, and throw the anterior portion of the sole forward, the os calcis is dragged upon by the strap passing over it at D, and the centre of motion is transferred from a point opposite the ankle-joint, to a point represented by the centre of the strap, E, which passes over the instep, and the heel descends until it rests upon the extension bar. The tendo

Fig. 62.



Achillis is thus thoroughly put upon the stretch, and may be felt as a tense band (see Fig. 63). The operation is repeated several times at each sitting, and the amount of flexion thus gained is held by readjustment of the brace in the acquired position. No danger need be apprehended from interference with the circulation, if proper precautions be observed; the pressure is not continuous, being rather a *momentary overstretching*, followed by relaxation. The foot should be inspected daily. After the treatment has resulted in bringing the foot to a right angle with the leg, a retention-shoe with stop-joint

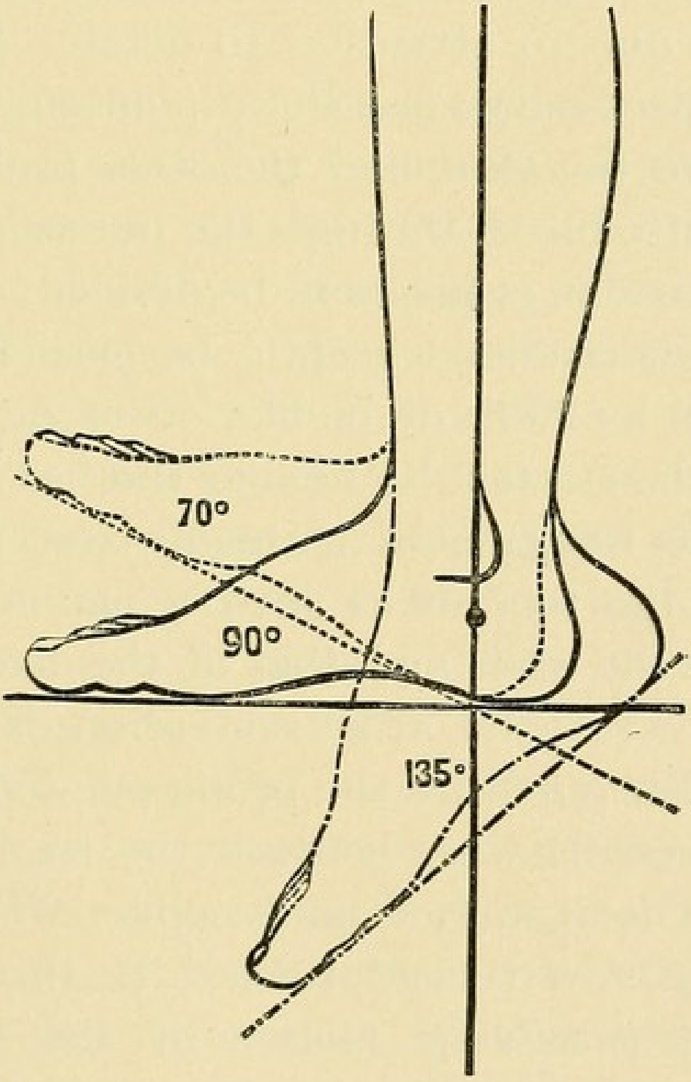
FIG. 63.



should be worn, to keep the foot in the corrected position, and a similar apparatus must be applied during the night throughout the treatment. Here let me remark that a cure is not effected when the amount of possible flexion of the foot forms a right angle with the tibia.

Referring to the diagram (Fig. 64), you will observe that the normal foot in extreme flexion forms with the leg an angle of about 70 degrees, and at the ankle-joint motion is possible, in the normal condition, through an arc of which the extremes are represented by 135 degrees of exten-

FIG. 64.



sion and 70 degrees of flexion. Our endeavor in the treatment of talipes equinus should be to make the acquired flexion reach this amount as nearly as possible. In connection with this subject, I wish to call attention to the existence of cases of *incomplete equinus*, designated "non-deforming club-foot."

In this condition flexion is impossible beyond 90 degrees, and the deformity is amenable to the treatment just described.

CASE III. *Acquired double talipes equino-varus from tetanoid paraplegia; tenotomy of each tendo Achillis.*—You will recollect the case presented at our last meeting, which comes before us now for operation. In performing tenotomy, much of its success is due to attention to detail. Two tenotomes are necessary; one sharp-pointed, with which to puncture the skin, and the other probe-pointed, which is introduced through the puncture and beneath the tendon or fascia to be divided. The parts having been rendered aseptic by cleansing with a solution of 1 : 2000 of bichloride of mercury, and put upon the stretch by flexing the foot, the puncture in the integument is made over the central portion of the tendon in such a manner that the incision in the skin and that of the deeper tissues shall not correspond after relaxation of the parts. Through this puncture the probe-pointed tenotome is introduced flatwise beneath the tendon and as close to its deep surface as possible. The cutting edge being now turned toward it, the tendon is divided by a sawing motion of the knife. An assistant keeps the tissues upon the stretch until the operation is almost completed, but relaxes his hold before the tendon is thoroughly divided, to preclude the possibility of the instrument cutting its way through the skin. The tenotome is again turned upon its side, and withdrawn through the puncture, the operator placing his finger over its point of exit, dusting with iodoform, and sealing with a pledget of cotton saturated with compound tincture of benzoin, which forms a pellicle and prevents the entrance of air. After the operation the foot is placed in the extension brace, in order that its degree of flexion may be controlled. This possesses the great advantage over fixed plaster-of-Paris dressings of allowing frequent inspection of the parts.

I shall only mention the operations of myotomy, or division of muscles; tarsotomy, or osteotomy of the tarsal bones; tarsectomy, or the removal of a wedge-shaped piece of bone; open incision, as advocated by Phelps and Hingston, instead of subcutaneous tenotomy; and amputation as a last resort. These are so rarely performed and so little necessary, that it is only essential that you should know that such procedures have been devised.

The next case I have to show you is one of acquired talipes calcaneus.

Case IV. *Acquired single talipes calcaneus from infantile spinal paralysis; application of Barwell's rubber muscle; improvement.*—Maggie B., aged ten, first presented for treatment in the Orthopedic Dispensary of the University of Pennsylvania. She has kindly consented to appear before you to-day. You will notice the characteristic deformity, the foot being flexed by the action of the anterior groups of muscles, the patient walking upon the heel. In this condition, no treatment does so well as the application of elastic force, advocated by Barwell. The rubber supplies the place of the paralyzed gastrocnemius and soleus, and should be applied as you see in this case. To the shoe are attached two uprights with an antero-posterior joint opposite the ankle. It is important that this joint should be so arranged that, while it will permit flexion to any degree, it will stop extension at a right angle. The posterior rubber muscle is attached above to a band which passes around the upper part of the calf and below to the heel of the shoe. Should there be much contraction of the anterior muscles, their tendons may be divided in the manner described, before the application of the apparatus. An operation has been devised for exsection of a portion of the tendo Achillis for the radical cure of this condition, and consists in the removal of a portion of the tendon and the stitching together of the divided ends.

The next case I have to exhibit illustrates a very important principle in treatment.

CASE V. *Acquired single talipes equino-varus; mechanical extension, aponeurotomy; recovery.*—Joseph F., aged ten years, applied to the Orthopedic Dispensary of the University Hospital for relief from a congenital talipes equino-varus with pronounced *cavus.* The case was treated by mechanical extension, as described when speaking of talipes equino-varus, and resulted in the perfect reduction of the equinus and varus. There remained, however, marked cavus caused by contraction of the plantar fascia. The extension-shoe was applied with the hope of relieving this condition, but without result, when aponeurotomy was resorted to.

Several operations were performed, the knife being entered beneath the plantar fascia, and the resisting tissues nicked, and the extent of the division was regulated by the degree of relaxation of the plantar arch resulting from each operation. As you see, the boy has made a perfect recovery.

I wish to draw your attention especially to the inefficacy of mechanical means in cases of cavus with marked contraction of the plantar fascia, and the reason will be readily understood if we consider the structure and function of the arch of the foot. In those forms of talipes which depend upon contraction of muscles, mechanical force applied through the tendon will act upon muscular tissue and elongate it. The plantar arch, on the contrary, is constructed with the view of supporting the weight of the body, the tissues entering into its formation are of the most unyielding character, *i. e.*, plantar fascia, and no amount of mechanical power which can be safely applied will suffice in cases in which it is markedly contracted. Aponeurotomy is necessary, and performed tentatively, nicking a little, and repeated as often as necessary, yields the best results.

The last patient to which I shall call your attention to-day illustrates a condition the opposite of cavus, the essential element being relaxation of the plantar tissues.

CASE VI. *Acquired double talipes planus* ("*flat-foot*") *from rhachitis; plantar springs; improvement.*—John B., aged thirteen years. This case shows the deformity in a marked degree, the plantar arch being relaxed and flattened, the internal border of the foot resting upon the ground. These cases, in which there is much pain, have received the appellation of "inflammatory valgus." Besides rhachitis, the other causes of this deformity are paralysis, ankle-joint disease, and rheumatism. It also occurs in growing children, and in those whose occupation necessitates long standing in one position. In mild cases the most efficient means at our disposal for its relief are the plantar springs, which have been applied in this case, with the resulting improvement which you notice. They are made as follows:

A tempered steel spring is placed inside the shank of the shoe, moulded in such a manner as to support the relaxed tissues of the arch and overcome the tendency of the foot to eversion. In cases of greater severity it should be supplemented by an ankle support having a pad which will make pressure upon the internal malleolus.

All forms of club-foot may be simulated by the neuromimetic or hysterical conditions. In cases of this kind the pedal deformity may be accompanied by contractions in other regions, or it may be the only symptom outside the general condition, and the dependence of the local trouble upon the neurotic state may be very difficult to discover. Here, as in neuromimetic affections in other regions, contractions and contractures may so counterfeit their organic prototypes as to render positive differentiation well-nigh impossible. In making a diagnosis, the general condition and surroundings of the patient, the hereditary history, together with any fact as to previous mimicry or simulative tendency, should be carefully weighed. The local condition alone is not a reliable guide: the contractions are often as unyielding as in the real deformity; the muscles do not relax during sleep, and the condition may be very persistent. It is only by a careful consideration of each case, and a diagnosis by exclusion, that a correct opinion can be formed.

The care of this condition taxes the patience and ingenuity of the surgeon to the utmost. In few words, the treatment is that of the general neurotic state, coupled with the absolute avoidance of all local manipulations and mechanical contrivances suited to similar organic deformities, and which would here direct the attention of the patient to the affected member. Despite the most careful general treatment, the deformity may persist for months, as shown by Dr. S. Weir Mitchell,[1] of this city. In this case, hysterical single talipes equinus in a young lady of fifteen had continued for two years, notwithstanding the fact that treatment had removed all the more general symptoms of the hysterical state; and it was not until division of the tendo Achillis, which I performed after consultation with Dr. Mitchell, that the deformity finally disappeared.

[1] Lectures on Diseases of the Nervous System, especially in Women. By S. Weir Mitchell, M.D., p. 129. Philadelphia: Lea Bros. & Co., 1885.

KNOCK-KNEE AND BOW-LEGS,

WITH REMARKS ON

RHACHITIS.

KNOCK-KNEE AND BOW-LEGS,

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RHACHITIS.[1]

LECTURE I.

GENTLEMEN: As Macewen, of Glasgow, and others have, by the revival of the operation of osteotomy for the cure of knock-knee and bow-legs, renewed the interest in these deformities, and placed themselves on record as being ardent advocates of operative procedures for their radical relief, it will be my endeavor to call your attention especially to these important malformations; and I purpose to inquire how far operations are a necessity for their correction, and what proportion and class of cases can be best treated by such means, and, also, whether mechanical methods of treatment are not fully as important as those of a more radical nature.

Mechanically considered, knock-knee and bow-legs result from an alteration in the plane of the articulating surfaces of the bones entering into the formation of the knee-joint, with or without a curv-

[1] Clinical Lectures on Orthopedic Surgery, delivered at the Philadelphia Hospital.

ing of the shaft of the femur or tibia, whereby the knee is thrown either inside or outside a perpendicular line let fall from the head of the femur to a point midway between the two malleoli. Should the knee fall inside this line, the resulting deformity is known as knock-knee or *genu valgum*, the opposite condition, that in which the knee is without the perpendicular, being called bow-legs or *genu varum*, and the causes producing these results may be summarized as: 1. Rhachitis. 2. Ligamentous relaxation. 3. Central disturbances destroying the equilibrium of muscular action, or affecting the nutrition of the epiphyses.

By far the most frequent and important cause is the one first mentioned, namely *rhachitis*, which favors the production of deformity by the softening of bone and the relaxation of ligaments which occurs during its progress, whereby we have an alteration of the normal development of the cartilage and periosteum from increased cell proliferation, the resulting cartilaginous and osseous tissues being less completely matured, and much more retarded in their development than in the normal course of bone growth. Moreover, the rapidly proliferated cells are not supplied with a sufficient quantity of inorganic elements, and, therefore, a relative excess of organic material with a corresponding deficiency of lime salts occurs. In other words, the cells which are deposited are immature, half ripe in character, and the dyscrasia interferes with their normal progression toward maturity. When the disease finds expression in the epiphyses, it occurs at the epiphyseal juncture, at which point we find the cartilage filled with young cells which are neither mature cartilage cells nor true bone cells, but have a character which partakes of both. In consequence of this abnormal cell deposit we find the thickness of the cartilage is increased, and the structure has not the resisting quality so marked in health; on the contrary, the aggregation of cells forms a soft, non-resisting material which breaks down and gives way under pressure, and if this pressure be unequally distributed, bending of the bones and alteration of the plane of the joints result.

Rhachitis is, primarily, a constitutional disorder, whose local manifestations fall with greatest force and frequency upon the organs of locomotion and support, the bones, the epiphyses, articular surfaces of the joints, the ligaments, and muscles. The osseous changes found are due to increased vascularity of the periosteum and other nutritive centres, the epiphyses, and medullary substance. Rhachitis is a disease of early childhood. Cases in which it is congenital have been reported, and knock-knee and bow-legs have been observed in the new-born. The disease most usually begins about the period of dentition, and is attended by disturbances in the alimentary tract, vomiting and chronic diarrhœa being frequent. The patients suffer also from sweating of the head, face, and neck, and prefer to lie quietly, resisting attempts to move or handle them. With this, notable weakness and marked tenderness are observed, and this weakness, noticeable chiefly in the muscles, sometimes gives rise to a condition which has been mistaken for infantile paralysis, although no palsy exists. While some children suffering from rhachitis appear fairly well nourished, the majority have a large belly, and a puffy, flabby condition of flesh, easily distinguished from the firm, resistant feeling of healthy tissues. They are also peculiarly liable to convulsive affections, as before mentioned, and chronic hydrocephalus occurs frequently. Thirst is at times urgent; the patients sit or lie about; are silent or drowsy, and at night often rest upon their hands and knees, with their heads buried in their pillows, or toss restlessly from side to side.

While these symptoms are progressing, notable changes are going on in the bones, muscles, and ligaments. I have already alluded to these changes in my general remarks on pathology, and have shown you how their chief expressions are found in the epiphyses and shafts of the bones. Clinically, it is not, however, alone in the long bones that the changes take place. The skull, with its thin and softened envelope and thickened sutures; the thorax, as shown principally in the beaded ribs, chicken-breast, and curved vertebræ, and the flattened, distorted pelvis, all bear evidences of the disease. Not all the cases, however, exhibit these universal effects of the general condition. Indeed, I have seen undoubted evidences of localized rhachitis where the disease, so to speak, had expended itself upon one locality. Thus, it is not unusual to see deformities which are unilateral in character, and one-sided cases of bow-legs and knock-knee are not uncommon. We have already spoken of the causes which produce this condition, and will only add that, although it is found more frequently among the poorer classes, the wealthy are by no means exempt from it. Poor sanitary surroundings, insufficient nourishment, lack of air and sunlight, and the crowding together of many people, frequent pregnancies, and the bringing up of children "by hand," all add their quota as active agents in its production. Locality and climate also have their influence as causative factors. Thus, it is by no means a common disease among American children, but is very frequent in Southern races, the negro being peculiarly liable to it; and its frequency in England has caused the Germans to give to it the appellation of "*Englische Krankheit.*"

I have dwelt at length upon the general manifestations of rhachitis as it is in this stage, before local symptoms have developed, that general treatment may prevent deformity. In beginning the treatment, great care should be exercised in the selection of appropriate diet, and all errors in this and the surroundings of the patient should be corrected. The child should be regularly taken out in the open air, and "sun-baths" given. Attention should be especially directed to the proper bathing of the child, and the skin kept in good condition by these means. The diet should be digestible and nutritious, and all approved methods having for their object the proper hygienic care of the patient should be persistently and systematically employed. As to drugs, those which are directed to checking the diarrhœa after the bowels have been emptied of irritating matter are first indicated. The time-honored "rhubarb-and-soda" mixture will best accomplish the latter purpose, while drop doses of tincture of opium, with the addition of an alkali, have best succeeded in my hands in checking the diarrhœa. To improve the general condition of the child, cod-liver oil may be given, and by many it is considered a specific; but there are many objections to its use; it is apt to increase the digestive trouble, and many children cannot be induced to take it, no matter how disguised. Good, fresh butter answers admirably as a substitute, and fulfils all the indications of the oil. The compound syrup of the hypophosphites is another excellent remedy, and is readily administered for a long time. Iron is an efficient tonic, especially the syrup of the hypophosphite or the iodide. Phosphorus also has given excellent results in this as well as other wasting diseases of the bones. Such is a brief outline of the medicinal treatment of rhachitis, important in all cases of the disease, but most important in cases prior to the occurrence of deformity, in addition to which mechanical supports should frequently be used as a prophylactic measure. The case I now show you will illustrate this principle.

Case I. *Softening of the bones from rhachitis; retention braces; improvement.*—J. M., aged twenty-six months. The hereditary history in this case is good, as to bone, joint, or lung troubles; she was apparently healthy until her eighth month, when her mother was obliged to leave her to the care of strangers. At this time it was noticed that she was not as lively as usual, had frequent diarrhœa, was peevish and restless at night, sweating freely, frequently soaking the pillow. She has never attempted to walk, but can hold herself erect by the aid of chairs. You will notice the flabby condition of the muscles, although she is apparently fairly nourished, and, although presenting all the characteristic symptoms of rhachitis—the large head, protuberant belly, and flattened epiphyses indicate rhachitis—there is, as yet, no evidence of deformity of the lower extremities, for the child has not yet walked, and nature has evidently acted in a conservative manner, by depriving the muscles of their proper tone, thereby making it impossible for the child to throw the weight of the body upon the lower extremities, and we have happily the power to prevent, by mechanical means, the occurrence of deviations which would surely follow were the softened osseous tissues allowed to bear unaided the superincumbent weight of the body.

In this case the object has been accomplished by the application of retention braces, consisting of two steel uprights fastened to the shoe, and extending above the knee, with joints corresponding to the articulation of the knee and ankle. These allow free motion, but at the same time remove the superincumbent weight. To one point I wish especially to call your attention: when I grasp the thigh and leg of the patient, and move the knee-joint from side to side, you can easily distinguish the preternatural lateral mobility of the articulation, a common condition in rhachitic subjects. This is due to ligamentous relaxation, and opinions vary as to the ligaments involved and their action in the production of the deformities, it being considered by some that primary relation of the internal lateral ligament results in a separation between the articular surfaces of the knee-joint upon the inner side, allowing increased growth of the internal condyle downward and inward in the gap between its lower surfaces at the head of the tibia, while others are of the opinion that shortening of the external lateral ligament, by permitting pressure to be exerted upon the external condyle, prevents its normal growth, the internal condyle, at the same time, completing its development. While some cases occur in which ligamentous relaxation seems to be the only *apparent* cause of the deformity, they are extremely rare, and I think that the relaxation, as a rule, is secondary to and symptomatic of the bony changes. While much attention has been given to the external ligaments of the knee-joint as factors in the causation of knock-knee, I am sure that the *internal* ligaments of the joint, principally the *crucial*, are largely concerned in the deformity; but as to the mechanism of these ligaments as causative agents, I cannot, for want of time, speak. In the small class of cases which exhibit no evidence of rhachitis, but which suffer from relaxation of ligaments, the term atonic can best be applied. They are similar to the class of lateral spinal curvatures known as habitual or functional; but, as before stated, in the majority of cases the ligamentous changes are secondary to the osseous ones, and depend upon the general condition, *i. e.*, *rhachitis*.

The changes which occur in the bones, and which lead to the deformity, may be divided into three stages:

1. *The stage of vascularity, or invasion.*
2. *The stage of softening, or deformity.*
3. *The stage of consolidation, or sclerosis.*

It is important that these stages should be recognized, as giving important indications for treatment. The second stage is well illustrated in the case before us: when I grasp the limbs and attempt to bend the bones, a characteristic springy sensation is imparted to the hands, showing that the stage of softening is still in progress, and indicating that constitutional and mechanical treatment are sufficient.

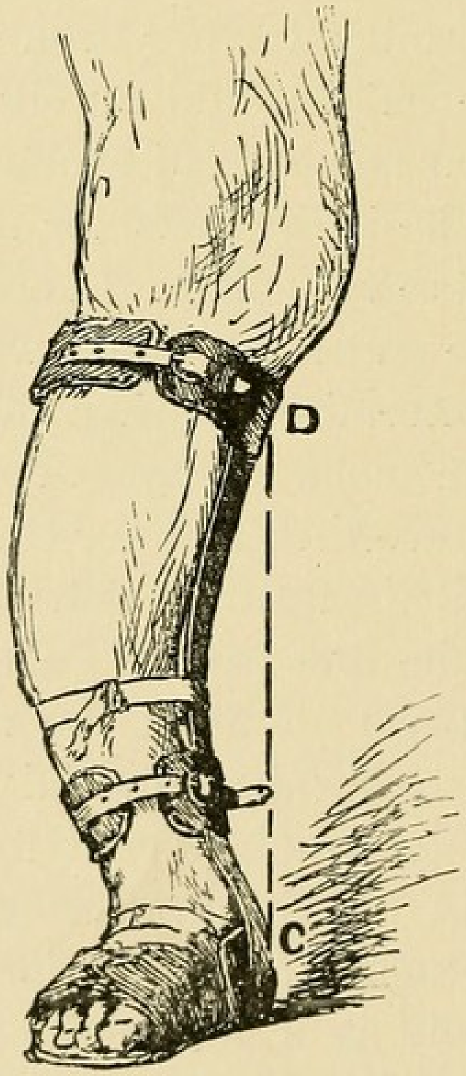
When softening has further progressed, and deformity has begun from the weight of the body upon the diseased tissues, mechanical support may still suffice; but when hardening or sclerosis has once occurred, and the bones are in a deformed position, nothing but operative measures will restore the limb to its normal position. To determine this stage in doubtful cases I use an instrument which I look upon as an important aid to correct diagnosis, *i. e.*, the ordinary bone drill, preferably, the cog-wheel drill of Colin, of Paris; the procedure is analogous to exploratory incision prior to other surgical operations. Where the drill encounters no obstacle to its entrance into the bone, and imparts to the hand the sensation indicative of soft tissue, operative procedures are not necessary; but, should the characteristic resistance of the sclerotic stage, as if the drill were being bored through ivory, be met, mechanical measures will be futile, and operation is necessary.

I have an opportunity of showing you another case illustrative of the stage of softening with beginning deformity.

CASE II. *Bow-legs from rhachitis; mechanical support; improvement.*—This patient, Mary W., is three years old; gives all the evidences of having had rhachitis, and still shows symptoms of what may be called the subacute stage. You notice many of the conditions to which I called your attention in speaking of the child who has just passed out; but, in addition to these, you are at once struck with the peculiar waddling gait, and the tendency of the feet to a varus position when the child attempts to walk. This varus is not constant, as in some cases of bow-legs there may be a valgoid position of the feet. Here you again see the unusual lateral mobility of the knee-joints. In the present instance the deformity, which is quite marked, is produced by curvatures affecting both the femur and the tibia; that is to say, the rhachitic process has involved the diaphyses above and below the knee-joint. This is not, by far, as common as those cases where the tibia is alone affected, in which case the deformity usually takes place at about the middle of the tibia, although the same condition, greatly magnifying the distortion, may occur at the lower third, or an anterior curvature of the tibia may be observed. When I grasp the bones firmly I at once get a peculiar springy response, and this serves as a guide to my treatment in this stage. In answer to inquiry concerning the increase of the deformity, the mother states that the bowing has increased very rapidly during the last four or five months; that before this it was not at all marked, and she has experienced no fear of a permanent deformity, having been told by a practitioner that the child would surely grow out of it. This is a popular fallacy, and cannot be too strongly condemned. The indications for mechanical treatment are therefore very plain. In order to counteract the effect of the superincumbent weight which falls on the lower extremities during the day in the act of walking, it becomes necessary to have something which shall relieve this, and for this purpose I use the conventional apparatus which I briefly described in speaking of the first case. This brace will allow your patient to go about at the minimum risk of increasing the deformity, and also give him an opportunity to get sunlight and fresh air, very important adjuncts toward improvement of his general condition. In cases in which deformity is present, this serves merely as a retention splint, and something more powerful must be used to overcome the deformity.

The brace which I have advised for the application of elastic traction has, in my hands, in private and hospital practice, accomplished excellent results. It consists of a piece of straight tempered steel, its upper extremity terminating in a semicircular steel band to extend half-way around the limb; below, and jointed to it opposite the ankle, is a steel foot-piece with heel-cup, which is secured to the foot by a strap passing over the instep, and a light leather shoe-piece laced over the foot. The length of the upright is regulated by the position of the curva-

FIG. 65.



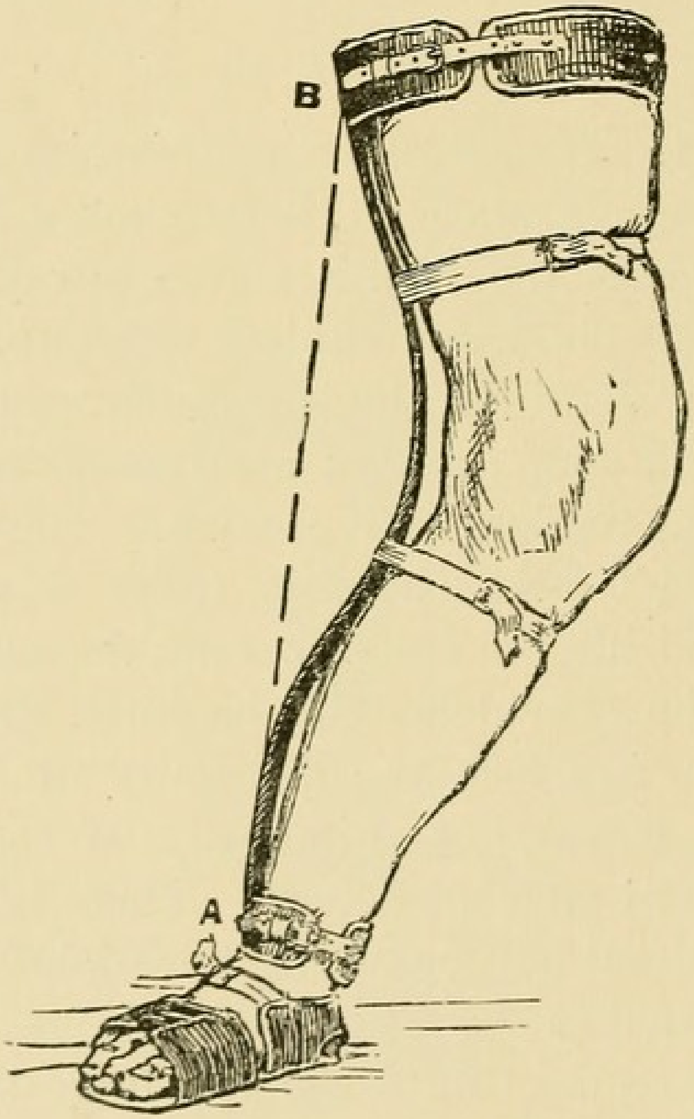
ture in the bones; in bow-legs where this occurs in the tibia, the upright should, therefore, extend only to its upper border. The brace is adjusted by securing it to the internal aspect of the limb, and the elastic element of the brace brought into play by strapping the steel upright to the leg at the point of the greatest convexity (Fig. 65). It should be thus applied at night, and it is readily seen that its constant effort to return to the straight line D C exerts a continuous elastic force in a direction calculated to reduce the deformity.

LECTURE II.

CASE III. *Knock-knee; application of elastic traction brace.*—Frances G. is two and a half years old, and has, as the father states, always been a weak, nervous child, and subject to croup. During the period of dentition she was much troubled with diarrhœa, and very thirsty; also perspired a great deal, and was restless and peevish. The ribs have the "beaded" feel; there is quite a prominent sternum, and all the epiphyses are flattened. The skull also shows evidences of rhachitis. On placing the child on her feet, the deformity of the lower extremities, consisting principally of the in-knee deviation, is at once perceived. There is the usual extensive lateral motion at the knee-joints which is also manifested in the other articulations. When I flex the legs on the thighs the deformity disappears; there is marked projection at the inner side of the knees, due to the hypertrophied internal condyle of the femur. The first thing that attracts attention to these cases is the peculiar gait when the children begin to walk, which they do not attempt, as a rule, until quite late, and, with this, much fatigue is complained of. Pain is not a frequent or urgent symptom, and, when it occurs, is referred to the inner side of the knee.

In the treatment of this case the same rules should be followed as are applicable to the cure of bow-legs; and as sclerosis has not as yet occurred,

Fig. 66.



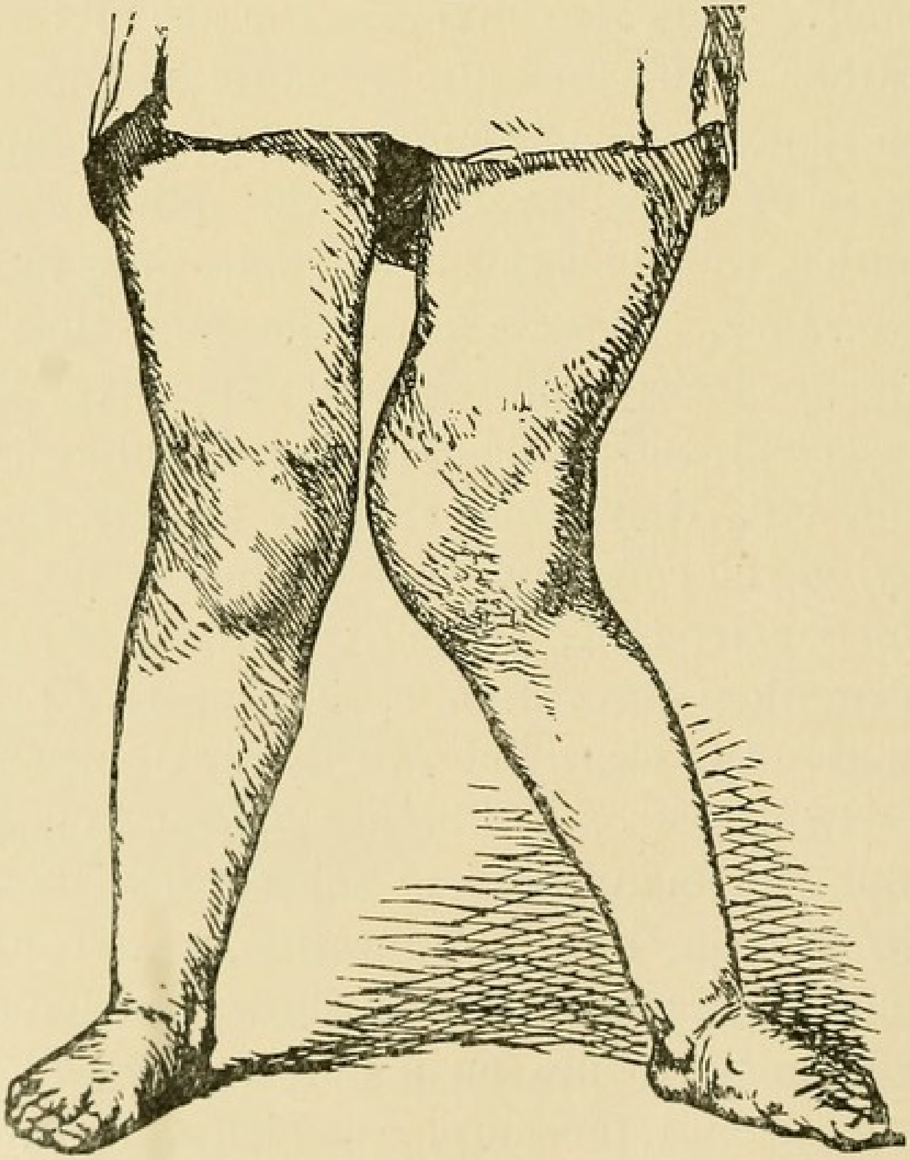
I shall use, in addition to the retention braces to be worn throughout the day, an elastic traction brace at night. (Fig. 66.)

It is applied to the external aspect of the limb, and the upright extends well up to the thigh, and is secured at two points, just above and just below the knee-joint, so that, in its efforts to right itself, it will produce continuous elastic pressure upon the *hypertrophied internal* condyle. It would be impossible in a clinical lecture for me to describe extensively the various forms of apparatus devised for the relief of this deformity, but among others used for removing it are those which aim at this result by the use of exaggerated interarticular pressure directed against the already hypertrophied internal condyle, thus attempting to produce absorption at this point. This also involves the use of intermittent rather than constant pressure. I am of the opinion that, while *intermittent traction* through soft tissues is of infinite value in the relief of certain deformities, this does not hold concerning intermittent pressure. Apart from the fact that these instruments are complicated and expensive, difficult of adjustment, and liable to constant malposition by slipping, etc., they must depend largely for their efficacy on the constant personal supervision of the surgeon or attendant. Again, the fallacy of attempting to produce absorption by intermittent pressure from without is clearly shown by Sir James Paget, in his "Lectures on Pathology," who, in speaking of atrophy as manifested in the Chinese foot, and also in stumps after amputation, says: "These examples, then, may suffice to show, as I have said, that constant pressure on a part produces absorption; occasional pressure, especially if combined with friction, produces thickening or hypertrophy, and that these result whatever be the direction of the pressure."

The positive atrophy and absorption of tissues from elastic pressure, on the contrary, are remarkably shown in the destruction and removal of large areas of bone, which frequently occur in aneurism of the aorta, and this brace is constantly exerting a similar influence upon the internal condyle.

CASE IV. *Unilateral genu valgum; osteotomy; cure.*—The next case is one upon which I operated

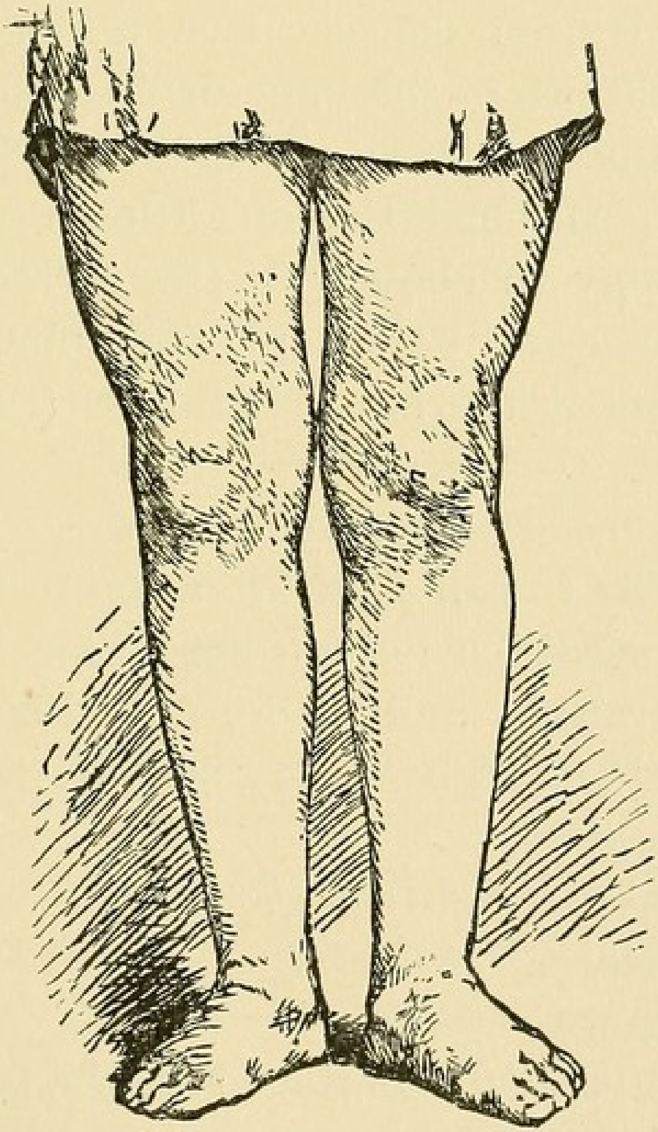
FIG. 67.



at the clinic a few weeks ago, and is the first osteotomy for *genu valgum* performed at this hospital.

Frank D., aged five, colored, an inmate of the children's ward, presented the following characteristic rhachitic deformities: The vertebræ are rotated upon their axis, and laterally deflected into the deformity of rotary lateral curvature and rhachitis, the primary curve existing in the lumbar region.

FIG. 68.



The deformity of the lower extremity presented as a unilateral genu valgum of the left limb. The femur is markedly curved in an anterior and lateral direction, the internal condyle being depressed below the normal plane of the joint, producing a decided in-knee deviation, as seen in Fig. 67, taken from a photograph prior to the operation. The duration and pronounced character of the deformity apparently render this patient a fit subject for the operation of osteotomy or subcutaneous fracture of the bone for restoration of the limb to a normal position. Yet in order to be perfectly sure that the stage of softening had passed, and that nothing more was to be expected from conservative mechanical treatment, I made use of the bone-drill spoken of, before operating, and finding all the indications of sclerosis present, I performed the operation of osteotomy, and am happy to show you the correction of the deformity as seen by these photographs, made prior and subsequent to the operation. (See Figs. 67 and 68.)

Before proceeding to my next case, I think it will be well briefly to call your attention to the different surgical procedures now in vogue for the relief of these deformities, and also to a short historical account of them. These may be placed under three heads, as follows:

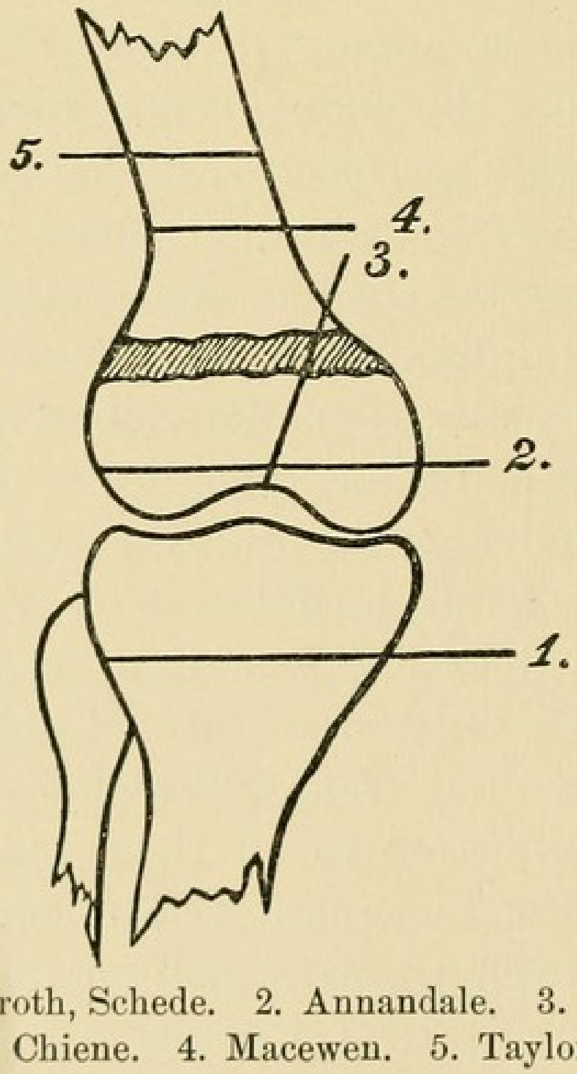
1. Forcible straightening.
2. Osteoclasis.
3. Osteotomy.

Of the first two mentioned methods, I will not enter into detail. They are approved by many surgeons, especially the French, and successful cases have been reported as having been brought about by these means; Delore, of Lyons, and Tillaux being their principal advocates. Excellent osteoclasts have also been devised by Colin and Robin.

The brilliant results attained by osteotomy have, however, given this operation the palm, and most surgeons now perform this in preference to osteoclasis.

Although osteotomy for an anchylosed hip-joint had been performed by Rhea Barton, of this city, as early as 1826, it was not until 1852 that Mayer, of Hamburg, first operated for knock-knee. He opened the joint in his operation, and one of his cases died of tetanus. In the same year Langenbeck proposed osteotomy in cases of anchylosed knee. Following this many osteotomies of different articulations were performed, and American surgeons, Pancoast, Sayre, and Brainard, were among the first to practise them. As applied to the deformity genu valgum, the first operator in England was Annandale, who virtually excised a part of the condyles of the femur for knock-knee, the operation being done under antiseptic precautions. Antiseptic osteotomy was introduced by Volkmann, of Halle, in 1875, the same year that Annandale operated. In 1876, Ogston performed the operation, using the saw, and was followed by Schede, of Berlin. The objection to all these operations was the fact that the knee-joint was opened, exposing the patient to even a greater danger than the original deformity. In 1877 Chiene cut through the condyle with a chisel, removing a wedge-shaped piece. In 1878 Barwell performed his "simultaneous multiple osteotomy," which consisted in a division of both femur and tibia. In 1878 Macewen introduced his supra-condyloid osteotomy, and this, involving no possible danger to the knee-joint, has been popularly adopted. In 1879 Reeves modified Ogston's operation so that the danger of opening the articulation was reduced to the minimum, the object being, at the same time, to replace the displaced condyle. The following diagram (Fig. 69) will illustrate the various points of election for the performance of osteotomy.

FIG. 69.

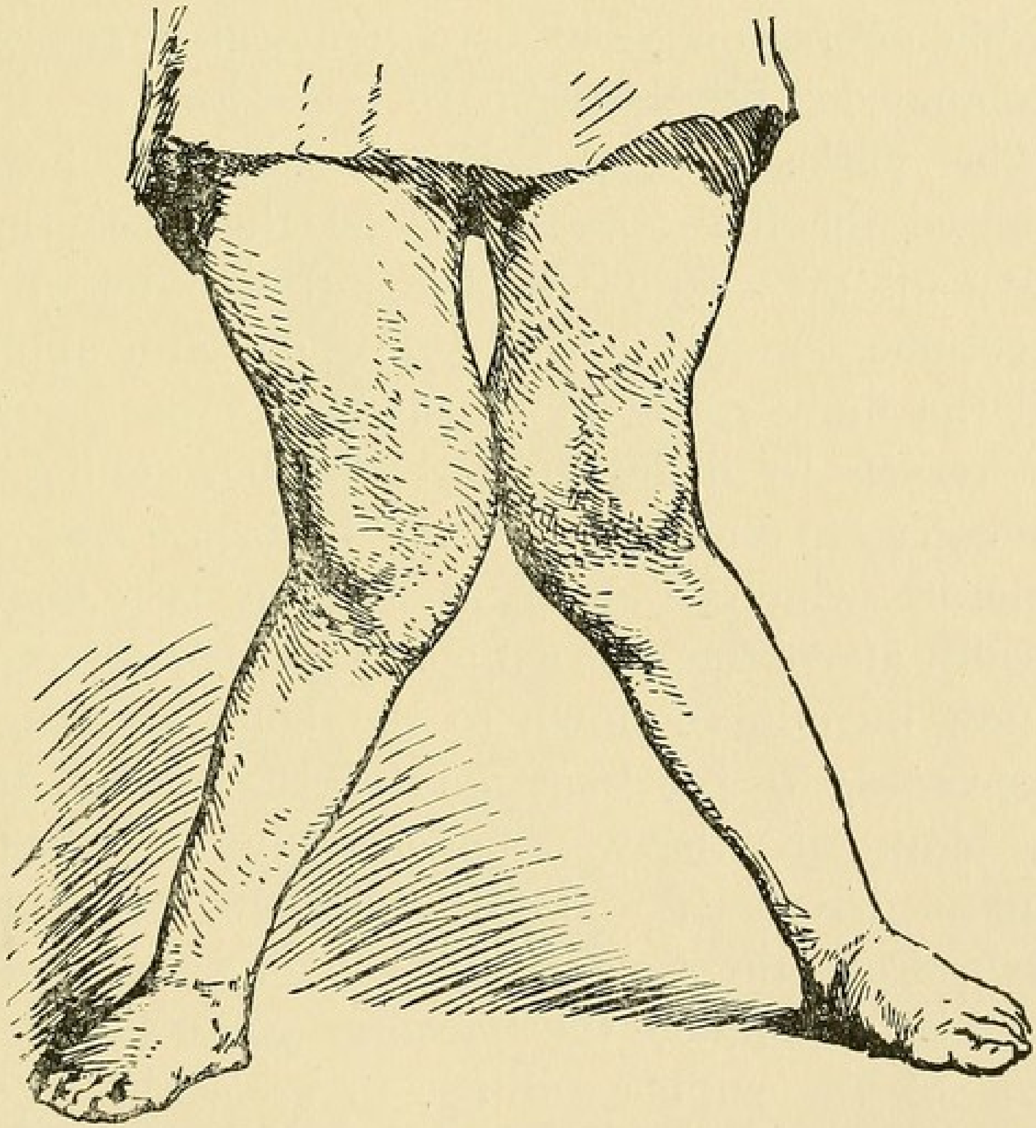


1. Mayer, Billroth, Schede. 2. Annandale. 3. Ogston, Reeves, Chiene. 4. Macewen. 5. Taylor.

Of all the operations mentioned, I give my personal preference to that of Macewen, and in the case which I now present to you, propose to perform the operation.

CASE V. *Bilateral knock-knee; double osteotomy by Macewen's method; recovery.*—The history in brief is as follows: Lottie H., aged five, colored, was admitted into the Philadelphia Hospital in 1881, suffering from severe bilateral knock-knee. No record could be obtained of her previous history

FIG. 70.

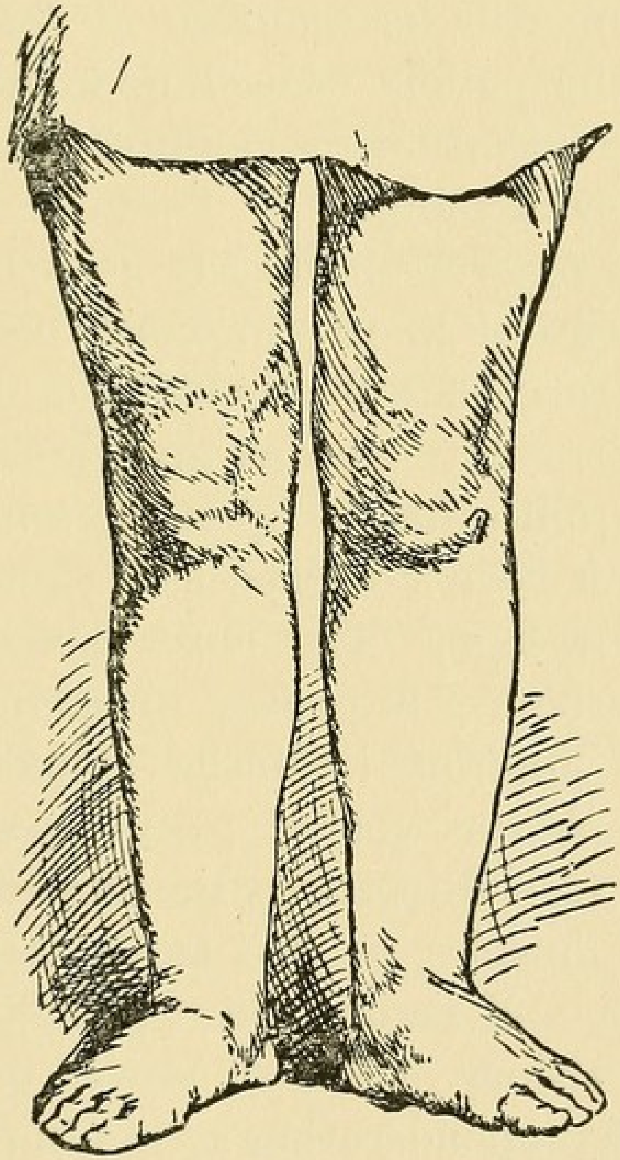


or the time at which the deformity first appeared. You will notice, however, that a marked curvature or in-knee deviation exists in both lower extremities (Fig. 70). The femora have an anterior bend in their lower third, as well as a lateral deviation.

Curves of similar character are present in the tibia. On measurement, I find, when the internal condyles of the femur are approximated, the malleoli at the ankle-joint are separated nine and a half inches, as shown in Fig. 70, from a photograph. On account of the long-standing and pronounced character of the deformity, having satisfied myself by the drill that sclerosis has taken place, I propose to do a double supra-condyloid osteotomy, after the plan recommended by Macewen, of Glasgow.

The patient being anæsthetized, and having cleansed the limbs and rendered them aseptic at the point of election for the introduction of the osteotome, the elastic roller of Esmarch is applied, and the limbs rendered bloodless. After securing the vessels by a few turns of rubber tubing, the bandages are removed, and the limbs are ready for puncture, which is made at a point two fingers' breadth above the internal condyle. The osteotome is now introduced down to the bone, and turned transversely to the long axis of the shaft. By a few blows of a heavy wooden mallet, the instrument is driven through the bone, and then withdrawn from the wound, a little force being now required to complete the fracture. Now loosen the turns of the rubber tubing, to ascertain if any hemorrhage has taken place, and, as you see, this is very slight and mostly venous. The punctures are dusted with iodoform, and covered with pledgets of lint that have been previously soaked in compound tincture of benzoin, which quickly dries, forming an excellent artificial seal. The next step is to envelop the limbs in a flanner roller, and place over all the plaster-of-Paris bandage from the toes to the upper third of the thigh. It is well always to have the plaster thoroughly dried in an oven overnight,

FIG. 71.



From a photograph taken six months after operation, showing correction of deformity.

as it facilitates its setting and makes a much stiffer and more durable splint; while the plaster is setting, the limbs are "over-straightened," and the knees brought in a position of slight genu varum, by placing a roller bandage between them, and bringings the malleoli together. Three days from the date of operation I shall cut a small fenestrum in the dressing opposite the point of puncture, and examine the wound. Should no unfavorable symptoms intervene—*i. e.*, suppuration or retarded union—the dressing will be removed at the end of six weeks, and the patient placed upon her feet with light steel retention-braces, jointed at the knee and ankle, to allow of motion.

Before closing, I desire to say a few words upon the other causes of knock-knee and bow-legs mentioned in the early part of this lecture. Disturbance of trophic centres acting either upon muscular tissue, destroying equilibrium, or upon the nutrition of the epiphyses, has been assigned as a cause of knock-knee and bow-legs. The most direct results of central disturbance are seen in connection with poliomyelitis anterior (infantile spinal paralysis), and in tetanoid or spastic paraplegia. Here deformity is induced directly by the lack of supporting power in the muscles, as well as the loss of tone in the ligaments, and cannot be explained by the old antagonistic theory of loss of power in one set of muscles, with preponderating action in others. The same conditions obtain which Volkmann had shown to exist in the production of club-foot, the deformity not resulting from loss of muscular antagonism, but rather from growth while the part remains in an abnormal position. It is also probable that in these paralytic cases the changes brought about in nutrition affect the bone to a large extent, as it has been shown that they are much thinner, more curved, and softer than normal. Here we cannot say that rhachitis enters as an etiological factor, owing to the absence of its characteristic symptoms.

The fact that cases of unilateral in-knee deviation are often observed without the association of symptoms denoting the presence of rhachitis has given rise to the idea that there is a condition which affects the nutrition of the epiphyses in such a manner as to produce knock-knee, and that this is a probable result of central changes having their expression in the epiphyseal cartilages of the knee-joint. This is purely theoretical, though not an entirely groundless idea.

I have thus endeavored to give you concisely the principal points in the pathology and treatment of bow-legs and knock-knee, and hope that, with the general indications I have attempted to impress, you will be enabled to cope successfully with these deformities.

FLAT-FOOT:

A NEW PLANTAR SPRING FOR ITS RELIEF.

FLAT-FOOT:

A NEW PLANTAR SPRING FOR ITS RELIEF.

Among the most distressing and painful deformities of the lower extremity which the orthopedic surgeon is called upon to treat, cases of flat-foot stand foremost. I should not have ventured to speak of this very common deformity did I not think that its importance is often overlooked, and that in many instances it is a source of much confusion regarding its etiology, diagnosis, and treatment, to those who have not had many opportunities for studying the disease.

As a rule, the ordinary forms of club-foot are unattended with pain; this sympton entering only secondarily, either as a result of pressure from walking in the deformed position, or from the faulty mechanical appliances used to correct the deformity. In the form of talipes under consideration, however, pain plays an important part, and with this the disability produced is often so extreme as to render the patient unable to pursue his ordinary occupation. Thus, in addition to the usual end to be attained in the treatment of deformities of the feet, namely, the restoration to the normal form of the foot, we have another and more practical object demanding our utmost attention and study, and that is the preservation of the means of livelihood to those who are unfortunately afflicted with flat-foot.

Like other forms of talipes, flat-foot, or talipes valgus, may be a congenital or an acquired malformation, but it is very rarely found at birth to such an extent as to be considered pathological. On the other hand, the acquired forms of valgus, taking all the varieties collectively—whether occurring as simple flattening of the arch, as secondary to rhachitis, as the result of infantile spinal paralysis, or those of the inflammatory type—talipes valgus probably occurs most frequently of all the distortions of the feet.

It may be well, in this connection, before proceeding to an account of the etiology of talipes valgus, to give a brief account of the normal mechanism of the foot and of the plantar arch. All of that portion of the lower extremity situated below the tibio-tarsal articulation enters into the construction of the foot, and in the adult has the form of an arch, with its convexity or dorsal surface above and its concavity or plantar surface below. At the highest point of this arch, which is formed by the astragalus, the weight of the body is received and transmitted; receiving the weight on its trochlear surface from the tibia, and transmitting it through the so-called pillars of the arch. Of these there are two, the anterior one, composed of the scaphoid, three cuneiform and the three inner metatarsal bones, being the longer, less oblique, and more elastic. The posterior pillar, formed by the os calcis, is shorter and thicker, its concavity being directed inward, and it is less elastic than the anterior one. The astragalus, therefore, may be regarded as the keystone of the arch; but it differs in certain respects from the keystone of the ordinary arch. While its anterior surface, by its apposition to the concave posterior surface of the scaphoid, fulfils this requirement, posteriorly it rests upon and overrides the os calcis. Hence, this weak point in the arch has to be supplemented, so to speak, and this is accomplished by the soft parts, the interosseous ligaments passing between and binding together the bones, the calcaneo-scaphoid ligaments arising from the inferior surface and forepart of the os calcis, and passing to the posterior and under part of the scaphoid bone, thus giving direct support to the head of the astragalus. Again, we have a secondary arch supporting the primary one. This is formed by the outer part of the os calcis, the cuboid, and the two outer metatarsal bones, this supplementary arch being supported by the calcaneo-cuboid ligaments, while the strong plantar fascia extends between and acts as a brace to the pillars of the arch. It must not be forgotten that, while an arch has ordinarily to receive weight only in one direction, in the case of the foot the direction of the weight is continually changed by the various positions assumed by the body in its movements. Thus, while in the standing position the weight would fall chiefly on the astragalus and be directly transmitted to the two pillars of the arch, in walking, running, dancing, etc., involving, as these movements do, the different parts of the foot, the weight is constantly shifted, and consequently the ligaments and muscles of the foot are called upon to reinforce the arch by their action. Added to this there is the mobility of the tarsus, and this mobility is the greatest just where the greatest strain falls, namely, between the astragalus and scaphoid. The muscle principally called upon in this connection is the tibialis posticus, while the inner part of the calcaneo-scaphoid ligament is chiefly engaged in resisting all extra strain.

It will be easily understood then, that, associated with the different complex movements alluded to, involving as they do the raising (flexion) and placing of the foot on the ground (extension), on the resistance offered by the tibialis posticus and calcaneo-scaphoid ligament, and upon the help thus given to the arch, depend the conservation of the form of the foot. Again, the normal curves of the foot give a certain amount of mechanical advantage in the distribution of the superincumbent body weight. Thus, in flexion the two curves of the foot—the larger, with its concavity downward, and a lesser one along the inner side of the foot, with its concavity outward—are increased. On the other hand, in extension, as when the foot is firmly planted on the ground, both these curves are diminished and the foot is flattened. It is evident, therefore, that any cause operating to weaken those tissues which, by their aid, serve to strengthen the arch, will cause a permanent extension of the foot, with obliteration of the natural curves. Thus, in occupations requiring continued standing or walking, or the maintenance of a given position for a long time, these structures become overtaxed, and, as a consequence, do not afford the proper accessory support to the arch; there exists a condition of permanent extension of the foot, and sooner or later, depending on the constitution of the individual, flat-foot follows as a consequence of this abnormal strain.

The morbid anatomy of flat-foot, or spurious valgus, shows differences according to the etiology of the given cases. Thus, in the congenital variety very few pathological changes are noticeable. The external appearance of the foot shows a decided lowering or flattening of the normal arch, with the inner margin of the foot depressed and closer to the ground, while the outer border is raised, and the anterior part of the foot everted. Sometimes in these congenital cases there is a marked degree of equinus associated with the valgus, and when this occurs there is decided contraction of the calf muscles. In the congenital form of valgus there is not much displacement of the bones of the foot, the principal changes consisting of the elevation of the tuberosity of the os calcis, while the astragalus is pushed downward and forward, and is seen as a prominence on the inner side of the foot, with the rotated scaphoid bone, which is also prominent. There is a slight rotation outward of the cuboid bone, and the malleoli are depressed, being found on a lower plane than normal. The weight of the body coming on these disturbed relations is not properly received and transmitted, and, as a consequence, the strain becoming too severe on those tissues which serve to assist the arch, there is a resulting stretching of the ligaments on the plantar and inner side of the foot. Thus the calcaneo-scaphoid ligament especially, which bears the brunt of resistance to displacement, and is constantly called upon in this connection, becomes relaxed. In the congenital form, although the muscles show few changes, with the continuance of the affection there often ensues a marked contraction of the peronei and calf muscles, the foot then taking the form of an equino-valgus. With this there is often found a contraction of the extensor longus digitorum, the extensor pollicis, and the abductor minimi digiti, with slight alterations in the relations of all the tendons of these muscles.

The forms of flat-foot which deserve most of our attention will come under those found in the acquired variety, and these are the cases which, from the unusual suffering and disability they occasion, constitute a large and important class. They have been variously called "splay-foot," "spurious valgus," "inflammatory flat-foot," "the tarsalgia of adolescents," etc. In children the acquired form of valgus usually met with is the result of a poliomyelitis anterior, and in this condition the anterior tibial and adductor muscles are usually the paralyzed ones. At times, as in the congenital form, there is a coincident contraction of the calf muscles, rendering the deformity a compound one, and we have a talipes equino-valgus. It is also found very often associated with knock-knee and bow-legs, as a mechanical result of these deformities, especially in rhachitic subjects. Rhachitis itself is a very prolific source of this deformity, while as a symptomatic condition in ankle-joint disease, after injuries and burns of the foot, and following rheumatism, flat-foot is of frequent occurrence.

Each one of these causes must be made out and its relations to the deformity closely studied, but the limit of this paper is too short to give an extensive account of each variety. It is the condition variously named, as already stated, that I wish to emphasize particularly.

While to the experienced orthopedist flat-foot is not especially difficult of detection, to one who has not seen many cases it frequently presents puzzling symptoms. Thus, it is frequently mistaken for neuralgia, rheumatism, and even for chronic osteitis of the tarsal bones, and I have had patients who have been treated for all these conditions before the real cause was diagnosticated. They are met with generally at the period of adolescence, although I have had several cases in which the patients were between forty and sixty years of age. In occupations necessitating long continuance of one position, as is the case in bakers, machinists, clerks, waiters, weavers, or in those vocations which compel constant and fatiguing motion, as in soldiers, the deformity happens frequently. Growing boys and girls, especially those of a languid disposition with a tendency to the accumulation of adipose tissue, are more liable to this painful trouble. Certain races seem prone to this affliction, namely, the negro and the Jewish races.

The gait and attitude of patients suffering with this trouble are characteristic and easily recognized. They have a heavy, dragging gait, the knees being bent, and the feet are placed in a careful, gingerly way on the ground, so that all the weight possible shall be kept from the tender part. When such patients step on an uneven surface the pain complained of is of an excruciating nature, and walking or standing is avoided as much as possible. The patients are easily tired, and have an anxious expression of countenance, the general condition sympathizing to such an extent with the local trouble that, in certain instances, the nutrition of the patient suffers very markedly. This is not difficult to understand when we reflect that, occurring as it does in young people generally active, and at a time of life when the desire for exercise and enjoyment is at its height, the enforcement of comparative idleness by the pain experienced prevents the proper completion of those functions which give the system at large its elasticity and tone.

The morbid changes found in the acquired form of flat-foot are those which are found associated with the special etiological factors entering into the production of the deformity. For a long time it was supposed that the painful variety, in which we are especially interested, was due to an osteitis, but no absolute evidence of an inflammatory lesion, such, for instance, as that seen in the head of the femur in *morbus coxarius*, has been found. Still, I have seen cases in which, on rotation of the tarsus, marked reflex spasm of the abduction muscles was occasioned. If any osteitis be present, it would seem to me to be of the nature of dry, or caries sicca. In none of the cases that I have seen have there been evidences of suppuration, the local symptoms at times showing swelling, especially below the malleoli, with a semi-fluctuating feeling; but heat is generally absent. On the contrary, the feet of flat-footed people are, as a rule, cold, and have a peculiar, dark-blue look, as though the venous circulation was badly accomplished. The appearances of the bones are such that pressure in the deformed position would amply account for them. They are not especially altered in their relative positions, although, with the gradual falling of the arch, the astragalus becomes slightly displaced downward, the scaphoid and internal cuneiform bones being brought to a lower plane than normal and nearer the ground. It is at the inner side of the foot where the astragalus and scaphoid show prominently, that, as a rule, the greatest amount of pain is experienced; but the location of the pain is by no means constant, the transverse tarsal joint, the metatarso-phalangeal articulation, and even the calcaneum being at times the seat. With the continuance of the abnormal pressure and the bony changes due to it, there is seen a gradual destruction of the normal arch. The abductor muscles begin to contract strongly, while the adductors are in a condition of functional paresis, and thus, added to the flattening of the foot, we have abduction and a constant condition of extension; and if the contraction of the abductor muscles be maintained, the outer edge of the foot is raised and does not touch the ground. In the extreme degrees of the affection the instep becomes totally obliterated through the loss of the convexity of the arch, and the internal malleolus especially becomes more and more prominent, and is seen with the protuberant astragalus and scaphoid bones as a prominence on the inner side of the foot.

In this condition, I have found, taking the mediotarsal joint as a base line of measurement, and erecting upon this a perpendicular corresponding to the long axis of the os calcis, that the angle of internal deflection is reduced from twelve degrees in moderate cases to five degrees in severe ones. From an examination of severe cases, I have ascertained the average deviation from the perpendicular to be about eight and two-tenths degrees.

The prognosis in cases of flat-foot depends in a large degree on the causes which occasion the deformity, the surroundings of the patient, and the time when he comes under treatment. In the congenital form of the disease, when it is not of great severity, the prognosis is usually a favorable one, but the severer cases, and those which have been allowed to go on for a long time, are usually more resistant, and often necessitate protracted treatment. In the acquired form, occurring as it usually does in the poorer classes, although the wealthy are by no means exempt, and being mostly met with in those who are dependent for their support on their vocation, the prognosis is not so favorable, many of these cases not coming under treatment until the pain becomes excessive and the deformity far advanced. Still, where the hygienic and other surroundings can be improved and the patients placed under favorable conditions, and when the disease is not the result of incurable paralysis or of chronic joint lesions, I know of no disease in which so much can be done for the relief of pain, and in which such gratifying results can be accomplished, although much time and patience may be necessary for the removal of the deformity.

Concerning the treatment of flat-foot very little need be said regarding the congenital type of the deformity. When seen shortly after birth the patients may be successfully treated by manipulations alone, these having for their object the carrying of the foot to a more inverted position. To retain the advantage gained by these movements moleskin adhesive plaster (Maws, London), with a roller bandage, may be employed to draw the foot into the varus position. When the deformity is more severe, and the child older, external splints of a simple character, composed of tin, gutta percha, or hatters' felt, may be employed. These are moulded to the part, and a gradual inversion of the foot accomplished. Should contractions occur which cannot be overcome by the use of the simple means mentioned, tenotomy of the peronei and extensor longus digitorum becomes necessary. Should the tendo Achillis be contracted, this will also have to be cut. These operations, however, are best divided into two stages, the peronei and extensor longus being tenotomized first, and the tendo Achillis subsequently. Massage and electricity to the weakened tibial muscle may also be resorted to with the greatest advantage. When the child is old enough to walk, a simple support, consisting of two lateral uprights, connected with a band to encircle the calf, and with an inner pad corresponding to the axis of the astragalo-scaphoid articulation, and attached to the bottom of the shoe, may be used.

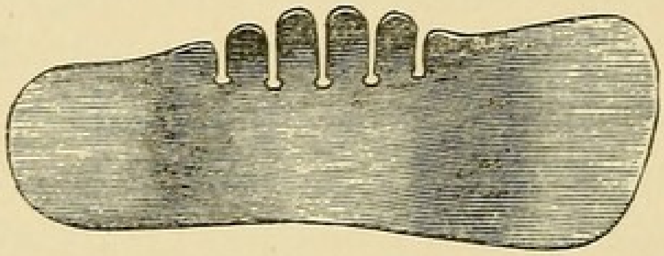
The forms of flat-foot which we shall be called upon to treat frequently are those which belong to the acquired variety. Here our treatment will, of course, be governed by the cause producing the deformity and by the amount of pain and deformity.

I have already, in discussing the etiology of the disease, given a brief account of the different causes operating to produce flat-foot, and will not dwell at length on the differentiation of these causes, but simply remark here that any constitutional causes or diatheses—whether strumous, rhachitic, or tubercular—should receive careful attention. Neither will it come into the province of this paper to discuss those extreme instances of valgus which, having been neglected for years, present so much deformity that nothing but exsections of the displaced tarsus will suffice for a restoration to a useful foot. The symptomatic valgus seen in the course of ankle-joint disease or osteitis of the tarsus, generally yields to the treatment employed for the primary lesion.

It is on the inflammatory form, so called, that I will place especial stress in the matter of treatment. I have already alluded to the difficulty of obtaining *rest* for these cases, owing to the fact that they for the most part occur in the working classes, where daily labor is necessary for their support. Where it can be done, the removal of the patient from all employment suffices, especially in beginning cases, to promote a rapid cure; but even in these cases some support to the weakened arch is called for. This has been accomplished in several ways—by inserting pieces of leather, pads of different material and construction, or tempered steel bars and springs on the plantar surface of the foot.

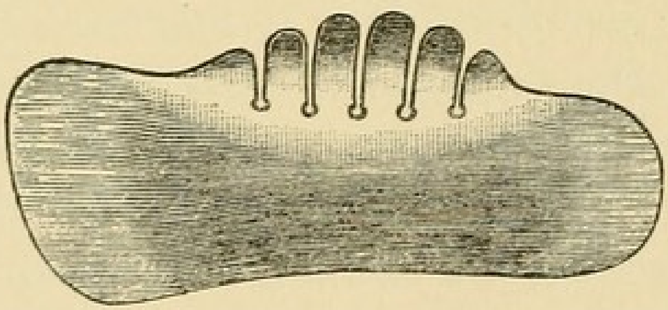
While relief can undoubtedly be afforded by these means, there are objections to their use, chief among these being the expense of especially constructed shoes and the introduction of these various contrivances. Of all those mentioned, however, I have had the best results from the use of tempered springs so made that the convexity of the spring shall be at that point where the arch of the foot is most flattened. These I have had made to extend from the middle of the os calcis to the base of the metatarso-phalangeal articulation, and their object is to supply an artificial arch for the foot. They have, however, to be inserted as a shank into the shoe, and this necessitates the construction of a special boot and oftentimes the making of a special last for the patient. Again, being very narrow, they do not, when there is extreme flattening, give the desired amount of support, patients often feeling the necessity for more pressure than can be given by them. I am indebted to Mr. Arthur H. Lea, of Philadelphia, for an improvement on this spring, and it gives, undoubtedly, the best support of all the contrivances I have used or am acquainted with.

FIG. 72.



Upper surface of spring.

FIG. 73.



Under surface of spring.

The artificial arch illustrated in the cut is made of tempered steel. An outline of the patient's foot is first taken on stencil-board, the tracing being extended upward on the inner side of the foot. The elevated portion, corresponding to the depressed arch of the foot, can be tempered to the extent required by the particular case. The lateral pressure brought to bear by the elevated flanges is such that, while giving support to the arch to a certain extent, the artificial arch also prevents further displacement of the astragalus and scaphoid. Again, in place of giving only a limited amount of support to the inner side of the foot, this appliance supports the foot as a whole. The objection urged against the narrow spring is entirely avoided by the use of this one. It can be placed in any shoe and changed at pleasure. In most of the cases in which I have used it the spring is simply inserted into the shoe without any fastening whatsoever. The transition from absolute disability to comparative freedom from pain which the use of this simple contrivance affords is surprising, and it is all the more gratifying from its simplicity and easy adaptability. Where the disease has lasted for a long time I sometimes combine with it the ankle support mentioned, and it often serves as a valuable adjuvant in cases in which the muscles and ligaments are fatigued from long use in the deformed position.

I cannot close these remarks without enjoining the necessity of proper massage and electricity to the weakened parts. Much good, also, may be done at times by the use of rubber bands, especially in those cases in which the tibialis anticus is in a paretic condition. Concerning the use of plaster of Paris for the *redressement* of the foot, I would simply say, that the chief objection against its use lies in the fact of its compelling the patient to keep his bed, and so depriving him of the benefit of fresh air and sunlight—both good adjuvants to the other treatment recommended.

CHRONIC ARTICULAR OSTEITIS OF THE KNEE-JOINT:

WITH A DESCRIPTION OF

A NEW MECHANICAL SPLINT.

CHRONIC ARTICULAR OSTEITIS OF THE KNEE-JOINT.

I HAVE chosen the term chronic articular osteitis as the one best expressing the pathological condition found in those lesions of the epiphyses of the knee-joint that have usually been described by the older writers under the caption "tumor albus." My reason for so doing has been by proper classification to refer directly to inflammation of the cancellous structure of bone, thereby avoiding the confusion that usually exists if the more general terms arthritis and knee-joint disease be employed.

Before considering the main feature of the paper, viz., to bring before your notice a new mechanical splint, designed for the treatment of chronic articular osteitis of the knee-joint, it may be profitable to review hastily the etiology and pathology of the affection, the latter especially in reference to its clinical expression, a thorough appreciation of which aids so materially in deciding upon an intelligent method of treatment.

From an analysis of many hundred cases of articular osteitis, I feel safe in asserting that two structures only are responsible for the development of chronic osteitis.

1. The cancellous structure of the epiphyses.

2. The synovial membrane.

Frequently the two are combined, and disease of either may develop from the other; it is not, however, until the cartilages and ligaments have been invaded by the inflammatory process that we are justified in using the term arthritis.

The pathological changes that give rise to the more familiar clinical symptoms may be classified in the following order:

A simple non-suppurative osteitis interna, the primary lesion in the more formidable osteitis interna fungiosa, caseosa, or necrotica, accompanying which suppuration or the formation of inflammatory neoplasia frequently adds serious complications to the process of cicatrization.

Of these and the many other subdivisions of chronic articular lesions designated by different pathologists, only two demand special consideration —the fungoid and suppurative, to which we may add the non-humid variety of old age, the "caries sicca" of Billroth.

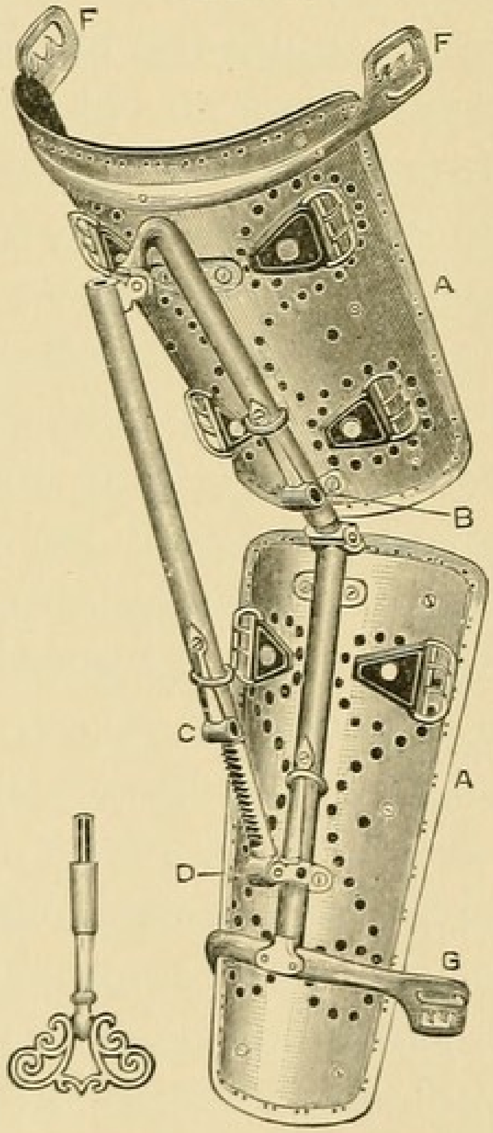
In all save the necrotic variety the process of destruction is by molecular death and absorption, or suppuration; the character of the discharge frequently marking the atonic form of the lesion.

The fungous proliferations of a chronic synovitis may, from pressure, eat their way through the cartilage and produce by contiguity an osteitis superficialis; traumatism, by direct injury to the articular surfaces, may produce the same inflammatory process; seldom, however, without a predisposition to the strumous, tuberculous, or rheumatic diathesis.

Any of these inflammatory conditions when existing in the epiphyses may give rise to certain neural disturbances that aid materially in their recognition. I refer to the ever-present symptom of rigidity of the joint due to a reflex spasm of the muscles that control it. This interference with normal joint-motion is due to an inflammatory irritation of the nerves distributed through the epiphyses, reflected by their centripetal fibres to the multipolar cells, thence to the great nerve-centres, causing the apprehensive condition of pain and the reflex spasm and consequent atrophy of the muscles controlling the articulation. It is to this involuntary muscular spasm that we are indebted alike for a means of differentiating true osteitis from many of the diseases that simulate it, as well as the insidiously progressive character of the deformity, *i. e.*, flexion of the limb and the frequent subluxation of the head of the tibia into the popliteal space. Accept what definition we may of the lesions found in post-mortem examinations of the joints, the progressive character of the disease, the tendency it presents to frequent exacerbations after long periods of repose, the difficulty in controlling deformity and of relieving pain, the frequent formation of cold abscesses, all class their treatment among the most difficult problems that may fall to the lot of a general surgeon. To meet the universally recognized principles of treatment, *i. e.*, fixation of the joint and extension, I have designed the splint that I now feel justified, from the success that has attended its use, in presenting to the profession.

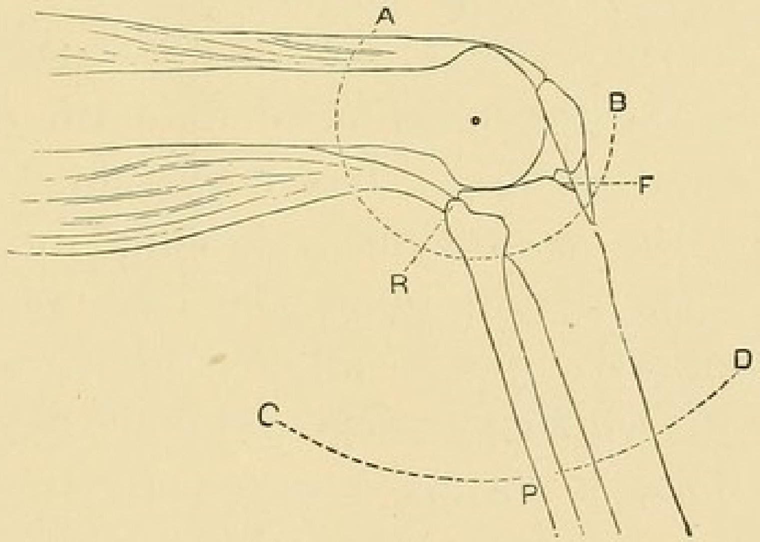
It consists of two light padded steel troughs (A, A) that are firmly secured to the limb by encircling bands of surgical webbing, affording absolute fixation to the joint when the extending rods are locked after adjustment. Three ratchet extension

FIG. 74.



bars arranged in the form of a triangle are placed posteriorly, corresponding to the long axis of the limb, placing within the control of the surgeon a power that will overcome the flexion and the tendency to the production of deformity, and at the same time produce extension. It will be noticed, in referring to Fig. 74, that the extension rod, B, acts directly upon the head of the tibia and parallel with the line of contraction of the flexor group of muscles, obviating thereby the error in the mechanical arrangement of the popular Stromeyer's splint, or in all where the power is applied low down on the tibia to overcome the flexion. Reference to Fig. 75 will illustrate diagrammatically the point at issue, *i. e.*, how to overcome the flexion and subluxation without establishing a fulcrum, F, at the

FIG. 75.



surface of the diseased joint, which would be the case should we apply our force at P, a distance below the insertion, R, of the resisting flexor tendons.

In the splint under consideration the long extension rod, C, is used only as a compensating bar, adjusting the angle of the splint to the angle of the flexion of the limb. The power for restoring the head of the tibia and overcoming the spasmodic contraction of the flexor muscles is applied directly in the axis of their contraction. Through the extension bar, B (Fig. 74), the head of the bone describes in its restoration the arc of a circle, A B (Fig. 75). The compensating bar in correcting the angle or flexion carries the limb through the arc C D, having a centre in the end of the femur. Mechanically this arrangement of force corrects the deformity and relieves, by extension, the reflex spasm of the flexor muscles, without crowding together the diseased joint-surfaces or aiding in subluxating the head of the tibia, as would be the case should the limb proper be used as the long arm of our lever, with the insertion of the hamstring tendons, instead of the normal centre of motion of the joint, as the centre of motion of the splint. Supplementing the direct extension upon the contracted muscles, another bar, D, has been added to aid in steadying the joint and relieving interarticular pressure. Its action upon the limb is produced through adhesive plaster applied above and below the joint, to which surgical webbing has been attached. This is firmly secured to the counter-extending band, F, and to the extension rod, G, affording a means of direct extension always corresponding to the angle of flexion. The extension bars are controlled by a key-and-ratchet movement held in place after adjustment by a small ring and pin. I have found that this method of securing fixation with extension by a portable appliance enables the patient to enjoy, by means of crutches, all the hygienic advantages of open air and exercise, facilitating thereby a better result than would otherwise be obtained.

DEFORMITY OF THE FOREARM AND HAND:

WITH AN

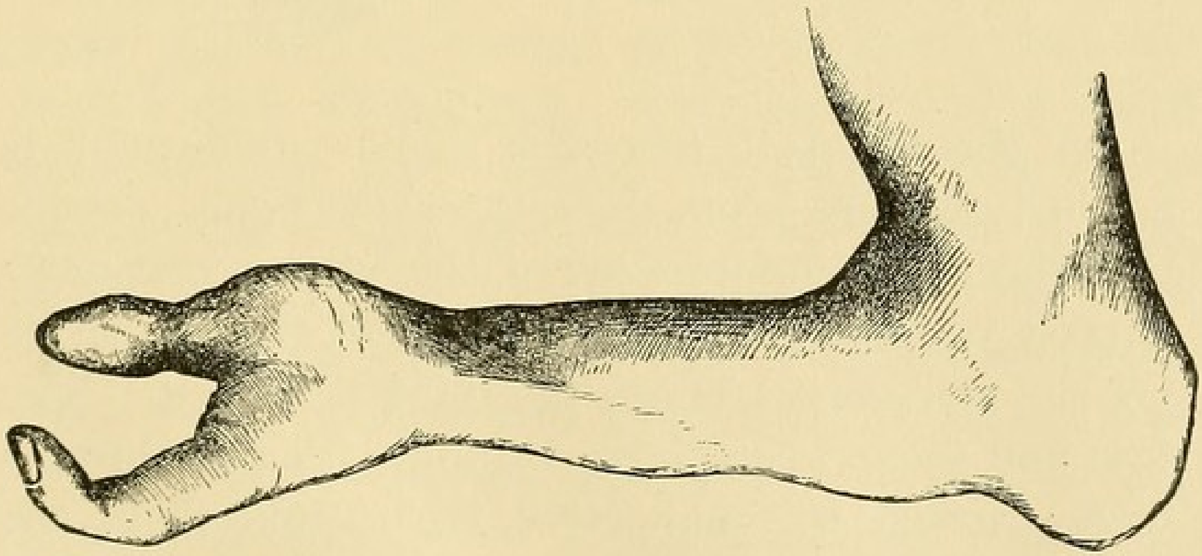
UNUSUAL HISTORY OF HEREDITARY CONGENITAL DEFICIENCY.

DEFORMITY OF FOREARM AND HAND.

Aaron MacIntyre, aged seventy-three years, six feet four inches in height, a peddler by trade, and a native of New Hampshire, was admitted to the Philadelphia Hospital on March 7, 1885. His forearm and hands exhibited the following congenital deformity:

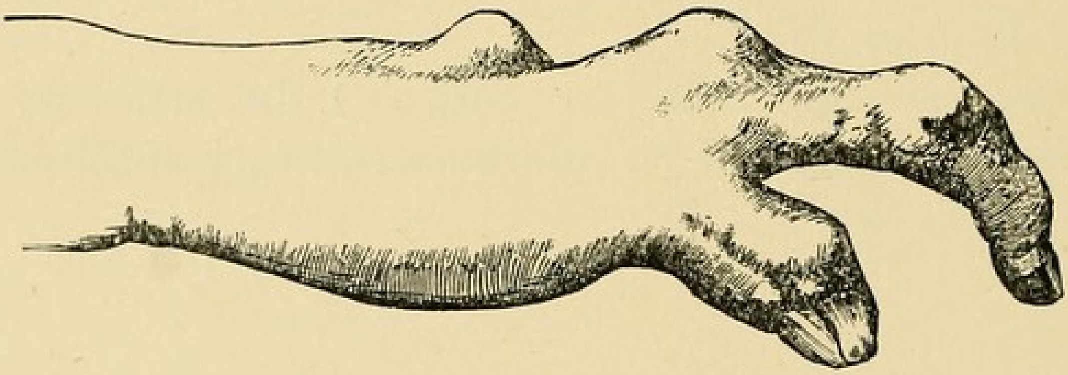
On the right side (see Fig. 76) the humerus is normal except that its inferior extremity is rounded

Fig. 76.



so that the condyloid notch is scarcely perceptible. In the forearm the ulna is absent, the radius forming with the outer condyle of the humerus an articulation which admits of limited motion in all directions, but which does not admit of either complete extension or flexion. The carpal bones present are those which articulate with the radius, and the first two metacarpal bones. The pisiform, cuneiform, and unciform bones are absent. Of the metacarpal bones, only the first and second are present. The thumb and index finger are present and normal, except that the first phalangeal articulation of the latter is anchylosed and the finger is, as a whole, slightly curved toward the thumb. The third, fourth, and fifth digits are wanting.

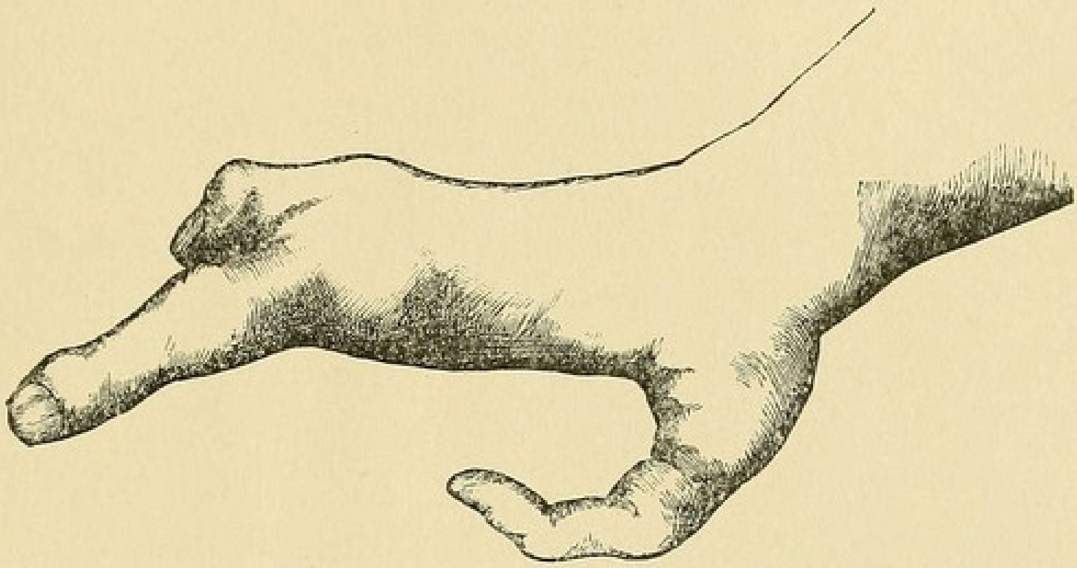
Fig. 77.



On the left side (see Fig. 77) no deformity is noticed until we reach the metacarpal bones, except that the olecranon process of the ulna is markedly curved toward the inner condyle of the humerus. Of the metacarpal bones the third is absent. The first and second each have a thumb, the two thumbs being united by connective tissue and skin, the thumb nails being contiguous, and each complete in itself. The metacarpo-phalangeal joints are enlarged. The index finger is somewhat curved on itself. The middle and ring fingers are absent. This leaves a fissure between the index and little fingers which extends to the wrist, as shown in

Fig. 78. The patient has considerable power in his hands, with full use of the parts present.

FIG. 78.



The following history of similar deformities in his family is interesting, and there is no reason for doubting the veracity of the patient's statement. His grandmother on his mother's side had one index finger stiff. Two uncles on his mother's side had each a stiff little finger. One sister had a hand deformed like the patient's left hand. She had a perfect child. Another sister's child had a hand deformed like his right hand. The patient has been married twice, and is the father of seven children. The two by his first wife were perfect. Of the five children by his second wife, two were perfect and three were deformed with malformations similar in character to his own.

Although many cases somewhat similar to or resembling the one above described have been reported, principally by Annandale,[1] to whom the

[1] The Malformations, Diseases, and Injuries of the Fingers and Toes. Thomas Annandale, F.R.C.S., Jacksonian Prize Essay, 1864. Philadelphia, J. B. Lippincott & Co., 1866.

reader is referred for a further study of these affections, the unusual heredity observed in the present instance was deemed worthy of more than passing notice. Here heredity seems to have assumed unusual prominence, several generations having reproduced at one time or another malformations, which, although not absolutely similar, have been markedly so in the type and locality of the deformity. In studying the etiology of congenital malformations we find the subject surrounded by much that is mysterious and confusing, owing to the varying importance attached by authors to the influence of physical and psychical conditions of the patients upon the child in utero. I will not attempt to deal here with the very extensive question of predisposition to or inheritance of disease in general, but only briefly consider malformations, and especially those due to arrested development.

Hereditary similarities have been observed alike in the most extensive and most minute forms. These may vary from the shape of a particular part of the body, or of a special organ, such as the nose or ear, to the small pigment stain known as a "mother's mark." Accompanying these physical marks, similar mental tendencies and physical carriage can be observed for successive generations, giving to races and persons their marked individuality, in the same way that organs perfectly normal, but characteristic, are reproduced and physical defects and abnormalities are transmitted from parent to child. Most congenital malformations, especially those due to arrested development, have been referred to pathological changes affecting the child in utero. It being granted that the fœtus has its own circulation and nutrition, and that, consequently, disease of a part may take place, resulting in effusions, exudations, atrophies, and hypertrophies, with consequent marked nutritive changes, this will not account for all the malformations met with. For whilst these lesions undoubtedly cause certain deformities, it has been found experimentally, according to Wagner,[1] that malformations may be produced by wounding the ovum, and thus preventing the development of the part implicated.

Thus the action of mechanical agencies, such as blows and falls at an early period of gestation, have a claim as causative agents in the production of anomalous development. The question of maternal impressions, through the influence of fright, shock, etc., is also to be considered, and their possibility as factors cannot be entirely denied on *a priori* grounds, the literature of the subject abounding in many instances where the relation of cause and effect is seemingly very clear. The result of the most recent investigations, however, would tend to show that the effects apparently brought about by these are the results of fœtal disease or spontaneous amputations. Simpson[2] and Montgomery[3] have described cases where portions of the digits and extremities have been so amputated, and Simpson

[1] Manual of General Pathology. Translation by Seguin and Van Duyn. New York, 1876.

[2] Simpson's Obstetrics, vol. ii. p. 375.

[3] Todd's Encyclopædia of Anatomy and Physiology, "Fœtus."

has called attention to certain rudimentary digits sprouting out from the end of the stumps. These effects have also been demonstrated by preparations, where it is shown that by the encircling of the extremities by turns of the umbilical cord, or by bands of false membranes, spontaneous intra-uterine amputations have resulted. Lastly, slight lesions in undeveloped fœtal organs can cause great disturbances by preventing proper nutrition of the parts, and thus, the progress, size, and quality of the organ being interfered with, the resulting adult development is either defective or entirely wanting.

These in brief are the causes of congenital malformations, and, while many of the questions in regard to this class of cases are still in doubt, sufficient etiological explanation can be deduced in the reasons already stated for most of the cases met with without resorting to apparent coincidences or fanciful theories.