

point of the pin into the tube. I let go of the pin and seized it again several times in this effort, but found it impossible; at length, concluding that the point was sticking into the wall of the bronchus, I finally determined that it would be better to scratch the air tubes all the way up than to take farther risks of losing the pin again, therefore I seized it firmly and drew the pin and bronchoscope out together. I found that the pin had been grasped near the head and it came out bent. In grasping the pin I did not actually see the blades close on it only once, for the forceps when opened shut off the field of vision. By measuring off the length of the bronchoscope on the forceps and marking this with a rubber strap about the forceps I could readily tell how far to introduce them before closing the blades and by a knowledge of the position of the pin the blades could be turned in the proper direction. The operation took, all told, an hour and a half.

**Result.**—At 9 p. m. the pulse was 90, at 3 next morning 78, and at 8 a. m. the pulse, temperature and respiration were normal. There was no temperature afterward. The tongue where it had been hurt by the tongue forceps, was sore and the bronchi were sore, but this had all disappeared in a couple of days. Four days after the operation the patient went home feeling well, excepting a little cough, which soon disappeared. I examined the trachea just before she went home and found that the granuloma had been rubbed off during the operation. On May 12 she wrote me that she was perfectly well, had gained several pounds, weighed 122 pounds and was in better health than before the accident.

## A NEW MATERIAL FOR SUTURES AND LIGATURES.

TENDONS FROM THE LEG OF THE CRANE.

CHARLES F. KIEFFER, M.D.

Major Surgeon United States Army.

FORT D. A. RUSSELL, WYO.

There is still room in the armamentarium of the surgeon for a reliable, slowly absorbable suture and ligature material. I have been recently investigating a material from a very curious source which I believe to be entirely new. Dr. George P. Johnson of Cheyenne called my attention to the long and strong tendons in the legs of the bird commonly known throughout the United States as the blue crane (Fig. 1). He had used this material with excellent results as a suture for the aponeurosis in a case of hernia, the suture giving no trouble and apparently being absorbed in time. I obtained from him a number of these tendons and immediately began a series of experiments to test their value as sutures and ligatures. These experiments comprised tests of the breaking strain of the tendons wet and dry, of the possibility of rendering them aseptic, of the effect of sterilizing processes and finally, tests to determine, if possible, the rate of their absorption in the body. As a result of these studies I have come to the conclusion that we have here not only a valuable suture and ligature material, but one easily obtained in all parts of the world and easily prepared for use. It is not only sufficiently strong for all practical purposes, but is absorbed very slowly indeed in the tissues and therefore seems peculiarly adapted for the cases in which a reliable and slowly absorbed suture is required. It certainly answers all of the requirements for which kangaroo tendon has hitherto been used and, in many ways, is superior to it.

As favorable results were obtained, these studies were not limited to the blue crane, but included two others, the sand hill crane and a rather more rare and larger species known as the whooping crane, one specimen of which I was fortunate enough to secure. The

tendons used are the extensor and flexor tendons which run from the thighs down to the toes. Usually from 6 to 8 useful tendons can be obtained from each leg or from 12 to 16 from each bird. It seems likely that the tendons from all of the larger grallatorial birds will be found equally useful. This would mean a wide source of supply, since these birds are distributed all over the world in two large families, the *Ardeidae* and the *Gruidae*, the herons and the cranes.

Probably the commonest bird of this type and the one most generally distributed in the United States is the bird commonly, though improperly, known as the blue crane. As a matter of fact it is not a crane at all but a heron, and therefore should be called the blue heron (*Ardea herodias*). It attains an average height of 3 1-3 to 4 feet, with a spread of wing of about 6 feet. Nearly half of its height is in the slender legs. Like all the rest of the family it is aquatic in its habits, feeds on fish and builds its nest in trees near swamps and streams. The leg tendons from this bird



Fig. 1.—Blue Heron (*Ardea herodias*).

will average 11 inches in length and, in large specimens, there may be quite 14 inches of tendon up to the tendinous expansions in the muscles of the thigh. When dry they are flat, glistening bands resembling rough silk worm gut and are about 1-16 to 1/8 of an inch wide. There is a still larger species of this family of birds found in the southeastern United States and popularly known as the great white heron of Florida, *Ardea occidentalis* (Fig. 2). I have not been able to obtain a specimen of this bird but its leg tendons should be considerably longer than those of *Ardea herodias*. The family *Ardeidae* is abundantly represented in Europe, Asia and in Africa, in which continent the largest known species is found, *Ardea goliath*.

The chief representatives of the second group, the *Gruidae*, in the United States are the common crane generally known as the sand hill crane, *Grus canadensis*, and the stately whooping crane, *Grus americana*. The sand hill crane is fairly common, the whooping crane, more rare. There are about 17 species of this

family distributed over all the great zoo-geographical regions excepting, perhaps, the neo-tropical, in which they are not abundant. The common species of these two families are so well known in this country that a more extended description is unnecessary. The leg tendons of the sand hill crane will average 14 inches in length. The tendons from the one specimen of the whooping crane which I had varied from 14 to 16 inches in length.

A large number of the leg tendons were tested for their tensile strength in the following manner. The tendons selected first for trial were leg tendons of the blue heron, *Ardea herodias*, that had been roughly dried without any attempt at preservation—in other words, the tendons were used just as they came out of the legs of the birds after being dried in the sun (Fig. 3). A number were made pliable by immersion in water for a few minutes. The average breaking strain was found to be 25 pounds. Then the wet tendons were tied in hard knots; the breaking strain at the knot was found to vary from 24 to 27½ pounds.

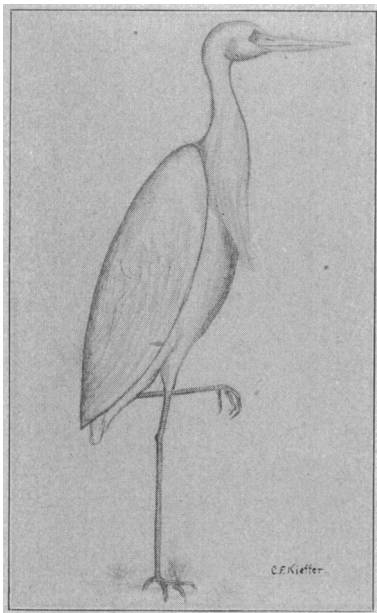


Fig. 2.—Great White Heron of Florida (*Ardea occidentalis*).

Perfectly dry tendons without preservation or preparation of any kind were then tested. A hard square knot tied in the continuity of the material broke at 24 pounds. Another knot under the same conditions sustained a weight of 30 pounds without breaking. Tendons immersed in the iodine solution for the sterilization of cat-gut according to the Claudius method, were then tried. After being immersed in this solution for 21 days the breaking strain of a number of tendons averaged 29 pounds. It may be that these were peculiarly strong tendons, but they seemed to be of the same size and stoutness as the others employed and while it may not be true that the tendons are actually stronger after being immersed in the iodine solution, it seems certain at least, that this process of sterilization does not weaken them. These results with the tendons of *Ardea herodias* are shown graphically in the appended illustration (Fig. 4.).

The tendons of the sand hill crane, *Grus canadensis* (Fig. 5), tested in the same manner, proved to be, on an average, ten pounds stronger than the tendons of the

blue heron. Separate tendons of this variety sustained a pull of 35 pounds without breaking when wet; with an average tensile strength of 33 pounds in ten specimens. The average strength of the unprepared and unpreserved dry tendons was 31 pounds. When tied in square knots either wet or dry these tendons behaved as the others; that is to say, even a hard dry knot showed no appreciable weakness from cracking or splitting of the fibers and sustained a pull as strong as the untied tendon.

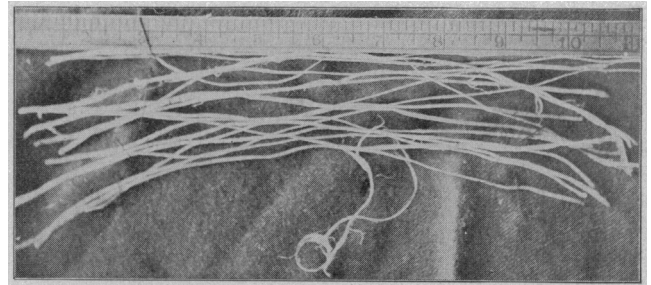


Fig. 3.—Tendons of *Ardea herodias*, sun dried.

Immersion in iodine solution showed the same results as with the tendons of the heron, an average increase of strength of 2½ pounds. One knotted piece sustained a weight of 37 pounds without breaking. From the specimen of the whooping crane (*Grus americana*), I obtained a number of tendons quite 15 inches in length, of extraordinary strength. Much stronger than the tendons of the sand hill crane and as strong as the heaviest kangaroo tendon. One of these tendons sustained a weight of 50 pounds without breaking.

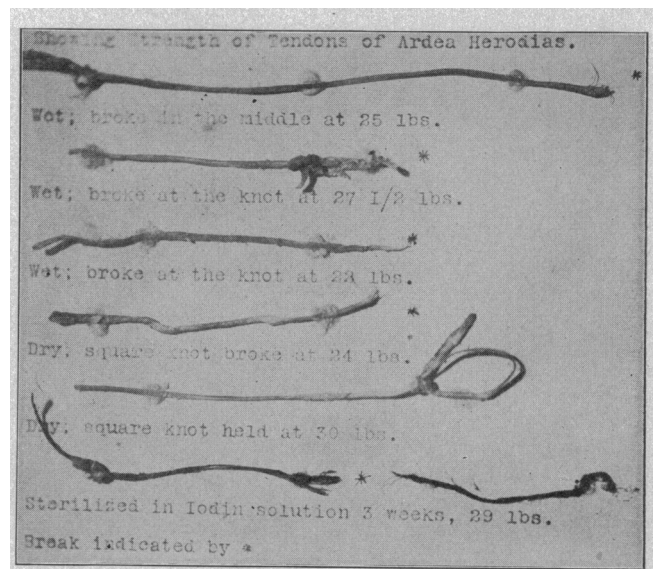


Fig. 4.—Showing tensile strength of tendons of *Ardea herodias*.

Only one process of sterilization was tried; the Claudius method for sterilizing cat-gut. Heron and crane tendons immersed in this solution take a deep mahogany or blackish-brown color. The solution seemed to have no deleterious effect whatever. They were smooth, if anything more pliable than in the fresh state and in appearance very much resembled ordinary heavy cat-gut or kangaroo tendon submitted to the same process. As has already been shown the tests applied to determine the strength of the iodized tendons

showed not only no diminution but an apparent increase of strength. Inoculations were made from the tendons treated in this manner and it was found that the tubes remained sterile when the tendons had been in the solution three days or longer. The method of making the inoculations was to take a tendon, cut it into small bits with sterile scissors and wash it thoroughly in absolute alcohol in order to remove as much as possible of the free iodine remaining in the tissue. The free iodine being an excellent antiseptic might hold a growth in check, although active germs might be present in the mass. To ensure the removal of the iodine, the tendons were well teased apart during the alcohol washing. Following this they were thoroughly rinsed in a large quantity of sterile water and directly planted on gelatin, agar and broth tubes and scattered free on the top and bedded in the substance of agar plates. All the tubes and plates, whether at the room temperature or incubated in the thermostat, remained sterile.

The tendons can not be sterilized by heat, as the temperature of boiling water destroys them in a very few

wound and a light one was used as a subcuticular stitch for the skin surface. The wound healed *per primam*. The subcuticular stitch was removed on the seventh day. It showed little if any alteration. The latest case in which I used this material was a cystic ovary with a heavy broad pedicle. After crushing the pedicle with an angiotribe, a heavy crane tendon was used to tie it off in the groove made by the instrument. Prompt healing was obtained and the ligature has not been heard from.

An effort was made to determine just how long these tendons would last in the tissues. Tendons of *Ardea herodias* were buried in incisions in the erector spinae mass of two dogs at intervals of a week. At the end of six weeks when the dogs were killed, each dog had a series of six tendons, the oldest of which had been in

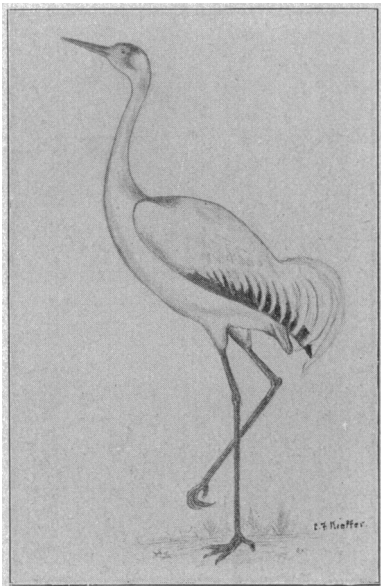


Fig. 5.—Whooping Crane (*Grus americana*).

minutes, converting them into a jelly-like mass. Boiling in alcohol was not tried.

After assuring myself of the reliability of the sterilization I employed the tendons in a number of cases. I tied the brachial artery with a moderately large tendon in an amputation near the shoulder for a railroad crush of the left arm. The tissues were widely devitalized by the injury beyond the level of apparent gross destruction. As a result there was some amount of breaking down of the skin flaps. One deep suture of cat-gut became infected and was discharged. The heron tendon gave no trouble and was not heard from. In a second case, I used a heavy tendon in suturing the aponeurosis of the external oblique in a modified Halsted operation for hernia. Four weeks after the operation the suture could still be indistinctly felt through a rather thin abdominal wall. Two weeks later it could no longer be felt. In a third case, with old enlarged glands in the left groin, probably of venereal origin, a clean dissection of the groin was made and all the enlarged glands were removed. A heavy heron tendon was used in the deep layer of the

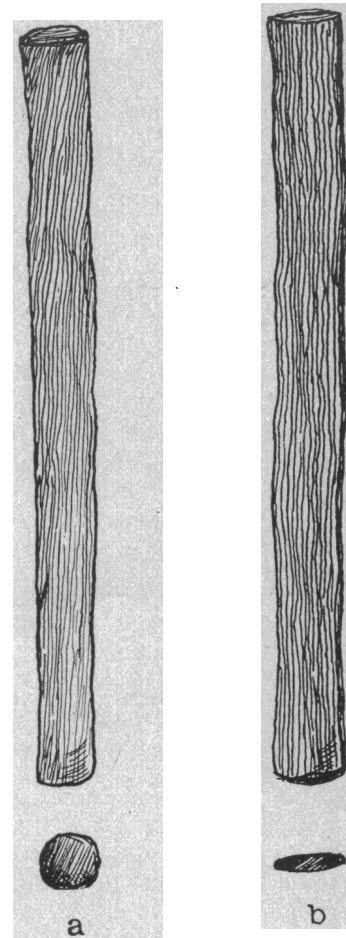


Fig. 6.—Showing diagonal course of fibers in kangaroo tendon. (a) Longitudinal course of fibers in Heron tendon (b).

the tissues six weeks and the most recent one week. The one-week tendons were practically unchanged. The two week tendons showed a slight decrease in size, which was progressive in the remaining ones. Of the six week tendons, two had almost entirely disappeared; these were thinner than the other two. The remains of the two heavier six week tendons showed a breaking strain of 4 and 5 pounds respectively.

It is apparent to me that we have here a valuable suture and ligature material; particularly where it is desirable to have a material slowly absorbable, as in operations for hernia and for ligations of large vessels and pedicles. The heavier tendons of the grallatorial birds answer these requirements admirably. The lighter

tendons make excellent superficial sutures. I do not know what effect chromization would have on them, but I do not believe that it is necessary or desirable. One of the chief disadvantages of chromicized cat-gut and kangaroo tendon is the uncertainty and unevenness of the results of the process. Kangaroo tendon is very hard to sterilize on account of its structure, cat-gut on account of its source. In this material all gross original contamination may be avoided. Indeed, I believe that with care, tendons practically sterile could be obtained in the first place. In any event they can be readily sterilized by the Claudius process. Kangaroo tendon is very irregular and difficult to handle. As purchased in the markets it is very uneven. Some of it is exceedingly good; others almost worthless. When kangaroo tendon is closely examined it is seen to be made up of fibers, many of which run diagonally to the length of the tendon (Fig. 6a). In handling, these fibers split off, leaving a ligature which tapers from a stout cord to a filament. In the bird tendons the fibers are longitudinal (Fig. 6b). Kangaroo tendons are cylindrical while the bird tendons are flat, ribbon-like and therefore easier to tie.

#### CONCLUSIONS.

The following conclusions seem warranted: The leg tendons of the large gallinaceous birds make an excellent suture material; strong enough for all practical purposes, readily made aseptic, slowly absorbable and easily prepared. The source of supply is practically world wide. I believe this new material warrants further investigation. Think of the comfort to the civil or military surgeon in isolated places of knowing that he can have a reliable suture material at the end of his shotgun.

### RETARDED ERUPTION OF THE TEETH; THEIR LIBERATION OR EXTRACTION.\*

M. H. CRYER, M.D., D.D.S.

PHILADELPHIA.

In order to fully understand this subject one should first be thoroughly familiar with the typical positions of the teeth when entirely erupted and in normal occlusion with those of the opposing jaw. It is also necessary to have a complete knowledge of the internal anatomy of the alveolar process. Therefore, a few illustrations showing the typically erupted teeth, with their occlusion, and the internal anatomy of the alveolar processes will be shown.

Figure 1 is a side view made from an almost perfect skull of a white woman. The teeth are fully erupted and are almost typical in their position and occlusion. It is evident there has been but little interference with the nutrition of either the jaws or the teeth of this subject. It will be noticed that the mental foramen is on a line drawn vertically downward from between the premolar teeth. This is quite typical and will be again referred to.

The mental foramen is located in the true non-movable cortical bone of the jaw on a line drawn vertically downward between the premolars. It is the external opening of a small tube communicating with the inferior dental canal. For this small tube, which I have described in previous papers, the name "mental tube" is suggested. Its internal opening into the inferior den-

tal canal is situated in the movable cancellated tissue near the apex of the root of the canine. If the skull of an infant be examined at birth it will be found that the mental tube, or short canal, passes directly outward nearly opposite the lower portion of the germ of the canine tooth. Then, again, if the skulls of children of various ages, up to adult life, be examined, it will be found that the inlet of this mental tube has been carried forward along with the cancellated tissue of the teeth, while the outlet has, apparently, moved backward, the distance varying according to the age of the child until adult life is reached.

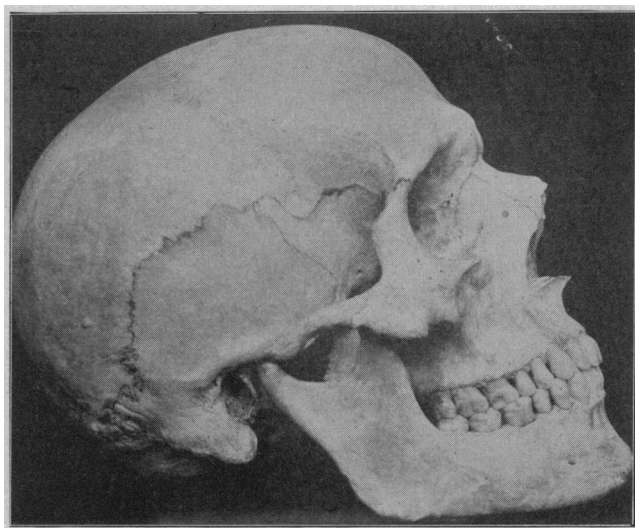


Fig. 1.—Side view of a typical skull with typical occlusion of the teeth.

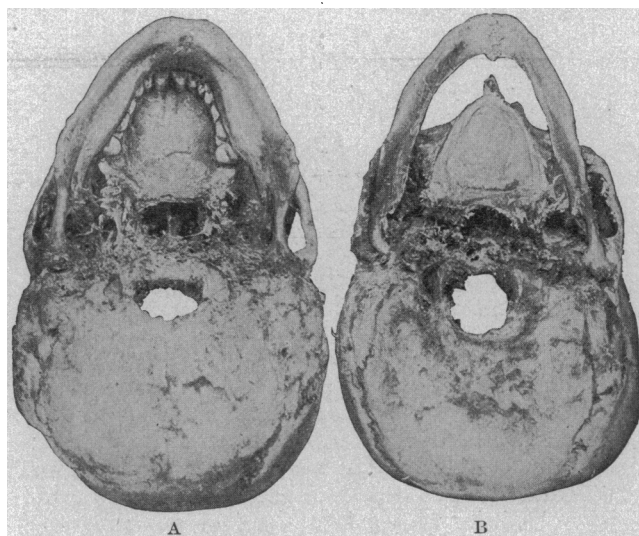


Fig. 2.—Under view of two skulls. A. From a subject about 20 years old. B. From one well advanced in years.

The position of the first molar during its early development was immediately below the upper or inner angle of the jaw. As it increases in size and the other molars are developed, the entire mass of cancellated tissue containing the teeth moved forward, the upper portion a little farther than the lower, as is indicated by the curvature of the trabecular and small cribriform tubes passing from the main tube or canal to the roots of the various teeth. To accommodate this growth the mandible proper—the cortical portion—enlarges interstitially as this process is carried on. Interference with

\*Read at the Fifty-fifth Annual Session of the American Medical Association, in the Section on Stomatology, and approved for publication by the Executive Committee: Drs. E. A. Bogue, Alice M. Steeves and M. L. Rhein.