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LESIONS OF THE CONUS MEDULLARIS AND CAUDA EQUINA.

A CONTRIBUTION TO THE STUDY OF SPINAL LOCALIZATION.

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It is only within the past few years that lesions of the conus medullaris and cauda equina have attracted the attention of medical writers. In 1895 Raymond collected 29 cases of spinal disease, in which either one or the other of these structures were involved. Since then Clemens, Schiff, Church, Koster, Mueller, Sachs and a few others have reported similar conditions. The symptoms produced by disease of the conus medullaris and cauda equina are well defined and, as a rule, easy of recognition. Experience shows, however, that unless one has learned to search directly for them, they may be readily overlooked. My chief aim in presenting this paper is to further the recognition of the clinical picture indicative of disease of these important structures.

The conus medullaris occupies a position in the spinal canal directly behind the first lumbar vertebra. Upon exposing the spinal cord, the conus is completely hidden from view by a mass of firm and coarse fibers, constituting the beginning of the cauda equina. Anatomic ally, its upper limit has not been accurately defined. Text-books on anatomy and neurology, if they refer to the conus medullaris at all, usually describe it as that conical portion of the spinal cord below the lumbar enlargement. Clinicians, in describing cases, have pleased their own fancy relative to its boundaries. Thus, Brautigam places its upper limit at the lower part of the lumbar enlargement. Valentini and others have described, as conus lesions, disease involving the whole sacral cord. Raymond, Müller and others who have written on the subject recently are inclined to limit the conus medullaris to that portion of the cord represented by the third, fourth and fifth sacral and the coccygeal segments. The recent studies of Müller relative to the histology of the lower end of the spinal cord appear to justify such an anatomical limitation.

The clinical picture produced by lesions of the conus medullaris thus anatomically restricted is characterized by well-defined sensory and motor disturbances. Sensation is impaired in an area symmetrically distributed, which involves the integument of the penis, scrotum, perineum, anus, inner aspect of the buttocks and posterior surface of the thighs. The sensibility of the mucous membrane of the penis and rectum may also be dulled. If the lesion is sufficiently destructive, the muscular

power of the bladder and rectum may be seriously impaired, sexual power lost, and bedsores may develop.

Lesions of certain fibers of the cauda equina may produce a clinical picture very similar to that of conus disease. To be able to recognize and differentiate the two conditions is not only scientific, but extremely practical from the standpoint of treatment. While it is not probable that focal lesions of the conus will ever be amenable to surgical treatment, a limited number of cases of caudal disease have already been reported successfully treated by operation. Focal disease of either the cauda equina or conus medullaris may exist alone or in connection with disease elsewhere. Disease of both structures may coexist.

During the last three years it has been my fortune to observe nine cases in which disease of either the conus or the cauda was present, one of which came to autopsy. The lesions represented in these cases included focal myelitis, tumor of the conus and disturbances of function of these structures due to the following conditions: Injury to the vertebral column, tumor of the vertebrae, and tubercular spondylitis. I have also observed one case of tabes dorsalis in which the symptoms of a conus lesion were present.

THE WORK OF STARR AND KOCHER.

That the case may be studied more understandingly I wish before reporting them in detail to refer briefly to the work of Starr and others on spinal localization. Starr was one of the first to recognize the importance of the fact that focal lesions of the different spinal segments were accompanied by sensory disturbances confined to certain areas of the skin. After an extended study of the cases reported, and of his own, both antemortem and postmortem, he elaborated a chart relative to the lower extremities, to which the reader is now referred. According to Starr, disease of the third sacral segment is accompanied by anesthesia of the area marked S3; similarly, disease of other segments gives rise to anesthesia of areas designated by the corresponding segment number. Subsequently, Head constructed a chart based chiefly on his study of herpetic eruptions and areas of cutaneous tenderness present in visceral disease. The gaps in the cutaneous areas not affected by visceral disease, such as that from the second to the fourth lumbar segments, inclusive, were filled in by him from a study of cases, the result of disease or injury. The result of Kocher's work on spinal localization is shown in an accompanying chart representing the lower extremities only. Wichmann's chart for the lower extremities shows marked overlapping of many of the segments. His conclusions are based on a consideration of nerve distribution combined with clinical cases. The dissimilarity in the results obtained shows that either

cutaneous distribution is not constant, or that knowledge on the subject is imperfect. It is hoped that a study of the following cases may contribute something to the subject of spinal localization.

CASE 1.—Illustrating Myelitis or possible Spontaneous Hemorrhage, involving the Conus Medullaris:

J. M., male, aged 40, was admitted to the hospital, Oct. 4, 1898. When 17 years of age, had chancre, followed by secondary lesions. Several years ago used alcohol to excess. Claims that he drinks moderately of late. Two days previous to admission, while drunk, patient was exposed to cold and wet and slept all night in his wet clothing. The next day patient suffered with headache, nausea and weakness of legs. He was able to work all day. That night he slept well; next morning went to work as usual and continued until noon. About 1 p. m., after returning from dinner, the patient sat down and upon attempting to arise found that he could not, on account of weakness of his legs. He was brought to the hospital and after his arrival walked a short distance. The same evening patient noticed he was unable to retain his urine. No sensation was felt in the bladder or urethra, as it

entered the hospital and says his legs feel stronger. Bladder is distended; the urine dribbles away and bowels move without producing any sensation. No pain has been experienced. Sexual power is lost. Sensory disturbances: Hyperesthesia of scrotum, penis and areas outlined in Fig. 1. In these areas the temperature sense is almost completely lost; a superficial pin-prick does not give the sensation of pain; a deep pin-prick is recognized. Slight anesthesia about the outer side of the left ankle. The process probably extends upwards as high as the lower portion of the first sacral segment. The testicles are tender on pressure. The anal sphincter is relaxed. The urethral mucous membrane is anesthetic to the passage of a sound. There is very little resistance offered by the membranous portion of the urethra.

The patient gradually improved in strength and on October

Figure 1.

dribbled away from him. He was then able to control his bowels. Numbness of the skin about the gluteal and anal regions was noted by the patient. Superficial examination disclosed areas of partial anesthesia and analgesia on the posterior aspect of the buttocks and thighs. Sensation elsewhere normal. Patellar reflexes slightly exaggerated. Temperature normal. Bladder palpable two inches above pubes. Gait was very unsteady. No painful sensations experienced by the patient. For two days the bowels did not move. Magnesium sulphate was given and followed by involuntary bowel movements.

Examination on October 11, one week after admission, revealed the following condition: No symptoms referable to the cranial nerves, upper extremities or trunk. The lower extremities are somewhat weakened, especially both peroneal groups of muscles. Patient is able to support his weight on his toes. Extensors and flexors of the right foot slightly weaker than those of the left. Fibrillary twitchings are not observed; no atrophies; normal response to electricity. Patellar reflexes slightly exaggerated, more on the left. Achilles reflex absent, both sides. Both plantar reflexes present, but abdominal and cremaster absent. No incoördination. The gait is slightly spastic—paretic. Patient is able to walk better than when he

Figure 2.

21 the bowel movement was controlled. On November 2, it is recorded that the patient can retain urine and can feel it as it is voided. The patient was discharged Dec. 28, 1898. The area of hyperesthesia remained about the same in outline, although not as pronounced as on admission. The patient has gained full control of his bladder and rectum.

Clinical Diagnosis: Myelitis or possibly spontaneous hemorrhage, involving the conus medullaris; influence of lesion at onset extending as high as the fifth lumbar segment. The differential diagnosis between conus and caudal disease will be considered at the close of the article.

According to Sherrington, the skin of a given locality is supplied by a higher root than the muscles lying directly beneath that area, with the exception of the posterior surface of the thigh. Only the pilomotor fibers of the sympathetic ganglion and the sensory cutaneous areas of the corresponding spinal ganglion coincide in their distribution. According to Langley, the secretory fibers of the sympathetic ganglion correspond in a like manner. It may be noted that in this case the statement of Sherrington does not appear to agree with the

findings. Relative to the exact location of the lesion in the cord, it may be safely stated that in the early stage the lesion extended high enough to influence decidedly the fourth and fifth lumbar segments, and possibly slightly higher, since the patellar reflex was exaggerated. Subsequently, the effect of the lesion was confined to the sacral segments. The upper limit of the permanent lesion reached the level of the lower part of the first sacral segment. Whether it extended downward to the tip of the cord may not be stated. The lower limit of cord lesions is always difficult to ascertain, the chief aids being the reaction of degeneration, and the condition of the reflexes.

CASE 2.—Illustrating myelitis or hemorrhage in the conus and adjacent cord: L. S., female, aged 17, was admitted to the hospital, May 24, 1901. Three weeks before admission the patient began to have pain in the small of the back during the regular menstrual period. Did not sleep much that night. The next day felt as well as usual. Three days later she began to have pain in the back and knees. While on an errand, her

the foot. Peroneal group totally paralyzed. Outward and inward rotation of the hip is paretic. Unable to voluntarily force the thighs backwards. Levator and sphincter ani relaxed. Detrusor muscle paretic. Mucous membrane of the vagina and rectum slightly dulled to touch and pain sense. Muscle sense absent. Sensation disturbed in the areas outlined in figure 2. There is complete loss of sensation of pain, temperature and touch in the areas outlined about the buttocks and perineum. The same is true of the more deeply shaded areas about the feet and the outer side of the legs. The inner side of the legs was hypesthetic. The loss of the temperature and pain sense was more sharply outlined and extended slightly beyond the areas of cutaneous anesthesia. Areas that showed slight hypesthesia were analgesic to superficial pinprick, and temperature could not be distinguished.

It was necessary to catheterize the patient for several weeks.

Figure 3.

Figure 4.

knees suddenly gave way and she fell to the ground. She was unable to get up and was carried to her bed. Pain was felt in the legs, especially in the calf muscles. The pain was sharp, intense, cramp-like in character and continued for five or six days. Some tenderness of the posterior thigh muscles developed. Patient cried out when the legs were moved. Pain was increased on pressure. One week after onset of paralysis, incontinence of urine developed. Bowels were all right for one week after onset, when constipation began. Bowels were moved by cathartics. These soon failed, and the strongest became futile. Enemas also had little effect. Patient did not feel feces passing the sphincter. No fever, nausea or vomiting was present. Three weeks after onset a large bed sore suddenly developed. Family history negative. Patient had not recently been ill.

Examination May 26 shows no spinal deformity or tenderness. Bed sore in the sacral region the size of the hand. Bladder distended. Some weakness of quadriceps muscles. Legs may be drawn up and flexed on the thigh with considerable exertion. Plantar and dorsal flexion of the feet is impossible. The patient is unable to move the toes or evert either edge of

The pain in the legs had disappeared when the patient came to the hospital. After about two weeks, it reappeared, but not as severe as at the onset. It came in paroxysms, lasting about fifteen minutes, returning about every hour. This continued for about two weeks, and has not since returned. The bed sore has persisted, although it is growing smaller. The condition at last examination, Oct. 21, 1901, was very little changed, except that the bed sore was nearly healed, and the patient was gaining some control over the bladder and rectum.

Since pain in the legs was an important symptom at two different times during the early history of this case, it is not improbable that the cord lesion was accompanied by a slight meningeal affection. A myelitis is often associated with slight meningeal inflammation. Intra- and extra-medullary hemorrhage not infrequently take place at the same time. On the other hand, it is doubtful whether in such cases one is justified in assuming that a meningeal lesion coexists, since irritation of the sensory paths in the cord may be accompanied by

radiating pains and hyperesthesias. (Berndt, Vix, Kocher and Gowers.) In a given case the nature of the process and the severity of the pain would count for much in determining whether the meninges were involved.

CASE 3.—Illustrating Lesion of the Cauda Equina: C. S., male, aged 35, walked to the hospital and was admitted Oct. 22, 1899. The first symptom noted by the patient was pain in the right lower extremity and soon afterward in the left. The pains gradually became more severe, and the patient began to lose in weight. Before his admission to the hospital he had been treated for sciatica. Upon admission to the hospital pain in the thighs and legs was very severe, but not increased on pressure. Power of the lower extremities somewhat impaired. A tumor having its apparent origin in the lower

that the distribution of the anesthesia, and the bladder and rectum disturbances indicate that the fibers coming from the third, fourth and fifth sacral segments, or, in other words, the fibers coming from the conus, were much more seriously affected by the compression than the remaining fibers of the cauda equina. The fibers from the conus hang in the center of the whole bundle of fibers constituting the cauda equina, and there is no apparent reason why they should suffer greater injury from compression than those immediately surrounding them. Thorburn, however, has previously made similar observations relative to compression of the cauda equina. In his book on surgery of the spinal cord, he writes:

Figure 5.

Figure 6.

lumbar spine was readily palpable through the abdominal walls. An area of hypesthesia corresponding to shaded portion of figure 3 was detected. During the following two months the hypesthetic areas became anesthetic, analgesic and thermesthetic. The patient lost control of his bladder and bowels. The anal sphincter became relaxed. The mucous membrane of the penis became anesthetic to the passage of a sound. Notwithstanding these symptoms, the patient could move his legs with considerable freedom. Their movement was restricted apparently by the increased pain produced. The electrical reactions were unchanged. At first the patellar reflex was slightly exaggerated.

At the time the patient was discharged, the reflexes were about normal. The tumor had increased rapidly in size and apparently involved the bodies of the vertebrae in the middle and lower thirds of the lumbar spine. It was probably a sarcoma. Unfortunately, the patient moved from the city, and I am not able to give the subsequent history of the case.

From the location of the tumor the lesion was probably compression of the cauda equina in the lower lumbar region. It will be noted, however,

“In a pressure lesion of the entire cauda equina the central fibers are more seriously injured than those surrounding them.”

CASE 4.—Illustrating traumatic Myelitis of the Conus and adjacent Cord: J. S., male, aged 40, was admitted to the hospital May 21, 1900. Patient fell a distance of ten feet, striking on his shoulders, doubling his spine. He immediately felt numbness in the right lower extremity, and pain in the small of the back. He could move his legs, but could not get up on account of pain in his back. No pain was felt in his lower extremities. No pricking nor tingling sensations were experienced. Before arriving at the hospital the patient noted that the penis and scrotum were anesthetic.

Examination, May 25: Slight angular deformity present at the first lumbar vertebra. Two small blebs on either side of the gluteal fold, about four inches above the anus. Excoriation about the head of the penis. Both lower extremities are weak, but all their movements, including flexion, extension and rotation, can be executed. No atrophies. Reflexes—patellar, Achilles, plantar, cremasteric and abdominal absent. Reflexes of upper extremities normal. Retention of urine exists, and

when the bladder is overfilled the patient experiences dull pain. The passing of a catheter is not felt. The anal sphincter offers slight resistance. The patient is not conscious of the examining finger, except in the region of the prostate. Rectal tube is not felt until the sigmoid flexure is nearly reached. No pain along the course of the nerves. Muscular sense everywhere intact. Sexual power lost. Sensation is disturbed in the areas outlined in figure 4. The areas shaded heavily corresponding to the cutaneous distribution of the second, third fourth and fifth sacral segments were anesthetic to touch and to ordinary pin-prick. A deep thrust of the pin produced the sensation of pressure and slight pain. Temperature sense lost. The areas shaded lightly were uniformly anesthetic to the camel's hair brush. It will be noted that the cutaneous area supplied by the first, second, third, fourth and fifth sacral segments are affected on both sides equally. In addition, on

Figure 7.

the right side the cutaneous distribution of the twelfth dorsal, first, second and third lumbar segments are involved. Electrical reaction normal.

Diagnosis: Traumatic myelitis involving the conus medullaris, influence of lesion extending as high as the twelfth dorsal segment. **Etiology:** Dislocation or fracture of the first lumbar vertebra. **Subsequent course:** Patient was seen last Oct. 21, 1901. He was able to walk and do some work. Areas of anesthesia confined to the distribution of the sacral segments. He had regained control of the bladder and rectum.

Since the fibers of origin of the cauda equina completely surround the conus medullaris, one might expect more serious symptoms referable to the cauda in a traumatic lesion of the conus, such as we assume exists in this case. Relative to this point, however, Oppenheim, Schultz, and Sarbo have each reported a case, with autopsy, in which the conus was destroyed by trauma, and the fibers of the cauda remained intact. When one compares the relatively delicate structure of the conus with the coarse fibers of the cauda that surround it, it

is easy to understand how a sudden and temporary displacement of the bodies of the vertebrae from fracture or dislocation might seriously injure the conus and produce few or no symptoms referable to the cauda equina. That simple compression of both of these structures may result in disturbing the function of the conus without affecting the fibers of the cauda equina is well illustrated by the following case of tubercular spondylitis:

CASE 5.—Illustrating uniform Compression of the Conus from Spondylitis: J. O'M. came to Dr. Preble's clinic, complaining of pain in his back. Examination showed slight deformity and tenderness in the region of the first lumbar vertebra. There was little or no loss of power in his legs. There was a sharply defined area of hypesthesia corresponding to the shaded outline in figure 5. It will be noted that there was dulled sensibility in the cutaneous area supplied by the whole sacral cord. The function of the bladder and rectum was undisturbed. The sexual power was intact. No painful sensations were experienced, with the exception of tenderness at the

Figure 8.

seat of the spondylitis. The patient gradually improved, so that he is now able to work. The deformity in the lumbar region has nearly disappeared. No trace of the cutaneous anesthesia is to be found. It is fair to presume that the hypesthesia was due to compression of the conus by the inflammatory exudate of the spondylitis, and that as the exudate was absorbed, the conus hypesthesia disappeared.

CASE 6.—Illustrating traumatic Myelitis or possibly Hemorrhage involving the Conus and adjacent Cord: R. received an injury to his dorso-lumbar spine, resulting in sudden paralysis of the legs, bladder and rectum three years ago. The patient is now able to work and has regained control of his bladder and rectum. Fig. 6 represents the sensory disturbances still present as the result of the injury. The lighter shades are intended to indicate hypesthesia, the darker shades anesthesia to a camel's hair brush. Pain sense was dulled and temperature sense lost in the area of darker shade. It will be noted that the sensory disturbances indicate that the lesion which now remains is symmetrical, and involves the cord as high as the twelfth dorsal segment. The function of the whole sacral cord, as shown by the cutaneous anesthesia, is more

seriously disturbed than that of the adjacent portion of the spinal cord.

CASE 7.—Illustrating Contusion of the Spinal Cord with possible Hemorrhage into its Substance: J. K., aged 44. On June 19, 1897, patient fell from a bridge, 23 feet high, striking on his buttocks. He was not rendered unconscious, but could not arise on account of weakness in his legs. He experienced pain in his back, but none in his legs or thighs. A feeling of numbness was present in his legs, and he was unable to move them. It was necessary to catheterize him. His bowels did not move without an enema. No pain was felt when the catheter was passed. In four months the patient was able to walk with the aid of crutches. During the last two years there has been no improvement in muscular power. He can control the bowels, but can not retain urine more than one hour. Sexual power is lost. Pain was not experienced at any time, except that felt in back immediately following injury.

Examination, Oct. 20, 1901, revealed the following: No

legs, area of imperfect tactile, thermic and pathic sensation can be found on the right leg, but can not be exactly outlined. Small area of anesthesia found on the outer side of the right knee. Patellar reflex can not be obtained on either side. Other reflexes appear normal. Romberg's symptom well marked. The patient complained of pain in the thighs and legs. The case was looked upon as a probable peripheral neuritis, and the patient was about the ward, apparently comfortable, for several weeks, when he showed signs of rapid decline. Pulmonary râles developed, and evidence of slight fluid appeared in the peritoneal cavity. The temperature was elevated.

Examination of the nervous system, August 27, one day previous to death, revealed the following condition: Marked hypesthesia of shaded areas (Fig. 8) of the whole penis and scrotum. Mucous membrane of the penis hypesthetic. Perineum hypesthetic; likewise shaded portion of the gluteal region. In these localities a moderate pin-prick was imperfectly felt. Camel's hair brush was not noticed. Deep pin-prick produced dull pain. Partial thermesthesia existed in these areas. The center of the shaded part of the thigh was totally anesthetic; its border hypesthetic. Anesthesia was profound to the sense

Figure 9.

spinal deformity; patient walks with the aid of a cane; gait paretic and slightly spastic. Toes were flexed upon the foot in the hammer-toe position; tendency to footdrop. Feet and legs were slightly swollen, but no edema. No individual atrophy present, although the peroneal group appeared somewhat flabby. The patient was unable to move his toes or flex his foot upon the leg. The power of extension somewhat impaired. Was able to bend both knees and rotate both legs. Abduction and flexion of hip normal. Quadriceps and abductors possessed fair degree of power. Anal sphincter was intact. Perineal muscles responded to volition. Patellar reflexes were normal. Ankle clonus marked. Plantar reflex normal. Muscular sense in toes entirely lost. Sensation disturbed, as shown in Fig. 7.

CASE 8.—Illustrating Tumor of the Conus and adjacent Cord: W. T., aged 19, was admitted to the hospital June 14, 1898. One year previous, tubercular glands had been removed from the neck. Three weeks before the patient was admitted, he had some difficulty in walking. Examination of lungs negative. Apex of the heart in the mammary line. No murmurs. Abdomen negative. Abdominal reflex normal. Arms negative;

Starr's chart.

of touch, pain and temperature in the shaded areas of both legs, extending slightly above the knees, as outlined in the figure. Here and there a deep pin-prick was felt by the patient. No tenderness on pressure; muscles of the leg soft and flabby; no individual atrophy. Motor power of feet and toes lost. Right patellar reflex absent. Left gave very slight response. Ankle clonus present on both sides. Small blebs containing serous hemorrhagic fluid on the plantar surface of the left foot. A bleb the size of a silver dollar was present on the dorsum of the same foot. Patient complained of pain in the thighs, which was not increased on pressure. Was not able to move the feet, but could draw the knees up slightly. Not able to control the bowel movements, if he waited long after desire to stool was felt. Normal feeling when bowels moved. Control of bladder same as rectum. Sexual power lost since short time after entering hospital. Sensation in other parts of the body normal. A careful test of the movements of the thigh muscles was not made, on account of the patient's condition. The patient died on the following day, before further examination was possible.

The diagnosis made as to disease of the nervous system was progressive lesion of the conus medullaris and adjacent cord, with probable involvement of the nerve roots. The great pain present, referred to the thighs and legs, could not well be produced by a pure cord lesion, and no pain on pressure being present, nor individual sensory disturbances, a meningeal or root process was probable. The ankle clonus, in association with loss of patellar reflex on one side and diminished patellar reflex on the other side, was very striking. Possibly the lesion destroyed the center for the patellar reflex and irritated the center for the tendo-Achilles reflex, or perhaps the lesion cut off the upper segment control of the tendo-Achilles reflex. It is also to be noted that the sexual power was lost, while the function of the bladder and rectum was fairly well preserved.

Autopsy showed miliary tuberculosis the immediate cause of death. A tubercular tumor was found occupying the upper sacral and lower lumbar cords. The upper limit of the lesion was at the lower part of the second lumbar segment, higher on the right than on the left side.

tion of a given root, it was necessary to divide five roots above and five below the one investigated. Head claims that the areas of distribution mapped out by him on the basis of herpetic eruptions and tenderness in visceral disease do not overlap and that they correspond fairly closely to the areas of Sherrington, determined by a study of posterior root distribution. He also claims that the great difference between the root and the cord supply is that the root supply overlaps greatly, while the cord supply does not. Finally, Head concludes that the mechanism for touch sensation in the spinal cord overlaps, and that the mechanism for pain and temperature and trophic influences does not overlap, or at least not to the same extent as the overlapping of the touch sensation. His conclusions receive support from a study of this series of cases. It was also noted that the pain and temperature areas approximately coincide. Refer-

Chart after Wichmann.

Figure 9 represents an area of cutaneous hypesthesia found in a case of tabes dorsalis. This was among the first manifestations of the disease.

In all the cases of this series the disturbance in temperature and pain sense was more sharply defined and, as a rule, extended slightly beyond the areas of cutaneous anesthesia. Areas in which tactile sensibility was only slightly dulled often showed analgesia and thermesthesia. Such observations have been previously made by Starr, Thorburn and others who have given attention to these particulars.

Sherrington's experiments on the posterior spinal roots show a marked overlapping of the cutaneous distribution. Cutting one root was accompanied by no loss in the sensation of touch. Such great overlapping was present that in order to map out the area of distribu-

Rocher's chart.

ring again to the charts of Starr, Head, Kocher and Wichmann, it will be observed that Wichmann's chart shows greater overlapping of areas than any of the others. This would naturally result from the basis upon which the outlines were constructed. The distribution of peripheral nerves was consulted largely and it is known that they overlap to a marked degree. Although these charts differ considerable in detail, they resemble each other coarsely and for clinical purposes any one of them would certainly be approximately correct. Viewed from the standpoint of accurate physiology, they probably do not represent final knowledge on the subject. Indeed, it will not be possible to draw hard and fast lines descriptive of cutaneous areas of spinal segment distribution until a great many cases have been studied in connection with autopsies. I be-

lieve a study of this series of cases contributes certain points relative to the physiology of the sensory distribution of the lower cord.

It will be observed that there is great similarity in the outline of the shading representing the areas of anesthesia about the posterior thighs, buttocks, perineum, penis and scrotum. These areas are fairly symmetrical, and correspond very closely to the areas said by Starr and Kocher to represent the distribution of the third, fourth and fifth sacral segments. Figures 3 and 9 show pure types of conus anesthesia. The area mapped out resembles somewhat the patch on saddle-breeches. Since this peculiar area is repeated in every one of the nine cases and in many others in the literature, it is fair to presume that lesion of a certain portion of the cord or cauda equina is regularly accompanied by such an area of anesthesia. From a study of these cases and those reported, especially the cases collected by Starr and Kocher, I believe the areas outlined in Figures 3 and 9 are due to disease of the third, fourth and fifth sacral

plies it lies directly above that for the saddle-breeches area. According to Head, lesions of the fifth and fourth lumbar segments produce sensory disturbances on the outer and inner sides of the leg respectively. Cases 2 and 7 are completely in accord with such a distribution. It may be noted that the outlines in the nine cases here reported corroborate very closely the work of Starr about the buttocks, perineum, penis, scrotum and posterior thighs, and that of Head about the feet and legs. It is also worthy of note that in connection with the saddle-breeches area the anesthesia of the posterior thighs did not extend downward as far as the bend of the knee, except in Cases 4 and 8. In Case 8 it is probable that disease of the second and third lumbar segments caused the anesthesia of the legs to become continuous with the anesthesia of the thighs. In Case 4, injury to the second and third lumbar segments caused an extension of the anesthesia downwards beyond the bend of the knee. This series of cases confirms splendidly the work of Starr relative to the posterior thighs, and does not at all con-

Chart after Head.

Author's chart.

segments, or to disturbance in function of caudal fibers leading to those segments. In case the lesion extends higher in the cord, involving the second sacral segment, this same area is extended so as to conform very closely to that outlined by Starr under the first, third, fourth and fifth sacral segments. (Figures 1, 2, 5, 7, 8 and the deeper shades on the buttocks of 4 and 6.) Thus far the outlines in this series agree perfectly with Starr's chart.

I wish now to call attention to the peculiar slipper-shaped area of anesthesia about the feet in figures 4, 5 and 6. By referring to the charts, it will be seen that Head has outlined such an area. Figure 1 shows an area of anesthesia about the left outer ankle, suggesting the beginning of the slipper-shaped area. Head has shown reasons for believing this area to be supplied by the first sacral segment. These cases furnish good evidence in support of the existence of such an area and it seems very probable that the cord segment which sup-

plies it lies directly above that for the saddle-breeches area. According to Head, lesions of the fifth and fourth lumbar segments produce sensory disturbances on the outer and inner sides of the leg respectively. Cases 2 and 7 are completely in accord with such a distribution. It may be noted that the outlines in the nine cases here reported corroborate very closely the work of Starr about the buttocks, perineum, penis, scrotum and posterior thighs, and that of Head about the feet and legs. It is also worthy of note that in connection with the saddle-breeches area the anesthesia of the posterior thighs did not extend downward as far as the bend of the knee, except in Cases 4 and 8. In Case 8 it is probable that disease of the second and third lumbar segments caused the anesthesia of the legs to become continuous with the anesthesia of the thighs. In Case 4, injury to the second and third lumbar segments caused an extension of the anesthesia downwards beyond the bend of the knee. This series of cases confirms splendidly the work of Starr relative to the posterior thighs, and does not at all con-

DIFFERENTIAL DIAGNOSIS BETWEEN LESIONS OF CAUDA EQUINA AND CONUS MEDULLARIS.

When disease of the cauda equina is accompanied by typical symptoms, there may be no difficulty in recognizing it. Except when due to trauma, disease of the

cauda usually develops slowly, producing symptoms more or less characteristic of root disease. The patient first experiences pain upon movement of the lower extremities; later the pain becomes spontaneous and persistent, with exacerbations. Subsequently, anesthesia begins and when the lesion is a uniform compression of the cauda, it has been observed in a few cases that the function of the central fibers was the first disturbed. Bladder and rectum symptoms may appear early and are usually present before anesthesia becomes pronounced. Muscular weakness is present in proportion to the pressure on the motor fibers and, as a rule, does not appear until pain has become a prominent feature. The paralysis is characterized by loss of muscular tone. An early examination may show exaggerated reflexes. Later they are diminished and finally lost. Atrophies develop. The electrical reactions may be altered. Decubitus has been noted. In reference to the height of the caudal lesion, if no local signs relative to the spine are present, to aid in locating the lesion, it is fair to presume that the upper limit of the lesion is just above the exit of the highest nerve that is disturbed in its function.

Disease of the conus is characterized by the sensory and motor symptoms described in the beginning of this article. In addition, the symptoms are likely to develop rapidly. Sensation may not be disturbed alike for all qualities. The pain and temperature sense is likely to be more seriously affected than the touch sense. Provided the conus lesion does not exert an influence on the caudal fibers, severe pain is absent. Decubitus is more likely to occur than in caudal disease. Above all, that which characterizes disease of the cauda equina is pain. A conus lesion may be associated with pain, provided the cauda or meninges are also involved. That which speaks directly for a conus lesion in a given case is the absence of pain. Differential diagnosis of the two conditions is important, as disease of the cauda equina may often be amenable to surgical treatment.

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BIBLIOGRAPHY.

- Kocher: Mittheilungen aus den Grenzgebieten der Medic., 1 Bd., 4 Heft.
 Valentini: Zeitschrift f. Klin. Medicin, xxii, 1893.
 Schultze: Deutsche Zeitschr. f. Nervenheilk., Bd. v, 1894.
 Müller: Deutsche Zeitschr. f. Nervenheilk., Bd., xiv, 1899.
 Elslenlohr: Neurolog. Centralblatt, 1884, Nr. 4.
 Thorburn: Brain, 1888.
 Oppenheim: Archiv f. Psychiatrie, 1889, 1.
 Lachmann: Ibid., Bd. xiii.
 Kirchoff: Ibid., Bd. xv.
 Rosenthal: Wien. Medic. Presse, 1888, Nr. 18-20.
 Bernhardt: Berlin. Klin. Wochenschr., 1888, Nr. 32.
 Huber: Wien. Medic. Woch., 1888, Nr. 39 u. 40.
 Osler: Medical News, 1888.
 Eulenberg: Zeitschrift f. Klin. Med., 1891, Bd. xviii.
 Sarbo: Arch. f. Psychiatrie, 1893, Bd. xxv.
 Raymond: Nouv. iconogr. de la Salpêtrière, 1895. *Léçons sur les maladies du système nerveux*, 1896.
 Schiff: Zeitschrift f. Klin. Medic., 1896, Bd. xxx.
 Higier: Deutsche Zeitschrift f. Nervenheilk., 1896, S. 185.
 Clemens: Deutsche Zeitschr. f. Nervenheilk., 1897.
 Koster: Ibid.
 Bregmann: Neurolog. Centralbl., 1897.
 Schlesinger: Wien. Klin. Wochenschr., 1897.
 Hirschberg: Deutsche Zeitschr. f. Nervenheilk., Bd. xvi.
 Bechterew: Ibid., Bd. xv.
 Head: Brain, vol. xvi.
 Starr: Am. Jour. Med. Sciences, July, 1892, and June, 1895.
 Sherrington: Proc. Roy. Soc., vol. lii.
 Wichmann: Die Rückenmarksnerven und ihre Segmentbezüge, Berlin, 1900.
 Thorburn: Surgery Spinal Cord, London, 1889.

Singular Fatality.—A little girl, aged 12, met with a singular death at Brighton, England, recently. In biting an apple she broke a tooth, a splinter from which penetrated near the throat, setting up such profuse hemorrhage that the child succumbed.—*Brit. Jour. Dent. Sci.*

PLASTIC SURGERY, WITH CASES.—FORMATION OF NEW CHEEK.

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Plastic surgery principally concerns the repair of skin or mucous membrane defects. Direct approximation of edges, by undermining and stretching, fixed by sutures, is easy and sure of satisfactory results if tension is not too great and the tissue healthy. This method may be aided by lateral subsidiary incisions to facilitate sliding, the lateral clefts being left to granulate and cicatrize, or are closed by grafts placed at once, or as soon as good healthy granulation tissue has formed.

Flap formation, with or without twisting of the pedicle, will in some cases serve a useful purpose. Marginal connection of flaps from a distant part of the body, re-

Figure 1.

leased from pedicle connection later, has a very limited field. The confinement is most irksome; besides, the vitality of the disconnected flap is feeble for a long time. In all cases where the new skin can be made to rest upon an underlying, healthy fresh wound, free from blood, or upon a granulating surface throughout, the chances of success are certainly good—especially if even a very moderate blood supply can be obtained for the flap. Where no base exists upon which to rest the flap, where subtegumentary connective tissue, skin and mucous membrane are lost, as in cases of cancerum oris, or the much more common deformity of almost total loss of one side of the face resulting from the use of cancer paste to remove carcinoma, real or imagined, the difficulties are increased a hundredfold.

CASE 1.—Such a case was presented at my clinic in September, 1900, in the person of Mr. R., of McCausland, Iowa, referred by Dr. F. C. Smith. He gave a