Exfoliation of the cochlea, vestibule and semicircular canals / by M.A. Goldstein.

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Goldstein, Max A. 1870-1941.
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Publication/Creation

[St Louis] : [Annals Publishing Co.], 1895.

Persistent URL

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BY

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OF ST. LOUIS, MO.

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REPRINTED FROM
ANNALS OF OPHTHALMOLOGY AND OTOLOGY, Vol. IV, No. 2.
April, 1895.

Reprinted from ANNALS OF OPHTHALMOLOGY AND OTOLOGY, April, 1895.

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EXFOLIATION OF THE COCHLEA, VESTIBULE AND SEMICIRCULAR CANALS.

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IN the history of otology, reports of cases of exfoliation of the labyrinthian structure have always created more than a passing interest on account of their rarity of occurrence, the importance of their recognition and the value of the many clinical phenomena observed in the course of so extensive a necrotic process in the delicate structure of the temporal bone.

Caries and exfoliation of the cochlea alone, as a sequestrum separate from the rest of the labyrinth, has been observed and described comparatively frequent. From the interesting bibliography on the subject may be mentioned a comprehensive report by Bezold, of Munich; in a monograph published in 1886 are collected perhaps the richest statistics of necrosis of the labyrinth coming under the notice of an individual observer. In the clinical observations in a series of forty-six (46) cases, he summarizes the principal factors bearing on the subject, as follows:

Necrosis of the labyrinth occurs in the male with twice the frequency that it does in the female; children under ten (10) years of age are especially predisposed to this affection (18 cases in 43); the acute exanthemata, especially scarlet fever, play an important role as causative factors in the long-continued suppurative otitis, with its frequent tendency to involvement of the internal ear; the necrosis usually follows in the wake of a suppurative otitis of long standing; in two (2) cases only necrosis occurred after an otitis of eight months' duration; in twenty-one (21) cases the otitis was of four years' standing; in eight (8) cases, of twenty (20) years; only one case is cited where the necrosis of the labyrinth is described as the primary and the otitis as the secondary process; the exfoliation and elimination of the sequestra occurred in 37 of 46 cases cited during the course of the disease; in nine (9) cases death ensued before the elimination of the sequestrum Larger sequestra, composed not only of the cochlea, but also of the vestibule, semicircular canals and pars acusticus internus, have been met

with but rarely. Such cases have been cited and described in detail by: Wilde (*Treatise on Diseases of the Ear*, 1854, p. 358); Shaw (*Transactions of the Pathological Society*, London, vol. VII.); Toynbee, (*Arch. f. Ohrenh.*, 1864, Bd. I.); Agnew, (*Amer. Med. Times*, vol. VI., p. 185, see Troeltsch, 1869, 2d Am. ed.); Voltolini, (*Monatschr. f. Ohrenh.*, 1870, No. 6);

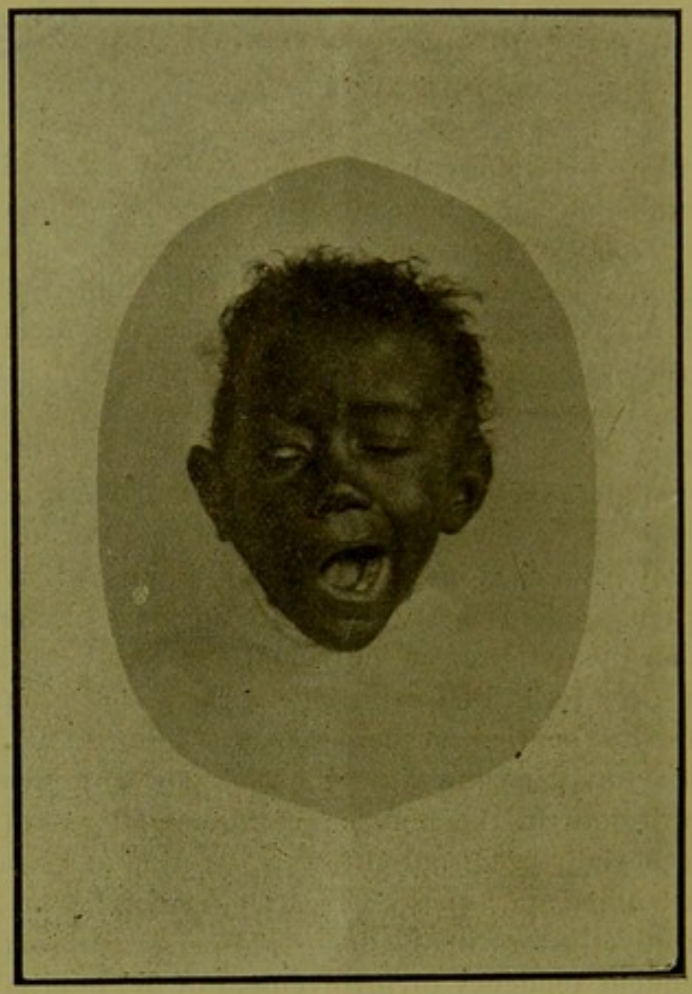

FIG. 1.

Illustrating the existing facial paralysis on affected side. Prior to operation the patient had complete motor paralysis of right eye; the photograph, taken one month after operation, indicates considerable amelioration of the described condition.

Pomeroy, (*Transact. Amer. Otol. Soc.*, 1872); Blake, (*Ibid*, 1880, vol. II, p. 417); Pollak, (*Archives of Otology*, 1881, vol. X., p. 361); Sexton, (*Illus. Quar. of Med. and Surg.*, N. Y., January, 1882). In the two cases cited by Toynbee, the sequestra were not removed until after death. In the other cases, with the exception of those of Pomeroy and Pollak, the large sequestra

were removed through the external auditory meatus. In the case reported by Pomeroy the large sequestrum was exfoliated by a natural process of elimination from the opening of a sinus behind the auricle. In Pollak's case the necrotic process had advanced to such a degree that the sequestrum, the major portion of the temporal bone, was lifted out of position and removed by the surgeon's fingers, no instruments being required. Each of the cases recorded was attended by a very marked facial paralysis, great disturbance of gait and equilibrium, and complete deafness on the affected side.

The case herewith described may, perhaps, in consideration of the size of the sequestra and the numerous clinical phenomena recorded, deserve a recognition with the rarest cases of necrosis of the labyrinth as yet reported.

H. M., colored, male, $6^1/_2$ years of age, has always been well nourished and of average strength and activity. At the age of three years (December, 1891) patient contracted measles, from which he recovered without any of the frequent aural complications. One year later (November, 1892) an intense, acute earache of several days duration ensued, followed by a copious purulent discharge; for eighteen months the discharge continued freely, uninterruptedly, without the accompaniment of any unfavorable symptom, the patient not even experiencing the slightest pain or difficulty in hearing. May 1, 1894, applied at the ear clinic of the Missouri Medical College Dispensary, where he received his first regular treatment for six weeks. During the following month the patient absented himself from the clinic.

July 17. Patient was admitted to the ear department of the Missouri Medical Polyclinic. His general condition and the suppurative process had now assumed a decidedly unfavorable aspect. The discharge had stopped, due to the plugging of the entire external auditory meatus with a cheesy mass, which, on examination, proved to be composed of partially dried and inspissated pus, epithelial shreds and detritis, emanating a thoroughly fetid and offensive odor. The entire posterior auricular region was very sensitive to the slightest pressure, the auricle assumed a position at right angles to the side of the head; the surface of the skin presented a sodden and irregular appearance; there was considerable induration, with distinct points of fluctuation, especially above a circumscribed area in a line with the upper margin of the auricle. This was incised and drained of about one and one-half ounces of green, fetid pus. A marked and almost

complete facial paralysis was demonstrable on the affected side. A small sinus, from which a spicula of bone had been recently discharged, was present, situated one-half inch posterior to the insertion line of the auricle and in a line with the posterior border of the lobule. Such was the condition existing when I took charge of the case, August 3.

August 5. The patient was prepared for operation. I made a long, free incision, connecting the upper, posterio-auricular abscess opening with the orifice of the sinus described. Hemorrhage was profuse and difficult to control, owing to the disorganized condition which the tissue in the field of operation had assumed by the long continuation of a severe necrotic process. A firm pressure by broad retractors was applied, and a free opening to the bone made. Placing a curette in position, preparatory to the removal of the necrotic bone mass, I observed a serious condition. The entire area was one rotten mass, and could have been more easily ladled out with a spoon than removed with a curette. After considerable manipulation with curette, forceps and irrigator, I succeeded in exposing to view a sinus, leading downward and forward, with a depth of nearly two inches, and diameters varying from one-half to one inch. The parts were thoroughly irrigated with bichlorid of mercury solution (1-1000), which was a difficult task, under the circumstances, as a communication had been established through free exposure of the Eustachian tube between the ear and naso-pharynx, and, there was considerable danger of asphyxia and accidental complications while the patient was under chloroform. The wound was well dusted with iodoform, packed with bichlorid gauze, and a well-padded compression applied. One hour later the little patient was up and walking part of the way home.

The following day I removed the first dressing. The discharge was profuse and the odor excessively fetid. Irrigated with warm bichlorid of mercury solution (1-1000). The patient swallowed a considerable portion of the solution. The communication between the large posterior opening and the auditory canal was free and drainage good. The cleansing and dressing of the wound caused the patient no discomfort, beyond that of the fluid entering the nasal and pharyngeal cavities during irrigation. The advantage of such an irrigation, in which the wound, the ear, nose and pharynx were simultaneously cleansed, is self-evident. It was noticed after the second dressing that the motor paralysis of the right eye had partially subsided, and that the patient was now

able to close the eye within one-quarter inch of complete closure. The dressings were reapplied daily for three months with but slight change in the general appearance of the wound or patient. Throughout the entire course of treatment, since the operation, there has been absolutely no pain, tinnitus aurium, vertigo, nausea and vomiting, or febrile reaction.

About the first week in November a change was noted in the general condition of the patient. He became restless, peevish, and complained of a general feeling of lassitude with a constant drowsiness.

The clinical memoranda appended will show the most interesting factors in the development of the case.

November 5. On redressing the wound, noticed for the first time a necrotic mass of bone, black in color, rough in surface appearance and touch, projecting from the anterio-lateral wall of the posterior auricular sinus. Discharge profuse and intensely fetid.

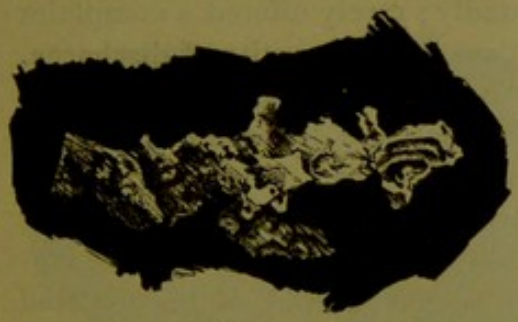

FIG. 2.

Main sequestrum; outer side; natural size. The beautifully preserved spiral of the cochlea stands out almost like an isolated picture from the rest of the petrosa. The full size of the exfoliated mass is well indicated.

FIG. 3.

Main sequestrum; inner side; natural size. The relationship of the labyrinthian structures is here clearly represented. Adjoining the prominent cochlea is the vestibular space with the ampullæ plainly visible; also a considerable portion of the posterior semicircular canal. At the further end of the specimen is the honeycomb mass of mastoid cells. The specimen measures 36 mm in its longest diameter; 18 mm. in its broadest diameter.

November 6. On irrigation, numerous soft, long discolord shreds were washed away. Discharge in 24 hours amounting to half an ounce of viscid, greenish, foul-smelling pus.

November 7. The black necrotic mass appeared nearer the surface of the sinus orifice. When touched with the tip of the irrigating syringe, it was found to yield slightly. With a strong shanked, milled-pointed dissecting forceps the mass was firmly grasped, the head of the patient steadied, and by gentle, steady

traction, the entire sequestrum was painlessly removed, through the fistulous opening. Not the slightest hemorrhage ensued, even oozing being scarcely perceptible. The entire proceeding was borne by the patient without the least expression of pain or a single unfavorable symptom. The wound was lightly packed with iodoform gauze and the auditory canal cleansed and dried. Sound tests were then instituted, as hereinafter described.

November 8. The discharge diminished to one-third the quaintity, issuing only from the auditory canal. The posterior wound, through which sequestrum had been removed, was clean, the gauze strip being removed almost dry and without stain. Inspection reveals the walls smoothly lined with numerous soft granulations. The fetor had disappeared. Drainage free. Antiseptic irrigation used throughout the treatment. Walking and standing tests for equilibrium were made.

November 9. The discharge remained odorless; quantity unchanged; general condition much improved.

November 11. Patient had again assumed his former lively disposition; ate heartily; slept soundly; rarely offered a complaint of discomfort. Perceptible decrease in the quantity of discharge.

November 12. On inspection by illumination, after thorough irrigation, detected a flat oblong sequestrum at distal end of long sinus, and gently removed same with forceps. Removal painless and without the slightest sequence. In the depth of the wound canal a pulsating or oscillating fluid, seemingly clear and shining, was discernable, and supposed to be the mucous of the exposed Eustachian tube.

November 13. Only traces of pus in the external auditory meatus; small, soft necrosed masses detached from the depth of the canal and removed with forceps and syringe.

November 14. Mirror illumination in wound canal revealed the presence of a necrotic bone mass attached to the posterior wall of the sinus. Examined with probe, it was found loose, and with forceps this, the third sequestrum, was easily removed.

November 15. Discharge very slight. Another small sequestrum was removed from the upper wall of the sinus. Numerous healthy looking granulations were observed in the depths of the sinus. Patient began to cough; a hoarse, short cough with frequent expectorations.

November 16. Discharge practically *nil*; a slight serous exudation noticed; similar to that found on granulating surfaces. Profuse granulations filling sinus.

November 20. Again some slight discharge. Located a small focus near the distal end of the bony portion of the internal auditory canal. with accumulations of epithelial shreds and pus.

November 25. Discharge of a yellowish green color, of thick consistency and increasing quantity. Cough had become more aggravated, loose, and expectoration profuse and of a muco-purulent character. Microscopical examination of the sputum revealed the presence of the tubercle bacillus in large numbers.

December 10. A bone sequestrum presents near the wound orifice. By restlessness of patient during attempted extraction, the mass was pushed out of place. Free communication between the sinus and the external auditory canal exists, as indicated by the probe in manipulation.

December 11. The sequestrum again presents, this time in the external auditory canal; presents with long diameter of sequestrum transversely to the axis of the external auditory canal. After some manipulation succeeded in turning and removing the rounded necrotic bone mass from the posterior sinus.

FIG. 4.

Sequestra in the order of their removal; natural size; all four sequestra were painlessly removed through a sinus of about three-quarter inch average diameter. The operative procedures, including the removal of the sequestra, extended over a period of about six weeks.

December 15. No discharge; wound looking comparatively dry. Irrigated thoroughly and dusted canal and wound with iodoform; very small gauze strips inserted.

December 19. Both wound and auditory canal dry; dressing of four days' standing removed dry and unstained.

January 5. Condition of wound unchanged. The patient was in lively spirits, talkative, and felt no discomfort from his recent siege of treatment. He was considerably emaciated, cough was still very harassing; expectoration profuse. Physical examination revealed the following: In the apex of the left lung there was cavernous percussion sound and rales. Over the entire area of the

right lung mucous rales, with slight percussion dullness; harsh inspiration over the right apex; prolonged expiration of high pitch; numerous subcrepitant rales. History of case points to the probability of a rapidly developing phthisis pulmonalis. The mesenteric glands are enlarged and easily localized by palpation. The cervical and other lymph glands of the head present almost a "rosary" outline, so general, regular and continuous is their enlargment. The sputum contained numerous tubercle bacilli. Emaciation of the patient had been marked and rapid the previous few weeks. A phthisical febrile reaction noted; rise of temperature, accompanied by night sweats and continued coughing.

By far the most interesting and important factor which presents itself for consideration in this case was the existence of the faculty of hearing on the affected side after removal of the cochlea and deep structures of the petrosa.

I have been thoroughly cognizant of the difficulties and responsibilities attending an effort to substantiate so radical a statement, and have necessarily adopted the most careful methods and delicate tests to convince myself of the accuracy of my conclusions. The most serious obstacle to contend with was the exclusion of the healthy ear from the sound tests which were instituted. In the majority of the tests made I adopted the method suggested by Dennert and Lucæ, with modifications. In determing what degree of sound perception still exists in an affected ear in a case of one-sided deafness, the healthy ear of the patient is stopped, turned towards the source of sound and the tests then made, the affected ear being alternately opened and closed. Whatever difference in the hearing then elicited, is attributed to the affected ear.

A more delicate modification of this method has been successfully used by Burnett. The patient is so placed that the affected ear is toward the operator. The healthy ear (not the ear to be tested) is plugged. With the affected ear open, hearing tests are then instituted. Having thus reached the apparent limit of the hearing power of the affected ear, that ear is then closed, and the tests continued. If the closure of the deaf ear causes no difference in the hearing distance already obtained, it is fair to conclude that whatever amount of hearing exists is not due to passage of sound through the external auditory canal of the affected ear turned towards the test. In such a case the conclusion must, therefore, be that sound has reached the brain through the agency of the healthy ear. If, however, the stoppage of the affected ear is accompanied by an absolute inability to hear sound tests, it is

again rational to conclude that this difference in the hearing power must be attributed to the affected ear. Thus, the final conclusion: "Whatever is heard just as well with the deafer ear stopped as when open, the better ear remaining stopped throughout the testing, must still be heard by the better ear through the head; but whatever is heard only with the worse ear open, the good ear being stopped, must be attributed to the worse ear."

The question might be asked, why cannot sound be conveyed to the deaf ear through the head; if it is conveyed to the better ear which is stopped and turned away from the sound source? The reply would be that an ear which, either when stopped or open, perceives no difference in sound conveyed by the meatus, is not sensitive enough to hear sound conveyed to it through the head.

In the consideration of the case at hand, bone conduction tests by aid of tuning forks were excluded, as they were deemed less delicate for a differential than aerial sound conduction. Furthermore, as our dealings were directly with an exfoliated labyrinth, the tuning fork, relative to bone conduction, was practically of no value.

The following tabulated notations will indicate clearly the conclusions reached in hearing tests of the affected ear:

Hearing tests.	Hearing capacity with both ears closed.	Hearing capacity with affected ear open and good ear closed.
Loud conversation	300 *cm.*	900 *cm.*
Whispered conversation	30 *cm.*	90 *cm.*
One hundred and fifty centimeter watch	5 *cm.*	15 *cm.*
Politzer's acoumeter, designated by patient as a loud ticking watch	15 *cm.*	35 *cm.*
Galton whistle; pitched high	30 *cm.*	60 *cm.*
Differentiation in sound of C from C^4 tuning fork	8 *cm.*	35 *cm.*
Musical notes of a long sounding-harmonium. Differentiation of C (3d octave) from C (5th octave)	35 *cm.*	90 *cm.*

In the execution of the enumerated tests the patient was blindfolded; the plugging of the meatus was done by a competent assistant, the fore-finger being used as a tight plug. Taking into account the age of the patient and all tendencies to a possible misrepresentation of the hearing capacity, the tests were repeated at frequent intervals with many variations; yet the tests proved doubly valuable, owing to the demonstrable accuracy of the patient's statement.

Next in the order or importance of the clinical phenomena observed, was the preservation of the equilibrium and balance of the patient. As previously stated, one hour after the operation, patient was up and walking home with absolutely no trace of altered equilibrium. Walking and standing tests have been repeated frequently, varying the same in every conceivable way by blindfolding the patient, testing with eyes closed, permitting the patient to walk under the influence of loud noises, etc. The results were always positive; his gait firm and steady; the power of equilibrium preserved to a niceity.

A factor of great interest was the prominent role played by the bacillus tuberculosis in the development of this case. Early in the history of the case a microscopical examination was made of the discharge from the ear and the presence of the tubercle bacillus demonstrated. A physical examination at that time gave no indication of a phthisical onset. The free communication of the suppurative aural focus with the pharynx; the tendency to frequent swallowing of this purulent material infected by the tubercle bacillus; the gastro-intestinal disturbances; incessant coughing; profuse expectoration; febrile reactions; enlargement of the lymphatics of the entire system; rapid emaciation; great prostration; and, finally, the involvement of the lungs, as determined by recent examination; the demonstration of the presence of the bacillus tuberculosis in the sputum — this well-marked series of symptoms point to a development of a rapid phthisical process. It seems rational and reasonable to conclude that this acute phthisis is, perhaps, a secondary development of the original tuberculous process in the ear.

In maintaining my position in the case at issue, with my conclusions drawn from the careful tests made and clinical phenomena observed, I realize that I am treading on delicate ground, and that the presentation of these results opens for consideration a new phase of development in the theory of sound, and in the complicated functions of the labyrinthian structures.

It is not my purpose to discuss the pros and cons of the theories which the results attained in the present case may suggest, but to indicate in the presentation of this series of simple firm facts, the existence of some inaccuracies in the now accepted theory of sound, and in the functioning of the semicircular canals in relation to balance and equilibrium.

POST-MORTEM NOTES.

The diagnosis and prognosis of a rapidly-developing and speedily-terminating miliary tuberculosis, as a complication and

infection secondary to the aural disease, in the case at issue, as expressed in the preceding pages, was thoroughly substantiated in less than one month after presentation of patient and complete demonstration of the results attained, before the local medical fraternity.

January 5. Patient was presented at the Saint Louis Medical Society. He was then bright, active and in good spirits.

January 15. General depression; painful, incessant cough; profuse expectoration, showing bacillus tuberculosis abundantly on microscopical examination; intense dyspnea; febrile disturbances; abnormal pains; severe diarrhea. The only cerebral symptom, mild stupor. Progressive emaciation and prostration with continuance of these symptoms was followed by the death of the patient January 29.

FIGS. 5 AND 6.

Necrosed temporal bone. Post-mortem removal. a. Mastoid process. b. Styloid process. c. Cartilaginous external auditory meatus. d. Necrotic sinus of about three-quarter inch average diameter, through which sequestra were removed. e. Area of necrosis. f. Zygomatic process. g. Squama. h. Remnant of posterior surface of petrosa, with the internal auditory meatus partially intact.

Unfortunately permission was not granted for a complete autopsy. The right temporal bone was removed, and the involved area carefully inspected.

The dry antiseptic dressing, applied ten days before, was removed perfectly clean. The post-auricular region showed but moderate depression at the site of so extensive a necrotic process; the sinus was almost closed, scarcely admitting a large probe.

Examination of the affected temporal bone, after its removal, corroborated our descriptions of the necrosed and exfoliated areas. Circumscribing the region of the osseous external auditory meatus, and involving the mastoid and squama, with a radius of about three-quarters of an inch, was a necrotic zone with irregular, but well defined margin. Designating this as the base of a long, cone-shaped canal, we note an axis of about two and one-half inches in length, directed inward, downward and backward, with its apex merging into the Eustachian tube. This cone-shaped sinus, through which the exfoliated bone masses were removed, was filled with quite firm, closely meshed granulations. All landmarks of the osseus meatus auditorius externus and cavum tympanum had disappeared. Of the petrosa, the superior wall and part of the posterior portion of the meatus auditorious internus still remained intact. Examined while fresh, the portion of the nervus acusticus, lodged in the depth of this canal was to all appearances normal in color and consistency.

After removal of the bone, the exposed cavity was carefully examined, with special stress laid on the cranial areas in direct relationship to the necrosed bone. On the periosteal surface of the bone still remaining, numerous erosions and irregularities were noted, yet the dura mater at all points was perfectly firm and intact. With the existence of a so disseminated and rapidly progressing tubercular process, our anticipations of the presence of a tubercular meningitis might have been well founded; the most careful and detailed search, however, failed to reveal any meningeal lesion whatever.

As it is not my intention in the present article to enter into a discussion of the probable theories of the physiology of sound, neither do I propose suggestions relative to these post-mortem notes.

It may be remarked that in a case of miliary tuberculosis, with the primary infection an aural one of long standing, and a necrosis, which by its extensive bone destruction, exposed to direct contact with the specific suppurative processes the largest portion of the temporal lobe, lateral sinus and temporal section of the internal carotid artery, the absence of any meningeal or cerebral complications must be considered a rare occurrence.

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