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# OPERATIVE TREATMENT OF ANCHYLOSIS OF THE SHOULDER-JOINT.

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A PARTICULARLY interesting case of ankylosis of the shoulder presented itself at the Charity Hospital, in the person of a colored man, J. A., an octroon, aged fifty-seven years, whose family and general histories had been good.

Some years before he had sustained a fall from a horse and injured his right hip, but especially the right shoulder. He was confined to his bed only a few days, but the injured shoulder became more and more stiff. Some time after he sustained another injury, a fall on the same shoulder, and although there was no fracture and no dislocation, yet the old pains revived, the joint became stiffer and the movements more limited; there developed also a peculiar tremor affecting the whole limb.

He entered the hospital on October 28, 1895, seeking relief. The pains upon pressure and manipulation were not very great; the muscles were not very much atrophied, but the movements were quite limited. Abduction did not extend more than three or four inches; the flexion or forward motion six or eight inches; the same for extension; rotation was impossible. When these motions were analyzed, it was found that much of their extent was due to the fact that the scapula moved with the humerus. The ankylosis seemed complete, although a semblance of motion took place in the joint. The tremor above mentioned still existed.

When thoroughly anæsthetized and the muscles were well relaxed, it was found that the adhesions were quite strong, and that in using too much force there was risk of breaking the bone.

An anterior incision was then made in front of the acromial por-

tion of the deltoid, perpendicular and parallel to the fibres of the muscles; the head and neck were soon reached and scraped close to the bone, but when it came to destroying the adhesions between the head and the glenoid cavity the greatest difficulties were encountered; they were fibro-cartilaginous and so close, so tight, that it was impossible to introduce an instrument of any kind between the articular surfaces to sever the connections. Rotation of the humerus was of no assistance and too much force could not be used lest the bone would break at an undesirable point. We then determined to use the chain-saw and sever the humerus just below the lower edge of the head, which was done with comparative ease without injuring the circumflex artery or nerve. Then seizing the head with lion-jaws forceps we tried to raise it to attack it from below, but this afforded no help. In the efforts the head gave way under the pressure of the forceps. It was about one-quarter under the ordinary size and had undergone some fatty degeneration. Taking advantage of what had happened we removed the whole head piece-meal with the lion-jaws forceps, making sure not to leave any piece that might necrose and cause trouble later. A posterior drain was then placed, coming out at the lower part of the posterior border of the deltoid. There was a good deal of bleeding, not from the injury to any large branch, but a general oozing, which required extensive and firm packing to check. Stitches were put in place but not tied, and instructions were given to tie them as soon as the packing could be removed safely. A thick axillary pad was placed in the axilla to keep the extremity of the bone away from the walls of the chest, and the arm was placed in a Velpeau bandage. It was only at the end of forty-eight hours that the packing could be removed. The temperature never ran higher than  $100^{\circ}$  F., but suppuration took place. It was yielding quickly to proper treatment, and passive movements were being cautiously practised, when the patient suddenly left the hospital without any one knowing his address. His former physician, Dr. Couvillon, was written to and replied that he had the man under his charge, stating that the suppuration had continued for some time, as the patient was poorly nursed, residing some nineteen miles from the doctor's residence. However, he was beginning to use his limb and thought he would, after a while, have a better use of it than before.

The striking feature of this case is the degree of adhesion between the head and the glenoid cavity, and the removal of the head piece-meal.

I believe that in such cases it would be better to expose the upper part of the surgical neck only, with no more dissection than necessary, to use a chain-saw or Wyeth's exsector, and sever the bone; then closing up everything at once establish a false joint. All the extensive dissections, bleeding, drainage-tubes, etc., would have been spared the patient. If thought necessary, an inch of the surgical neck might be removed. Such a conservative procedure has been proposed and has been done in cases of irreducible dislocations of the humerus, and have all been justly condemned, because they left the head in an abnormal position, often pressing upon important structures. But in cases of ankylosis of the shoulder in the glenoid cavity the conditions are totally different, as the head is left in its natural place and is injuring no structures of any kind. It is no question in my mind that this course would be the best for all cases of ankylosis without existing diseases of the bone (osteitis, tuberculosis, caries, necrosis).

*History.*—This case keenly aroused our interest in the subject, and we at once looked up the authorities for information, but, as is so often the case, we were sorely disappointed. In fact, bibliographical researches revealed no complete special writings on these most interesting conditions, and this determined us to study the subject exhaustively and fix the present state of our knowledge on this point. The number of cases found recorded by operators are few, but bear with them most interesting information.

Ankylosis of the shoulder is less troublesome than that of any other large articulation, because of the comparative mobility of the scapula and of the sterno-clavicular articulation.

*Clinical Forms and Varieties.*—There are no less than twenty-nine clinical forms and varieties of ankylosis of the shoulder. By clinical form and variety we mean a condition characterized by some feature or features bearing upon the diagnosis, prognosis, treatment, and the result. Many widely differ and call for proper and thorough diagnosis since they require different treatment and give different results.

There are first three large classes,—ankylosis that should not be operated, false ankylosis, and true ankylosis,—each presenting several varieties as set forth in the following table:

TABLE OF THE CLINICAL FORMS AND VARIETIES OF ANCHYLOSIS OF THE SHOULDER-JOINT.

*Anchylosis not amenable to operation.*

- (1) Anchylosis with a still useful arm.
- (2) Anchylosis with persistent atrophy of the muscles.
- (3) Anchylosis in subjects rheumatic or gouty or affected with diseases at large.

*False Anchylosis.*

- (4) Anchylosis hysterical.
- (5) Anchylosis spasmodic.
- (6) Anchylosis due to muscular degeneration (sclerotic or fatty).

*True Anchylosis.*

- (7) Anchylosis in young subjects.
- (8) Anchylosis in old subjects.
- (9) Anchylosis incomplete or fibrous, and weak.
- (10) Anchylosis incomplete or fibrous, but strong and resistant.
- (11) Anchylosis following rapid arthritis and traumatic suppurative arthritis.
- (12) Anchylosis complete or fibro-cartilaginous or osseous.
- (13) Anchylosis complete without actual disease of the bones.
- (14) Anchylosis with actual disease of the bones.
- (15) Anchylosis with disease of the glenoid cavity.
- (16) Anchylosis with complete fusion between the head and the glenoid cavity.
- (17) Anchylosis with the limb in adduction.
- (18) Anchylosis with the limb in abduction.
- (19) Anchylosis requiring resection of the superficial portion of the head.
- (20) Anchylosis requiring subtrochanteric resection, or resection on a level with the lower edge of the head,—*i.e.*, removal of the whole head.
- (21) Anchylosis requiring resection through the surgical neck.
- (22) Anchylosis requiring resection at the point of insertion of the tendon of the great pectoral.

(23) Anchylosis of the resected extremity of the humerus in or near the glenoid cavity (this is also seen after resection for dislocation).

(24) Anchylosis of the head of the humerus in an abnormal location (as in irreducible dislocation).

(25) Anchylosis requiring resection and followed by dislocation of the resected extremity inside the coracoid process or under the clavicle.<sup>1</sup>

(26) Anchylosis with resection and followed by a dangling arm.

(27) Anchylosis without resection, but presenting false union.

(28) Anchylosis followed by stiffness of the new joint.

(29) Anchylosis followed by dry arthritis of the new joint.

*Anchylosis not amenable to operation.*—The cases of anchylosis which should not be operated upon are the following :

(1) *Anchylosis with a fairly useful limb* as it stands, unless there is positive assurance of improving the movements, especially the movements that are particularly needed for the patient's work.

(2) *Anchylosis with atrophy of the muscles*, which condition would render the results of the operation useless. It may require the application of electricity and massage for some time before it is decided that the muscles are past redemption and the operation useless.

(3) *Anchylosis in a subject liable to rheumatism and gout, or complicated with some serious disease* in an organ at large, should not be operated upon.

Operation is contraindicated, especially when the muscles are irretrievably atrophied or degenerated, such as is the case in a great number of old anchyloses, and particularly those following long articular suppuration.<sup>2</sup>

When the muscles were in good condition at the time of the operation, if their nerves have been spared, and also their insertion to the periosteal sheath, they may acquire such strength that will allow them to raise with the lower segment of the humerus the balance of the limb, and also perform useful movements.<sup>3</sup>



Cases operated after long standing will never give the results that cases of short standing give.<sup>4</sup>

Operation for ankylosis is really justifiable only in recent cases occurring in full-grown subjects, or in young subjects old enough so that the removal of the head will not be followed by too great a shortening.<sup>5</sup>

It is especially indicated in cases of ankylosis following arthritis with a rapid course (dry acute arthritis), observed sometimes in subjects affected with acute rheumatism, and especially blennorrhagic arthritis. Also in cases of ankylosis consecutive to suppurative traumatic arthritis. In those cases the ankylosis occurs before the atrophy of the muscles.<sup>6</sup>

*False Ankylosis.*—False ankylosis is ankylosis due to rigidity or disease of the structures outside of the ligaments and of the joint itself.

(4) *Ankylosis hysterical* is a remarkable form, occurring especially in females, and presenting itself often with all the symptoms of chronic inflammation and of true ankylosis.

(5) *Ankylosis spasmodic* due to a contraction or contracture of the muscles, resulting from some former injury, and determining such condition that when an attempt is made to work the joint the whole shoulder moves, but there is no movement in the joint itself. This is not unusually met with after blows or falls on the shoulder, after the reduction of a dislocation. Such cases are sometimes easily diagnosed by gentle and persistent efforts to move the joint, when the muscles will yield and motion take place in the articulation. But most usually it is necessary to resort to an anæsthetic pushed to the thorough relaxation of all the muscles. When these are simply contracted they will yield, and motion in the joint takes place at once in all directions and to the full extent.

(6) *Ankylosis sclerotic or fatty*—*i.e.*, due to a fibrous or fatty degeneration of the muscles—is recognized by the fact that, when under an anæsthetic, while the muscles of the opposite shoulder are completely relaxed, yet those of the affected side are still rigid and tense and call for section of the unyielding muscles. This sclerotic and fatty condition is not rare in cases of ankylosis of old irreducible dislocations of the shoulder specially, and

is often one of the most potent factors preventing the reduction of the bone even after the head has been exsected.

*True Anchylosis.*—True anchylosis is due to considerable thickening of the ligaments and to the adhesions of the articular surfaces between themselves, requiring serious operations.

(7) *In anchylosis in young subjects*—i.e., in children and in subjects seventeen or eighteen years of age—it is most important not to injure the epiphyseal cartilage. The ossified portion of the head may be removed, but the epiphyseal cartilage between the head and the shaft must be spared if there is any possibility. A horizontal section with the saw starting at the internal insertion of the capsule around the head will surely carry away the totality of the conjugating cartilage.<sup>7</sup>

In young children, if the resection is made below the epiphyseal cartilage, the arm will cease to grow. A superficial resection intra-epiphyseal would very likely be followed by a return of the anchylosis. The anchylosis does not prevent the arm from growing if the cartilage is intact, so that the operation should only be performed as a last resort in young children.<sup>8</sup>

The arrest of development following the resection of the epiphyseal cartilage may be such that in spite of the re-establishment of the movements, the limb may be less useful or more deformed than an anchylosed limb which has continued to grow.<sup>9</sup>

Ultra-epiphyseal resections in children should be postponed as long as possible, because spontaneous cure, even without anchylosis, even in the most unpromising cases, are not uncommon.<sup>10</sup>

The resected extremity should not be pushed into the glenoid cavity in children, lest the growth of bone cause anchylosis again.<sup>11</sup>

(8) *Anchylosis in old subjects* had better not be operated upon except under very favorable local and general conditions.

Anchylosis due to the thickening of the ligaments alone may exist by itself.

Anchylosis due to the adhesions of the articular surfaces between themselves may also exist by itself, although most commonly both coexist.

Anchylolysis, incomplete or fibrous, is a most important form, and is characterized by the presence of some motion in the joint.

(9) *Anchylolyses, incomplete or fibrous, with weak adhesions* are the most favorable, because they may be cured by rupture under an anæsthetic. The use of an apparatus may be of service if the adhesions are weak; if it is mostly due to articular stiffness, the use of a traction apparatus on the limb may be beneficial.<sup>12</sup> When these fail they should be treated by rupture.

Ritscher says to give chloroform, placing the patient on a low bench; immobilize the scapula by an assistant, flex the forearm to right angles; grasp the humerus near the condyles and raise it as high as possible above the acromion; rotate it upon its axis several times, using the forearm as a lever; when the adhesions give way the hand of the operator perceives a decided creaking. The pains following the operation disappear by the next day, and the treatment can be continued by working the limb in all directions possible to make sure that all the adhesions have been destroyed.<sup>13</sup>

The following is a case reported by Sédillot:

Man; age unknown; very little mobility of the head. Chloroform; easy rupture of the adhesions; the motions of the head rough, noisy; after the chloroform the patient uses his limb freely. Passive exercise. Patient leaves the hospital. The anchylolysis soon returns. The same treatment is applied; the mobility of the limb is re-established almost entirely.<sup>14</sup>

(10) *Anchylolysis, incomplete and fibrous, but with strong and resistant adhesions*, precludes the display of too much force, because the bone may break at some undesirable point.

1859. Erichsen. Woman; old; partial or incomplete anchylolysis; chloroformization; the muscles are thoroughly relaxed, but the rigidity persists; rupture of the adhesions by force; distinct sound at the time of the rupture of the adhesions; immobilization of the limb; a few days afterwards passive motions; final results not stated; partial anchylolysis of the other shoulder; forcible rupture of the uniting mediums.<sup>15</sup>

(11) *Anchylolysis following rapid arthritis also traumatic*

*arthritis* is the most favorable for operation, because the ankylosis occurs before atrophy of the muscles.<sup>16</sup>

(12) *Ankylosis complete or fibro-cartilaginous or osseous* is the most laborious to operate, as is seen by some of the cases of the following form or variety.

(13) *Ankylosis complete without actual disease of the bones*, or ankylosis indolent and without fistules or still existing disease of the bones, constitutes a simple deformity, and an operation should only be done from an orthopædic point of view,—*i.e.*, simply because of the limited movements, and not because there is pain and diseased bones.<sup>17</sup>

Ankyloses with strong fibrous, fibro-cartilaginous, or osseous adhesions are, of course, the worst, requiring operations often of great difficulty. The diseases which produce this variety are inflammation of the subdeltoid bursa (Kermisson), arthritis (traumatic or simple or blennorrhagic), dislocations reduced, fractures, intra- or extracapsular, cured tuberculosis, osteitis caries, necrosis.

The following eight cases have been recorded :

I.—1866. Didiot. Gunshot wound ; comminuted fracture of the upper extremity of the humerus ; purulent osteitis ; exploratory incisions and removal of all the necrosed portions of the bone (which were keeping up the suppuration), so as to simplify the affection and favor the termination by ankylosis ; later on, resection of the head which was ankylosed and formed body with the glenoid cavity ; the head had to be as it were enucleated and removed by pieces by means of cutting forceps and the gouge. The glenoid cavity was also gouged until sound bone was reached.<sup>18</sup>

II.—1868. Bockenheimer. Male, aged fourteen years. When four or five years old he fell against a wall on the right shoulder ; the whole region of the shoulder was subsequently much swollen and very painful ; after five or six weeks the pain decreased and the swelling disappeared, but a certain stiffness of the joint remained ; during the next six years this immobility increased, and during the last four years he has not been able to move the shoulder-joint in the slightest manner ; right arm is much weaker than the left and lies close to the thorax ; can only be used by moving the whole shoulder ; when the scapula is fixed the arm cannot be moved ; the shoulder

region is flattened, the muscles being less developed and the caput humeri diminished in size. Resectio capitis humeri on July 9, 1865; head exposed by making a cut three inches long; adhesions were ruptured that had resisted all efforts before; the materially atrophied head is removed with the saw; the rough and pointed osseous growths on the glenoid cavity are chiselled or cut away; one of the blood-vessels belonging to the region of the anchylosed circumflex humeri artery was cut and had to be ligated; the upper portion of the wound was closed with catgut, the lower end being left open for drainage; suppuration set in; no marked reaction. Patient was discharged as the upper portion of the wound had healed; he was directed to appear for examination once a week; in the fifth week a suppurating cavity was found in the sulcus bicipitalis, which was opened and drained; both openings formed fistulæ, which remained open for some time and discharged pus; they finally closed towards the end of December. The arm could be moved in two and a half months, though at that time it was not easily raised; after the wound closed methodical movements were practised, which strengthened the muscles, and after a time heavy objects could be lifted with ease.<sup>19</sup>

III.—1882. P. J. Hayes. Male, aged forty-three years; admitted July 22, 1881. Struck by a grain of buckshot April 2; shot entered about three-quarters of an inch below the coracoid process of the right scapula; traumatic fever, accompanied by discharge from the wound; wound healed, but the shoulder was stiff; ankylosis of the right shoulder; manipulations under inhalations of ether; application of very moderate force caused the arm to move, but it was manifest that fracture had taken place, as true crepitus attended each movement of the humerus; inflammation; the old shot-track opened again, and for ten days discharged pus freely; abscess formed close to the anterior fold of the axilla, opened by free incision August 25; cut upon the humerus after Ollier's method; the head was fused to and formed a common bony mass with the glenoid angle of the scapula; slight force caused refracture of the anatomical neck of the humerus, and from the line of fracture was picked out the buckshot; corresponding to the situation of the shot the bone was carious; with moderate use of the gouge it was possible to expose perfectly healthy tissue above and below the line of fracture; union of soft parts took place, save at the upper and lower angles of the wound, where granulation tissue completed the reparative process; then passive movements were practised daily so as to insure fibrous union

between the bone surfaces. September 30, discharged, possessing a movable and useful arm; within the past month have heard that the patient now enjoys great strength and freedom of movements in the previously almost useless limb.<sup>20</sup>

IV.—1883. William Stokes (No. 1). Female, aged twenty-four years. Fall down stairs twelve months ago; swelling, pain, and ultimately an abscess, which opened into the axilla; the opening of the abscess was followed by a sinus, through which, on probing, denuded bone could be felt; any attempt to move the arm was attended with the acutest pain; considerable atrophy of the muscles of the arm; the well-marked ankylosis was due mainly to the formation of adventitious fibrous bands, which held the bones firmly together. Single oblique incision (Langenbeck-Ollier), which commenced midway and a little above the coracoid and acromion processes, and extended downward and a little outward for a distance of four and a half inches; owing to the great amount of ankylosis there was much difficulty in protruding the head of the bone through the wound; it was found to be completely denuded of cartilage; passive movements begun in the early part of January; not borne very well at first, but soon became used to it; in a short time got such power with the arm that she was able to render considerable assistance to the nurses of the ward. Subsequently became a ward maid herself, in which capacity she had to scrub floors, clean fireplaces, make beds, and in fact perform all the duties of her former vocation. The remarkable feature in connection with this case is the short time that elapsed between the period of the operation and that at which good use of the arm was again obtained. Mr. Hodges states that the average length of time before some use of the arm was commenced, as calculated from thirty-one cases, was over four months; and a much longer period was required to elapse before the limb could be said to have become really serviceable.<sup>21</sup>

V.—1883. William Stokes (No. 2). Female, aged twenty-six years. In 1882 miscarriage, followed by fever, and while in hospital suffered from an attack of acute arthritis of the right shoulder, followed by abscess-formation, one of which was opened close to the insertion of the deltoid, and others below the clavicle; right shoulder rigidly ankylosed, and the muscles of this shoulder, especially the deltoid, were much atrophied; the limb was wholly useless; attempt to break down adhesions by manipulations while under ether; succeeded to a certain extent; result not satisfactory; increase of pain and no

material improvement in the ankylosis; excised shoulder in the same manner as in preceding cases, April 26. On May 3 the wound quite cicatrized; Ollier-Langenbeck periosteal-capsular method; after-treatment same as in preceding; passive movements, massage of the muscles of the shoulder and arm were commenced and carried on daily up to the end of June; recovery. Patient has been engaged as a laundress. Accompanying this article are two photographs showing the position in which the arm could be placed. (1) In the act of using knife and fork in cutting pastry, etc., on a plate. (2) Arm raised laterally, hand on a level with top of the head. Rapidity of union is strongly indicated after this operation, and can be best obtained by a rigid adherence to the Listerian antiseptic practice. Passive movements, gymnastic exercise, and massage should be commenced as soon as possible after operation.<sup>22</sup>

VI.—1884. E. Albanese. Female, aged twenty-one years. Cause of the ankylosis not known; seven years' standing; ankylosis incomplete fibrous; movements limited. An incision was first made into the soft parts of the posterior scapulo-humeral region nine centimetres long and down to the bone, along the spine of the scapula. The incision was in the form of an inverted L, forward and upward, as far as the anatomical neck of the humerus. The capsule was then divided and the articulation penetrated; next the wound was held apart by means of strong retractors, and the head of the humerus cut off at the height of the anatomical neck with a chisel and two blows of the mallet. The surgical neck was then cleaned off all around and the edges rounded off with a rasp and a file. A cavity in the humeral head, which yet adhered to the glenoid cavity, was afterwards made with a spoon of such a size as to allow the introduction of the surgical neck of the humerus already made smooth and round. Care was taken that it moved easily in the new locality; a drainage-tube was introduced and the wound united by stitches. Primary union; patient can move the arm, approaching it to the body and raising it until forming an angle of seventy-six degrees. She can arrange her hair without any difficulty; the rotatory motions of the arm are free and perfectly normal; the deltoid contracts very well; patient returns to her work and moves the right arm almost as freely as the other.<sup>23</sup>

VII.—1888. L. Ollier. Female, aged eighteen years. Has been suffering with the shoulder for the last ten years; considerable atrophy of the region; shortening of the arm; absence of movements in the joint; it is the scapula that moves; however, there is no abso-

lute soldering. Resection; vertical incision antero-internal; second transverse incision directed outwardly along the acromion; the head is sufficiently exposed to denude the external tuberosity and divide the fibrous interarticular adhesions; removal of forty-five millimetres of bone. Posterior incision with drainage-tube; also tube in front. The patient can use her arm in almost all positions; she can comb her hair without difficulty and carry children; however, there is some weakness in the position of the stretched or extended arm. She had a fall on the hand with the arms stretched out; this caused a return of the pains and a stiffening of the new joint so as to render impossible the active elevation of the arm above the level line; the upper extremity of the humerus is slightly enlarged; the atrophy of the muscles is not as profound as formerly; the anterior part of the deltoid which had been divided has preserved its contractility; there seems to have taken place there a small amount of progressive elongation of the muscular cicatrix.<sup>24</sup>

VIII.—1888. Mario Spada. Female, aged sixteen years. Anchylosis due to a fall on the left shoulder; seven years' standing; anchylosis incomplete, fibrous; movements very limited; they are affected almost exclusively through those of the scapula; patient abducts the arm about twelve centimetres and about as far forward and backward. The adhesions were completely broken up under chloroform and passive movements thoroughly made. Condition of the joint was not improved. Twenty-five days later, resection without any difficulty; secondary union; passive movements began fourteen days after the operation; patient is able to approximate the hand to the breast, to the face, the forehead; moves her hand as well in adduction and abduction and raises it to the height of an angle of eighty degrees; the rotatory movements of the arm are normal and the patient able to do all kinds of domestic work.<sup>25</sup>

*Remarks on the Foregoing Cases of Anchylosis without Actual Disease of the Bones.*—The foregoing cases are too few and too incompletely reported, except the case of Ollier, which is a model and a masterpiece, to establish any general principles. Still, each should be studied carefully, as it carries its own most useful instructions. However, we are forced to mention here the following facts in particular.

Traumatism as a cause is mentioned as being a fall by Bockenheimer, Stokes (No. 1), Spada, and ourselves.



The cases were all of long standing, especially Ollier's, ten years; Albanese and Spada, seven years; Bockenheimer, six years.

Incomplete ankylosis is mentioned by Spada only.

The atrophy of the head is especially mentioned by Bockenheimer; it was also present in our case.

Breaking up of adhesions requiring later resection happened in the case of Spada.

The capsulo-periosteal operation was followed by Stokes (Nos. 1 and 2), Ollier, and ourself.

Difficulties in protruding the head are specially mentioned by Stokes (No. 1) and ourself.

The head was fused with the glenoid cavity in the cases of Didiot, Hayes, and ours, and had to be gouged out.

The head was removed by pieces in two cases, Didiot's and ours.

There were osseous growths in the glenoid cavity in one case only (Bockenheimer).

A branch of the circumflex was injured in the case of Bockenheimer.

False joints were established in two cases and with good results (Hayes, Albanese).

In no case was the bone sawed *below* the head and a false joint established there.

Rapid union was obtained in Stokes's two cases and in Albanese's case.

Long suppuration is specially mentioned in Bockenheimer.

The atrophy of the muscles is mentioned specially by Bockenheimer, by Stokes in his two cases, and by Ollier, and yet the results were satisfactory.

The longest time mentioned for the re-establishment of the functions was two and a half months (Bockenheimer).

However, we will recall here that Dr. Hodges states that the average length of time before some use of the arm was commenced, as estimated from thirty-one cases of resection for various causes, was over four months, and a much longer period was required to elapse before the limb could be said to have become really serviceable. (See Stokes, No. 1.)

Good use of the limb is stated by Bockenheimer, Hayes, Albanese, Ollier, and Spada.

Poor use is mentioned by none.

(14) *Anchylosis of the Shoulder with Actual Disease of the Bones.*—In anchylosis with diseased bones still existing, the operation is not for the anchylosis, but for the disease of the bone.<sup>26</sup>

We have found on record only thirteen cases of anchylosis with persistent disease of the bones.

I.—1855. Birkett. Bones diseased. Male, age not stated. Shoulder partially anchylosed or motionless, swollen, and painful; large triangular flap by long incision down the external border of the shoulder through the deltoid; the head of the bone is easily dislocated backward by throwing the forearm forward; it is quite denuded of cartilage, and one point had arrived at a state of necrosis; after resection the head is found very much diseased. It is hoped the patient will have very effective use of his arm and shoulder.<sup>27</sup>

II.—1857. Gunn. Bones diseased. Male, aged twenty years. Caries of head and necrosis of the shaft, involving the upper two-thirds of the bone; partial anchylosis. Resection; incision from the acromion to a point just below the deltoid insertion, through fascia and muscle down to the bone; joint opened. Progress was much impeded by adhesions which nearly obliterated the synovial cavity; head dislocated; section at the deltoid ridge; erysipelas. Went home fourteen days after the operation.<sup>28</sup>

III.—1871. Bockenheimer. Bones diseased. Female, aged seventeen years; no cause given nor duration of disease mentioned; anchylosis vera (osseous). Resection in the shoulder-joint; no difficulties or subsequent complications; a very useful joint resulted, the patient being able to raise the arm over the shoulder and carry out all motions. Further details are not given.<sup>29</sup>

IV.—1873. Durham. Bones diseased. Male adult. Five years ago had an attack of inflammation of the left shoulder-joint; an abscess formed and has discharged ever since; the joint is now thoroughly fixed; the deltoid muscle has completely wasted away; all the bony prominences usually covered by it are prominent and distinct. Resection in the usual manner; head completely necrosed and firmly fixed in the glenoid cavity. Result not stated.<sup>30</sup>

V.—1876. Laudi. Bones diseased. Boy, aged fourteen years. Suppurating osteitis and necrosis of upper third of the humerus; semi-ankylosis; incision five millimetres long in front of the coracoid process, parallel to the inner border of the deltoid and passing through fistulous openings; detachment of the periosteum without any difficulty; the head is brought out and sawed where it was found healthy. Twenty days later the patient left the hospital.<sup>31</sup>

VI.—1879. Krabbel (No. 1). Bones diseased. Male, aged fifteen years. Cause not given; has had pains in the right shoulder for one and a half years; the movements of the right arm became more and more restricted and painful; when received at the hospital extended motion of the arm could only be made by moving the scapula with it. Resectio capitis humeri; a piece six centimetres long had to be removed as the caries extended that far; glenoid cavity of the scapula was not affected; salicylic acid gauze bandage, and arm fixed to thorax; wound closed in five weeks with the exception of a fistula; from this a small piece of bone was removed, and recovery was then rapid; patient could move the arm forward and backward and raise it to a horizontal position when discharged; subsequent result not known.<sup>32</sup>

VII.—1879. Krabbel (No. 2). Bones diseased. Male, aged thirty-two years. Disease has existed for six years. The whole region of the shoulder has been swelling for some time. An incision was made and much pus discharged; the fistula remained and continually discharged pus. On two occasions small pieces of bone appeared; joint is ankylosed, limited motion only possible by moving scapula with the arm. A bone splinter was removed from the fistula, which at one point shows a smooth surface. Resectio humeri now resorted to; head of humerus is carious, has lost its roundness, and is flattened. Glenoid cavity is also carious in some spots, and these portions are removed by the spoon; salicylic acid gauze bandage; temperature the next day (May 20), 39.2° C.; bandage removed; much coagulated blood in the wound. On the morning of May 30, heavy chills followed by severe sweat; no retention of pus; granulations look unfavorable; fever rises to 41.5° C.; chills occurred again, and patient died of pyæmia on June 15. Post-mortem examination showed metastasis of the lung and partially purulent, partially hæmorrhagic enlargement of the spleen; glenoid cavity and os humeri of the resected shoulder normal; through a fistula the probe passes into the cavity under the scapula, which contains much pus.

On the frontal side of the scapula, under the musculus subscapularis, carious bone is found; the portion of the scapula to which the coracoid process is joined is also diseased.<sup>33</sup>

VIII.—1879. Hy. Morris (No. 1). Bones diseased. Male, aged thirty-six years; admitted October 14, 1878. Twenty-three years before, after a game of cricket, he felt stiffness in the right shoulder. In three months an abscess formed and discharged through a sinus near the insertion of the deltoid for twelve months. Pain ceased, the patient regained movement but not perfect mobility. Some time after the sinus closed, a clear fluid discharged itself; sinus again closed; and so continued to discharge at intervals until the end of three years, when it closed entirely and remained sound nineteen years. No bone at any time came away. Caught cold; lump formed; poulticed it; discharged pus; almost complete ankylosis of the right shoulder. Around the shoulder, especially in front, there was considerable thickening. Passive movements gave rise to occasional rough creaking, thought to be extra-articular. Movements not painful unless the head of the bone was at the same time pressed against the glenoid fossa. Excised the diseased upper end of the humerus; the glenoid fossa was also devoid of articular cartilage, and carious upon the surface, part of which required to be gouged away. The shaft of the humerus below the section made by the saw was partially denuded of periosteum, but was firm, compact, and healthy throughout. The excised head was entirely denuded of articular cartilage, and its compact layer of bone in places was destroyed. The day after the operation the patient was allowed to sit up, and after the sixth day to get up and be around the ward. Much pain for some weeks at the back of the shoulder, which ceased after an abscess formed and broke in the posterior fold of the axilla. The 7th day of May, arm admits of a fair amount of forward and backward movement, and some slight adduction and abduction. The patient can lift a chair with ease, and has all the use of the forearm and hand perfectly. Two small sinuses near one another in line of the cicatrix discharge thin pus; they do not communicate with dead or bare bone. Constitutionally quite well and gaining more and more use of his limb every day. Since reported himself well.<sup>34</sup>

IX.—1879. Hy. Morris (No. 2). Bone diseased. Male, aged forty-three years. Eighteen years ago he fell upon his right shoulder. Suppuration; abscess formed; recovered perfect use of

his shoulder. May, 1877, injured same shoulder while rowing; swelling; abscess burst in the arm in October; on December, 1877, the old sinus in front of the axilla reopened and has ever since been discharging; shoulder almost completely fixed; the movements of which it is apparently capable being in reality scapular. On fixing the scapula, however, a small amount of joint movement could be made out, accompanied by grating. Two sinuses discharged a little pus. March 12, head of humerus excised through a straight incision three inches long from the acromion process downward. A second piece of humerus was removed, as the medullary cavity in the line of the first section was seen filled with a quantity of pale-yellow, unhealthy-looking marrow, and the cancellous tissue was soft and unusually vascular. A little carious bone was gouged away from the glenoid fossa. Patient made a good recovery. April 15 discharged well.<sup>85</sup>

X.—1881. Lange. Bones diseased. Female, aged eighteen years. Acute osteomyelitis of the upper end of the humerus; supuration of the joint; bony ankylosis; resection of the head; also necrotomy; cure; useful limb. The patient can perform all the ward household work, although the arm can only be raised to feeble height; she can eat with it and wash her face; the motions anteriorly and posteriorly are not hindered and are vigorous. In the excised head the prolongations of the medullary canal upward almost to the epiphyseal line presented two large canals leading to the exterior; this upper extremity presented a small encysted abscess surrounded by dense fibrous tissue; the epiphyseal cartilage had entirely disappeared.<sup>86</sup>

XI.—1882. Pratt. Bones diseased. Male, aged eighteen years. No injury known; shoulder was large; every movement excited pain and was accompanied by considerable motion of the scapula, signifying a certain amount of ankylosis. Abscess opened; sinus then found leading to the back of the scapula. About two inches of the head of the humerus was removed, and found to be much diseased. There was some ankylosis, but the glenoid cavity was free from disease. In six weeks healing was complete except in one spot, which led by a deep sinus down to dead bone. Sinus did not close and suppurated freely. Patient was again put under chloroform and another inch of diseased bone was removed from the humerus. This time the precaution was taken to pass a drainage-tube right through

the triceps into the axilla; by this means the wound was kept perfectly clean; no further difficulty; healing process proceeded rapidly; lad grew fat and was able to use the arm in doing work about the infirmary. At the beginning of the present year he was discharged and took a groom's place. Seen in March in first-class health with a most useful arm.<sup>37</sup>

XII.—1887. Cleland Lammiman. Bones diseased. Male, age unknown. Anchylosis almost complete; shoulder-joint swollen, hot, and painful; its mobility was much curtailed, the movements being limited to abduction in common motion with the scapula, and a slight power of advancing and retreating the elbow. Very great nocturnal pain. Over the insertion of the coraco-brachialis, sinus of some age, still discharging; this led, through a distance of five or six inches, to the inner side of the shoulder-joint. October 28, performed Ollier's subperiosteal operation. Two and a quarter inches of bone was removed. The inner side of the periosteal pouch thus made was seen to be covered with nodules of new bone. The glenoid surface was healthy. Drainage-tube conducted down the sinus over the insertion of the brachialis anticus, from the wound. Iodoform was placed in the gap; healing took place in about ten days; passive motion was begun about the fourteenth day. The head and neck of the bone were covered by pits and depressions, soaked in pus, and deeper in the cancellous substance were many loose sequestra. March 25, no tenderness; abduction could be effected nearly to the shoulder line; he could place the forearm behind his back, and could advance the arm well in front; was beginning to recover the power of rotation; had great purchase in lifting from the ground; and was doing a good day's work. A new joint apparently existed in the space between the coracoid and acromion processes.<sup>38</sup>

XIII.—1894. Pearson. Bones diseased. Male, age not stated; fall from a wall, twelve or thirteen feet in height, on his shoulder; arm partially ankylosed; very slight motion in the joint, and it was attended with great pain. Abscess formed on the front of the arm about two and a half inches below the joint. This was opened and a probe passed in the direction of the shoulder-joint, but did not reveal any dead bone. Sinus continued to discharge pus for a few weeks, then another abscess pointed behind about half-way down the scapula; this was opened. Cut down upon

the joint and found several loose pieces of bone and the head of the humerus quite rough and spiky. The loose pieces were removed and the head well scraped with a raspatory and the wound stitched up, leaving a drainage-tube in it. Sinuses were well scraped out. Patient improved and gained weight, the sinuses did not heal, but the man was free from pain for nearly eight months, at the end of which time a second operation was submitted to. Found considerable disease of both the head of the humerus and the glenoid cavity; also the tip of the coracoid process of the scapula was rough and bare. Small collection of pus at the back of the head. This time, removed the whole of the head of the bone and the tip of the coracoid and scraped out the glenoid, and put in a drainage-tube back and front. Patient made a rapid recovery, and was doing light duty as a policeman two months after. Sinuses quite healed. Has now been able to do ordinary fireman's duty for six months or more and has gained two stones in weight. He can lift a very considerable weight, but cannot extend the arm laterally to a right angle with the body.<sup>39</sup>

*Remarks on the Foregoing Cases of Anchylosis with Diseased Bone.*—The number of cases here is also comparatively so small and they are so incompletely and unsystematically reported that but few remarks and deductions can be made.

The long standing of the case is remarkable, eighteen years (Morris, No. 2), twenty-three years (Morris, No. 1).

Anchylosis with diseased bones often requires resection at the surgical neck, extending sometimes as low as the pectoral insertion (Gunn, Krabbel, No. 1, Morris, No. 2, Pratt, Lammiman).

It is seldom that the head is tightly bound down in the glenoid cavity, as in anchylosis, without disease of the bones,—only three times (Gunn, Durham, Bockenheimer).

The periosteum is easily detached (Laudi).

In some cases the glenoid cavity is reported as being free from disease (Krabbel, No. 1, Pratt, Lammiman).

They often give rise to considerable and persistent capillary hæmorrhage, on account of the long standing of the inflamed condition of the parts.

They rarely unite by primary union, which is readily understood. One case only died (Krabbel, No. 2).

In two cases the patient had to be operated a second time to remove more diseased bone (Pratt, Pearson).

The muscles require a longer time before recovering their full contractility.

In one case a new joint apparently existed in the space between the coracoid process and the acromion (Lammiman).

(15) *Anchylosis with disease of the glenoid cavity* is, of course, more serious than when the cavity is not involved.

(16) *In anchylosis with complete fusion between the head and the glenoid cavity* the gouge should be used between the two bones; when the mobility of the two bones one upon the other is effected, then the resection is continued as though the surfaces had been movable from the start. This previous rupture of the anchylosis with the gouge is preferable to the sawing of the fused bones.<sup>40</sup>

(17) *Anchylosis with the limb in adduction* is the most common case.

(18) *In anchylosis in vicious position, or with the limb in abduction*, it is best to resect a wedge piece.<sup>41</sup> On account of the mobility of the scapula osteoclasia is contra-indicated.<sup>42</sup>

The section should be done as close to the head as possible.<sup>43a</sup>

(19) *Anchylosis requiring the resection of the superficial part of the head* is apt to be followed by a new anchylosis. For this reason it is best in adults to resect more extensively than is actually necessary to produce movement, but in young subjects, especially in children, the great importance of not injuring the epiphyseal cartilage will render the opposite course the rule to be guided by.

(20) *Anchylosis requiring resection on a level with the lower margin of the head,—i.e., the removal of the whole head—*is the most common and the most favorable.

(21) *Anchylosis requiring resection through the surgical neck* is apt to be followed by a loose arm.

(22) *Anchylosis requiring resection at the points of insertion*



of the tendons of the great pectoral and great dorsal have a greater risk of being followed by a dangling limb, especially if the subject is old, if the muscles have become much atrophied, and have undergone fibrous degeneration.

(23) *Anchylosis of the resected extremity in or near the glenoid cavity* is not uncommon. It may require either section of the muscles or resection of the ankylosed extremity. The latter is often a laborious undertaking on account of the extensive and resistant adhesions, due to the fact that the parts have already been operated on before. The muscles are also retracted and degenerated in these cases.

This condition is often due to improper consecutive or after-treatment, either because it was not begun soon enough or because it was not kept up long enough.

(24) *Anchylosis of the head of the humerus in an abnormal location*, such as in old dislocations, is mentioned here for the sake of thoroughness, but it belongs to another subject.

(25) *Anchylosis requiring resection and followed by dislocation of the resected extremity* under the coracoid process, or under the clavicle, is the result of improper attention to after-treatment at the proper time. In one case (Luckie) the resected extremity articulated with the under surface of the acromion.<sup>43b</sup>

(26) *Anchylosis requiring resection and followed by a dangling arm* is often the result of an extensive resection, or an unnatural condition of the muscles. Prosthetic apparatuses place the arm in the same condition as if it was ankylosed.<sup>44</sup>

When the distance between the resected humerus and the glenoid cavity is only six or seven centimetres, the extremity should be pared and stitched to the glenoid.

When the distance is greater, the same should be done and the bone stitched as high up as possible.<sup>45</sup>

Bone-grafting may be very useful, especially fragmentary grafting.<sup>46</sup>

(27) *Anchylosis without resection, but with fracture and followed by a false union*, has a special interest as bearing upon the treatment proposed by the writer in some cases.

Two cases of this kind are reported: the case of P. J. Hayes,

above described,<sup>47</sup> and that of E. Albanese, also reported above.<sup>48</sup> We will recall here the following interesting cases, although they are not cases of pure ankylosis with a regular resection.

188? Albert. Subcoracoid dislocation; while rotating the head, fractured the surgical neck; the head was drawn in place by hooks and the fragments were united by sutures; false joint resulted, which, however, gave a useful limb.<sup>49</sup>

188? Hamilton. Epiphyseal fracture of the head of the humerus; fibrous union; five months after the injury was received the fragments had not yet united; child still unable to lift the arm; forearm and hand retained their usual strength and freedom. Some crepitation could occasionally be felt in the shoulder and some abnormal mobility.<sup>50</sup>

Sir Astley Cooper. Case of fracture of the cervix humeri within the capsular ligament; there was forward luxation of the head, but ligamentous union had occurred between the fragments.<sup>51</sup>

1883. Lindner. Patient aged sixteen years. Fracture of the head of the humerus; lower fragment displaced upward and inward towards the coracoid process, overriding the other for two inches or more; attempts to reduce by traction failed, and as the movements of the limb were much restricted and the position of the fragments such that their union was impossible, the parts were cut down upon to the bone on the twenty-third day; excision of enough of the upper portion of the lower fragment to permit reduction; found it so firmly adherent to the soft parts that he had much difficulty in removing it. The antiseptic method was used and the wound healed without incident, but at the date of the report, two months after the operation, the union of the bones was not solid, the limb, however, had become very firm, and it was hoped that the union might yet become bony.<sup>52</sup>

Ollier remarks that removal of a slice of bone by the saw would leave two surfaces not well adapted to articulate. A cavity could be dug into the surface of the upper piece. A long distance between the two bones is most important. What is still more important is the preservation of the periosteal sheath.<sup>53</sup>

(28) *Ankylosis of the new joint*, due to hypertrophy or irregularity of the new ossification, is only seen in cases of subperi-

osteal resections. New resection may be attempted, but will not do much good on account of the condition of the tissues of the region.<sup>54</sup>

If there is only one bony projection, then it should be excised.<sup>55</sup>

(29) *Anchylosis due to dry arthritis of the new joint* formed after a few years presents modifications analogous to those of dry arthritis. The joint becomes stiff and cracks. This is especially observed in rheumatic and tuberculous subjects, in the latter caries may develop again.<sup>56</sup>

#### REMARKS CONCERNING THE OPERATION.

The following points, mostly from the admirable book of Ollier,<sup>57</sup> should be well borne in mind by operators.

Lagrange states that Boucher was the first who thought of resecting the upper extremity of the humerus, but it was White, of England, and Vigarous, in France, who performed the first operation.<sup>58</sup>

In 1789 a boy presented with his right hand to the Academy of Surgery the head of his right humerus, which had been resected by the surgeon-major of the regiment, Du Berri.<sup>59</sup>

But Ollier asserts that Bent, of Newcastle, in 1771, is really the first who resected the humeral head.<sup>60</sup>

Ollier was the first to recommend (1858) the preservation of the capsulo-periosteal sheath without cutting the muscles as a means of obtaining a new joint, and, if possible, to cause the formation of a new head.<sup>61</sup>

Langenbeck's incision, starting farther behind the internal border of the acromion, sacrifices the innervation of a greater portion of the deltoid.<sup>62</sup>

Ollier's rule is to expose the head by an incision as near as possible to the antero-internal border of the deltoid, and, if necessary, by the disinsertion of its internal portion.<sup>63</sup>

The incision should never be made internally on account of the nerves and veins, except in rare cases of subglenoid dislocations where the head projects under the skin.<sup>64</sup>

The deltoid is the most important of all the muscles, as is

demonstrated by the cases of paralysis of the circumflex nerve, when the insufficiency of the muscles which are inserted on the head become evident.

The preservation of the circumflex nerve is also of great importance.<sup>65</sup> This circumflex nerve runs parallel to the posterior border of the acromion, from which it is distant in an ordinary adult by five and a half or six centimetres. This is important for the limit of perpendicular incision and for the incision for the drainage-tube behind.<sup>66</sup>

The loss of the elevating action of the deltoid must be accepted, like the loss of the rotating power from the division of the muscular insertions into the two tubercles, as a necessary consequence of resection of the head of the humerus. But the holding or supporting powers of this muscle exerted upon the whole of the upper extremity, owing to its position, its extensive origin, and the manner in which it embraces and protects the mutilated parts as well as its faculty of carrying the arm backward and forward, are all functions which may still remain and serve to point to the great importance of preserving its integrity as fully as possible. The wasting of the internal fibres, however, seems a necessary result of resection by the single incision, but it has this compensating feature, that it is a less serious loss to the patient than an atrophied condition of the outer and posterior fibres would be, because the upper clavicular fibres of the great pectoral can take the place of the inner deltoid fibres to a considerable extent in supporting the shoulder and drawing it forward to the chest.<sup>67</sup>

The movements of elevation are seldom required save by those who follow climbing occupations, as sailors, masons, etc. The mode of performing the operation as well as the operation itself will naturally influence these movements. If the deltoid be cut completely across, by means of an elliptical incision, the power of abduction of the arm and its elevation will be permanently lost. If its fibres be merely split by a longitudinal incision they may be preserved or regained in great part.<sup>68</sup>

The incision shall be as forward as possible, because all that portion of the muscle which will be to the inner side will be

paralyzed. It is best to avoid the interdeltoïdo-pectoral groove on account of the cephalic vein; make the incision a little behind.<sup>69</sup>

In exceptional cases the clavicular portion of the deltoid may be disinserted,—*i.e.*, by section of the insertion near the bone without preserving the continuity with the periosteo-capsular sheath. It is different from the subperiosteal detachment of the muscle done with the gouge.<sup>70</sup>

The disinsertion of the clavicular portion of the deltoid, in part or in totality, is especially indicated when the head of the humerus is bound down, and the arm cannot be separated from the chest.<sup>71</sup>

The relations of the large vessels and nerves must not be overlooked. However, in subperiosteo-capsular resections they run no risk as long as the operator remains within the capsulo-periosteal sheath.<sup>72</sup>

As one of the chief drawbacks of the operation is the poor amount of abduction and elevation which remains, owing, in a large measure, to the humerus being too short to be brought into the glenoid cavity when the deltoid acts. Holmes thinks that in this joint a trial of the subperiosteal method should be carefully made to insure as much reproduction of bone as possible.<sup>73</sup>

Ollier described several cases of reproduction of bone after his method.<sup>74</sup>

Langenbeck mentions a case in which the whole shaft of the humerus was necrosed and was removed, the elbow-joint being resected at the same time, and yet the reproduction of bone was so complete that the shortening was no more than one and one-fifth inches. The new humerus broke several times, but the movements of the shoulder and elbow were satisfactory, and the hand capable of most delicate movements.<sup>75</sup>

In cases of rarefaction of the bones it is important to seize the head with tooth forceps or rotating forceps; ordinary forceps mash the head.<sup>76</sup>

The posterior drainage incision must be made at the most dependent part when the patient is lying down; this depends

upon where the resection has been done. Care should be taken not to wound the circumflex nerve nor the artery. When the incision is made very low down, it is the musculo-spiral nerve that must not be wounded.<sup>77</sup>

It is best to place the tube even in cases where the bones are not diseased.<sup>78</sup>

In adults the rule is to push the resected extremity into the glenoid cavity when regeneration of the bone is not expected.<sup>79</sup>

A thick pad should be placed in the axilla to prevent the humerus from being drawn inward.

The preservation of the deltoid roundness is a peculiarity of the subperiosteal resection.<sup>80</sup>

*Remarks concerning the After-Treatment.*—The sooner the passive movements are begun the better, a few days after the operation, because the resected humerus may become ankylosed.<sup>81</sup>

The more the wound-healing progresses the more the movements should be extended.<sup>82</sup>

The muscles, especially the deltoid, must be soon massaged and electrified.

It is especially in operations on the shoulder that the after-treatment is of importance. Too much care cannot be given to that after-treatment; if incompletely done, or stopped too soon, almost all the benefits of the operation may or will be lost.<sup>83</sup> It must be kept up for weeks and even months.<sup>84</sup>

Extensive movements, especially those of abduction, should not be practised until several weeks after the humerus is sufficiently fixed in the glenoid cavity; lest the resected humerus may pass under the coracoid process, or there may form a coracoid articulation instead of a glenoid.<sup>85</sup>

The re-establishment of the complete mobility is retarded by thickening of the capsule, which in some cases is shrunken and in some points is as resistant as cicatricial tissue; also to the adhesions of the tendons and muscles with the surrounding tissues; also to the fibrous and fatty degeneration of the muscles.<sup>86</sup>

This condition of the muscles is all the more difficult to over-

come because other muscles instinctively take their place, especially these that move the scapula.<sup>87</sup>

Rotary movements must be begun as soon as there is no pain.<sup>88</sup>

The electricity, massage, gymnastic exercises must be conducted slowly, carefully, but continuously, every day.<sup>89</sup>

*Remarks Concerning the Final Results.*—In a number of cases operated on by Percy (1795), the movements were all good except that of elevation, and the arm had to be rested against the chest to work the forearm, which then enjoyed all its strength.<sup>90</sup>

In order to appreciate the usefulness of the new joint, the following manœuvres should be practised :

To measure the force of the abduction—*i.e.*, of the action of the deltoid—weights should be fastened to the elbow, and the patient directed to raise the elbow outward first without and then after fixing the scapula. Then do the same with the weights attached to the forearm or placed in the hand.<sup>91</sup>

To measure the movements of rotation, flex the forearm against the anterior surface of the thorax, and place some object in the hand ; then fix the elbow and make the hand describe an arc of a circle from inward outward, keeping the elbow well fixed.<sup>92</sup>

In doing this we must watch the actions of the other muscles inserted in the humerus, which by the successive contraction of their various parts may, at a given time, become rotators.<sup>93</sup>

The patient should be made to cross the arms, to place the operated arm behind the head, on the forehead, behind the back, on the buttock, throw a stone, etc.<sup>94</sup>

Some patients may perform some energetic movements and yet feel hampered in delicate movements requiring rotation. The resistance of a fibrous band or the existence of an abnormal projection on the new head explains these discrepancies.<sup>95</sup>

Resections are certainly better than disarticulations (p. 121). Resections primary or for gunshot wounds give the worst results, as demonstrated by Gurlt and Otis.<sup>96</sup>

Secondary or tardy or retarded resections, those which took place after periosteal hyperplasia, have given better results.<sup>97</sup>

However, excision of shoulder in military surgery gave better results in primary cases than in the inflammatory stage. The mortality is twice as great as in the primary, and nearly 12 per cent. greater than in the secondary. Secondary cases give a mortality of 50 per cent.<sup>98</sup>

As for the conditions of the new joint, out of 213 resections, Gurlt observed 96 tight articulations, 21 anchyloses, and 76 dangling limbs.<sup>99</sup>

*Remarks concerning the Findings at the Autopsies of Operated Cases.*—In some cases there is formation of a new head more or less irregular.<sup>100</sup> These gave almost an ideal result.

In one case Testor found an intra-articular cartilage.<sup>101</sup>

Chaussier, Roux, Syme, Breen, Hutchinson, and others have dissected articulations of shoulders resected, from three months to twenty years. They all found a fibrous cord, strong and resistant, joining the humerus to the scapula, and adherent by its external surface to the surrounding soft parts more or less atrophied. But they never found a real articulation.<sup>102</sup>

Ollier reports several cases of reproduction of bone after operation, found at the autopsies.<sup>103</sup>

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