

A STUDY OF AN ABNORMAL SHEEP

by

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### INTRODUCTION

The purpose of this study is threefold: first to determine the derivation of the muscles, arteries and skeletal parts which made up the anomalies in an abnormal sheep; second to discover the variations in the normal parts which were the result of the anomalies; and third to discover the relationship of the abnormal to the normal and to attempt an explanation for such anomalies as exist.

### MATERIALS AND TREATMENT

The sheep for this investigation was furnished by Dr. H.H. Lane, who had received it from Mr. C.D. Bunker. It was a still-born lamb having an abnormal equipment of arms on the left side, while the limbs on the right appeared to be normal.

As there was no satisfactory reference available on the anatomy of a normal sheep with which to make comparisons, it was thought necessary to make a study of the right side. A comparative study was then made between the left and the right sides of the animal.

All the observations were confined primarily to the pectoral region and the vertebral column since other parts appeared to be normal.

Drawings were made of the various abnormal parts and additional drawings of the normal side were added for purposes of comparison.

EXPLANATION OF TERMS

- Right.....R.
- Left.....L.
- Muscle.....M.
- Artery.....A.
- Normal right arm.....N.R.A.
- Usual left arm.....U.L.A.  
(this being the one which most closely coincided with the normal right arm)
- Abnormal arm.....A.L.A.

## DESCRIPTION OF THE LAMB

This lamb was of average size. Externally the abnormalities were revealed by several variations from the usual. The most conspicuous abnormality was the second arm on the left side. This was situated anterior to the usual arm and was inserted on the same scapula, thus making the shoulder joint appear enlarged and prominent. This abnormal arm, however, really did not have a part in the regular shoulder joint but was inserted just above or dorsal to it on the spine of the scapula. Just beyond this point, the posterior side of the abnormal arm passed under the normal joint. A cursory examination would give one the impression that this arm extended directly from the shoulder joint instead of coming from in front and under it.

The arm differed greatly from a normal arm, as its general contour was straight sided and broad jointed and did not have the angles and curves which are characteristic of the normal arm. The elbow and wrist joints were very much enlarged. There was very little movement at these articulations. Three tests

each, were made to determine how large an arc each could inscribe. The average for the shoulder was thirty-six degrees; for the elbow twenty-two degrees; and for the wrist forty-five degrees. The shoulder could not rotate indicating the lack of a ball and socket joint; this point was verified later by dissection. In fact movement in all joints was confined to an anterior or forward movement. The hoof was double, but fused, each hoof a little smaller than the normal hoof. This double hoof with the enlarged joints indicated a double arm enveloped in a common integument; that this was the case will be brought out in the discussion of the skeleton. The members or parts of the pair were of equal size. When the lamb was standing, this abnormal arm had a slight posterior bend, although the humerus extended straight down from the shoulder joint. This slight bend did not throw the hoofs out of position as they faced toward the ground when the lamb was standing, even though they did not quite reach it, since this arm was slightly shorter than the normal arm.

The usual left arm was of normal length, size

and, in all of its contours, compared very favorably in every way with the normal, or right arm.

The appearance of the left side of the animal gave the observer the impression of a normal arm with something dangling in front of it from a somewhat enlarged and prominent shoulder joint.

There was a variation in the location of the left scapula. The normal position is somewhat parallel to the spinal column while the left was placed at right angles to it, so that on the left it extended straight above the abnormal arm. This location of the scapula did not change the location of the usual arm as the shoulder joint was in its normal location and appeared to have acted as a pivot on which the scapula swung until it reached the vertical position. As a result of this, the usual left arm appeared to be able to articulate in a normal fashion.

There was a left lateral curvature of the spine. This began just above the lumbar and in the dorsal region it continued curving to the left for three-fourths of the length of the dorsal region then curved back toward the normal median line of the body but did

not reach it. In the cervical region, there was again a very decided curve thus placing the head completely to one side of the normal median line of the body.

The only head movement was a slight bend forward with no rotation, which indicated only a slight articulation between the head and atlas; there was no movement at all between the atlas and the axis; these two vertebrae were wholly ankylosed.

With the exception of the anomalies found in the muscles, circulatory and skeletal systems chiefly in the pectoral region, this lamb proved to be normal in all other parts of the body. These anomalies will be described later in detail.

MUSCLES

The muscles of the sheep are similar to those of other mammals, having homologous positions and functions. In this specimen, the abnormality did not cause as great variation on the left side as might have been expected. A description of the normal or right side will be given, followed by the variations in the left.

The muscles of the shoulder girdle are divided into two divisions: the dorsal and the ventral. The dorsal division may again be separated into a first and second layer.

The first layer consists of the trapezius which is a flat triangular muscle. Its origin is in the mid-dorsal line of the fasciae from the third cervical vertebra to the eleventh dorsal vertebra; its insertion is on the spine of the scapula. (See plate I, a)

On the left or abnormal side of the lamb, the trapezius was wanting, an aponeurosis taking its place. (See plate II)

The second layer is composed of the rhomboideus

and the latissimus dorsi muscles. The rhomboideus muscle lies just under the trapezius. This muscle is divided into two parts, the rhomboideus cervicalis and the rhomboideus thoracalis. The rhomboideus thoracalis has distinct anterior and posterior regions; the anterior is somewhat thicker and heavier than the posterior.

The rhomboideus cervicalis is fanlike at its origin and then tapers, becoming very narrow where it joins the rhomboideus thoracalis to be inserted on the vertebral border of the scapula. These muscles originate on the cervical and anterior dorsal vertebrae. (See plate III, a and a')

On the left side, the scapula is not in its normal position as it lies almost perpendicular to the vertebral column. As a result of this change in position of the scapula, the rhomboideus muscle is very much smaller and very poorly developed. The separate parts are not discernible and the anterior portion becomes quite cartilaginous. (See plate IV, a)

The latissimus dorsi is a large triangular

muscle which is inserted on the humerus and comes into view from under the triceps; the ventral edge is parallel to the ventral side of the body; the anterior edge comes from under the triceps to bend anteriorly, overlying the posterior angle of the scapula and passing under the trapezius muscle. Caudad it ends in a broad aponeurosis which extends over the entire pelvic region. (See plate I and plate III, b)

This muscle is normal on the left side. (See plate II and plate IV, b)

The ventral division of the muscles of the shoulder girdle may be divided into three main muscles, the brachiocephalicus, the pectoral and the serratus ventralis; the last is in the second layer of muscles.

The brachiocephalicus muscle extends diagonally across the neck from the anterior mid-dorsal line to the shoulder. In the head region it is divided in two portions which blend together as they pass downward to form an aponeurosis which joins with one from the superficial pectoral muscle and covers the shoul-

der joint. (See plate I, c and d)

Another student had done some work with this specimen before this problem was assigned to me. In this region on the left the musculature was somewhat destroyed but as best I can reconstruct it, it appears to be the same as the right; however, the aponeurosis between the brachiocephalicus muscle and the superficial pectoral muscle was necessarily larger as it had to pass over the double shoulder joint and be divided as the normal arm passed through it. (See plate II, c and d)

The pectoral muscle is divided into two parts, the superficial and the deep.

The superficial pectoral extends from the sternum to the humerus and is inserted between the brachialis muscle and the biceps muscle. This fills the space between the sternum and the arm and gives what little prominence there is to the breast. The aponeurosis of this fuses with that of the muscle brachiocephalicus as has been described before. (See plate I, d)

On the left side, the superficial pectoral is much

larger than on the right as it spreads over the humerus of the abnormal arm and part of it lies over the supraspinatus muscle and is inserted on the supraspinatus fossa of the scapula. (See plates II and IV, d)

The deep pectoral originated on the sternum parallel with the shoulder joint and extended to the seventh rib. (See plate I, e)

On the left this muscle was considerably longer as it extended to the ninth rib. (See plate II, e)

The serratus ventralis is a large fanshaped muscle with serrated edge. It is this characteristic edge which gives it this name. It lies completely under the latissimus dorsi, pectoral and brachiocephalicus muscles and extends over the lateral surface of the neck and thorax to the seventh rib. Its insertion is under the scapula. (See plate III, d)

The left serratus ventralis muscle is not so strong and heavy as the right but extends to the ninth rib instead of the seventh. (See plate IV, d)

The sternocephalicus lies on the ventral side of the neck and extends along the trachea from the sternum to the jaw. (See plate I, L)

Left, the same. (See plate II, m)

The splenius muscle is a flat muscle in the neck region and is partly covered by the following muscles: trapezius, rhomboideus, cervicalis, serratus ventralis and the brachiocephalicus. It extends from the ligamentum nuchae to the cervical vertebrae. (See plate I, k)

On the left side the splenius is the same as above described except that due to higher placement of scapula, it extends from the scapular ligament and ligamentum nuchae to the cervical vertebrae. (See plate II, L)

The obliquus abdominis is a broad, thin, sheet, widest caudad. It originates in an aponeurosis of the deep pectoral and extends backward. The fibers extend more or less in an oblique direction across the posterior part of the trunk and it is from this characteristic that this muscle obtains its name. (See plate I, j)

Left side, just the same. (See plate II, k)

The muscles of the shoulder girdle may also be divided into lateral and medial groups. In the lateral

are found the deltoideus, supraspinatus, infraspinatus and the teres minor muscles.

The deltoideus muscle (plate I, f) is inserted on the humerus and extends over the shoulder joint to the scapula parallel to the spine.

The left deltoideus muscle (plate II, f) is much smaller than normal and is not so well developed. It covers only the attachment of the infraspinatus and does not cover the teres minor at all, as it lies diagonally across the neck of the scapula and is attached to the spine.

The infraspinatus muscle (plate III, e) lies under the deltoideus, and has its origin on the ventral border of the scapula and extends over that to be inserted on the proximal region of the humerus.

On the left (plate IV, f) this muscle is more developed and a little heavier.

The supraspinatus muscle (plate III, f) is inserted on the humerus and is dorsal to the infraspinatus muscle lying parallel to it on the scapula but separated by the spine.

The left supraspinatus muscle (plate IV, g) arises

in the anterior angle of the scapula and is inserted on the humerus under the abnormal shoulder joint. It is not so large nor so long as the normal supraspinatus muscle. It is completely covered by the abnormal development of the superficial pectoral which is attached to the anterior angle of the spine of the scapula.

The teres minor muscle (plate I, h and III, g) is a small muscle lying under the ventral edge of the deltoideus muscle and overlying the triceps muscle. It is inserted on the humerus just under the infraspinatus muscle.

On the left, (plate II, h and IV, h) this muscle is very small.

The medial group of shoulder muscles is composed of the following: the subscapularis, the coracobrachialis and the teres major.

The subscapularis muscle is a flat, triangular muscle occupying the subscapular fossa. It is inserted on the humerus; the tendon of its insertion is crossed by the tendon of the coracobrachialis muscle. (plate IX, a)

The left is the same as the right.

The coraco-brachialis is a round muscle extending from the scapula to the humerus. (plates VII, a and IX, b)

The left is just the same.

The teres major (plate IX, c) is a flat muscle lying chiefly on the middle surface of the triceps, along the posterior border of the scapula and inserted on the proximal end of the shaft of the humerus.

The left is just the same.

The following muscles are found in the upper arm region: the biceps brachii, the brachialis, the tensor fasciae antibrachii, the triceps brachii and the anconeus.

The biceps brachii lies anterior to the humerus and extends from the scapula to the radius; its insertion is divided, one portion being on the lateral, the other on the medial surface of the radius. (plate V, e)

The left is normal. (plate VI, d)

The brachialis is a flat muscle extending from the proximal region, posterior surface of the humerus to the neck of the radius, where it is inserted. (plate V, f)

The left is normal. (plate II, 1)

The triceps brachii lies from the posterior to the anterior of the humerus and is divided into three parts:

(1) The long head is the largest and is situated on the posterior edge of the humerus. It is triangular and extends from the posterior border of the scapula to the olecranon. (plate V, g')

(2) The lateral head is a quadrilateral muscle and lies on the lateral surface of the arm, anterior to the long head of the triceps. It extends from the scapula to the olecranon. (plate V, g'')

(3) The medial head of the triceps muscle is smaller than the other two and lies on the medial surface of the humerus. It extends from the posterior edge of the scapula to the olecranon. (plate VII, b)

The left is the same:

(1) the long head of the triceps (plate VI, f');

(2) the lateral head of triceps (plate VI, f'');

(3) the medial head of triceps (plate IX, 1).

The tensor fasciae antibrachii is a very narrow muscle lying chiefly on the medial surface of the

triceps. It comes from the tendon of insertion of the latissimus dorsi muscle and posterior angle of the scapula and extends to the olecranon. (plate V, h)

Left the same. (plate VI, g)

The anconeus is a small muscle covering the olecranon fossa and lies diagonally at the side of the medial head of the triceps and is attached to the distal third of the humerus. The ulnar nerve and brachial artery overlie it. (plate IX, k)

Left the same.

The muscles of the forearm of the sheep fall into two groups, the extensors and the flexors. All of the extensors and the ulnaris lateralis lie on the lateral surface of the forearm. On the medial surface along two-thirds of the radius is subcutaneous.

The extensor carpi radialis is the largest of the extensor group. It lies on the dorsal side of the radius. It arises on the humerus and extends to the metacarpal tuberosity, where it is inserted. It is of a round shape. (plate V, i and j)

The left usual arm is the same. (plate VI, h and i)

There are three digital extensors: 1 - extensor digiti tertii, 2 - extensor digitalis communis, and 3 - extensor digiti quartii.

The extensor digiti tertii lies posterior to the extensor carpi radialis. It is a more slender muscle somewhat rounded but having a compressed appearance. It arises on the lateral epicondyle of the humerus and terminates in a tendon, passing over the carpus and metacarpal and is inserted on the phalanges. (plate V, k)

U.L.A. the same. (plate VI, j)

The extensor digitalis communis lies between the other two digital extensors. It arises on the humerus and ulna and terminates in a tendon, which passes over the carpus and metacarpus. This tendon lies parallel to the tendon of the digiti tertii; they both incline forward to the anterior surface of the metacarpal.

(plate V, L)

U.L.A. the same. (plate VI, k)

The extensor digiti quartii is the posterior muscle

of the digital group. It is a smaller muscle than either of the others. It arises at the elbow and terminates in a tendon which just before it passes over the carpus receives a small tendon from the ulnaris lateralis. It then flattens out as it passes over the carpus. At the distal end of the carpus, it is divided, the largest or anterior portion passing to the anterior surface of the metacarpals and phalanges. The posterior portion unites with the tendon from the ulnaris lateralis and passes down the lateral surface of the metacarpal. (plate V, m)

U.L.A. the same. (plate VI, L)

Of the flexor group ulnaris lateralis lies on the lateral surface of the forearm. It is one of the two largest muscles of the forearm, the other being the extensor carpi radialis. It is rounded in shape. It terminates in a tendon which branches just above the carpus, the anterior branch joining with the tendon of the extensor digiti quarti and passing over the carpus. At the distal end of the carpus these two appear to separate and the posterior branch joins with the posterior or main tendon of the ulnaris

lateralis which has passed over the carpus and continues down the lateral surface of the metacarpal. (plate V, n)

U.L.A. the same. (plate VI, m)

The flexor carpi radialis lies on the medial surface of the forearm. Its origin is on the medial surface of the humerus and it is inserted on the proximal end of the medial metacarpal bone. The median nerve and medial artery lie in front of it at the elbow. The nerve passes over and across it, passing posteriorly over the carpus, and then inclining anteriorly on the metacarpal until it reaches the center of the medial surface. The medial artery passes diagonally under the flexor carpi radialis to emerge in the carpus region then passes posterior to the nerve down the metacarpal bone. (plate VII, i)

U.L.A. the same.

The flexor carpi ulnaris lies on the medial and posterior aspect of the forearm partly under and partly behind the preceding muscle. It arises on the humerus and olecranon and is inserted on the posterior

side of the carpus. (plate VII, j)

U.L.A. the same.

The musculature of the abnormal arm is very meager. The entire arm is covered by a very tough fascia. In the proximal region of the upper arm this fascia forms an aponeurosis with the superficial pectoral muscle. In this region, there is some well developed muscle tissue and some that is not so well developed. (plate VIII, a and a')

The superficial pectoral appears to extend distally on this abnormal humerus and over it, finally to be attached to the anterior angle and spine of the scapula. (plate IV, c and c') There are a few other "patches", so to speak, of the muscle scattered on the medial side along the paths of the blood vessels. Most of this tissue was not well developed. None of the muscle tissue on the entire arm terminated in tendons.

Plate IV shows the connection of the superficial pectoral of the usual left arm to the abnormal arm and shoulder.

Plate VI shows a complete lateral view of the

left arms and their muscle connections.

Plate VIII shows the muscle of the abnormal arm medial view; it was not considered necessary to portray the usual arm as it is normal.

## ARTERIES

The blood-vascular system showed more variations than the muscular system. In general the arteries and veins of the left side were a little larger and the walls of the veins were almost as heavy and thick as those of the arteries.

The aorta (plate XI, A) makes the usual aortic arch, one half inch after it leaves the heart, and before it leaves the pericardium a very large artery known as the innominatum is given off. (plate XI, B) This is approximately one fourth inch long when it divides into the bicarotid artery (plate XI, C) and the right subclavian artery (plate XI, R.D) This branching takes place just outside the pericardium and opposite the first rib. The bicarotid continues forward about one half inch, when it branches into the right and left carotid arteries.

The right subclavian (plate XI, R.D) artery turns ventrally and bends around the anterior border of the first rib and continues to the arm. (plate X and XI, D)

The left subclavian arises from the aorta about three fourths of an inch to the left of the innominate

artery and extends across the body cavity to the arm.  
(plate XII, L.D)

The right subclavian artery gives off the dorsal artery, sub-costal artery, and vertebral artery which are combined in one trunk, also the inferior cervical artery, the internal thoracic and the anterior circumflex of the humerus.

Chaveau states that the deep cervical artery is lacking except for a branch of the dorsal artery and that some branches of the vertebral artery take its place. My findings agree with his.

The first branch to be given off from the right subclavian was the common trunk which I shall hereafter refer to as the dorso-vertebral trunk as in some mammals the sub-costal artery is a branch of the dorsal artery. Just anterior to the first rib, the first branch of the dorso-vertebral trunk is the branch of the dorsal artery known as the transversa colli. It supplies the muscle serratus ventralis and the muscle rhomboideus. (plate XI, 2)

The sub-costal artery is a very small artery given off from the dorso-vertebral trunk between the

seventh cervical vertebra and the first rib. It branches immediately; one branch turns mesad around the vertebra, the second goes laterally to the muscle spinalis and the third turns posteriorly and passes to the rib and supplies the first three intercostal spaces, then anastomoses with the first aortic intercostal artery. (plate XI, 3)

Between the processes of the sixth and seventh cervical vertebrae the third branch of the dorso-vertebral trunk is given off. This is the vertebral artery. It passes through a foramen in the sixth cervical vertebra and continues along the neck through a series of foramina giving off branches to the adjoining muscles. (plate XI, 4)

The trunk continues forward to the gland region; it might be called the thymus artery as it supplies that gland. (plate XI, 5)

The next artery arises cephalad from the right subclavian sending branches upward and forward; this is the inferior cervical artery. (plate XI, 6)  
This has two main branches, the ascending cervical and the descending cervical.

The ascending cervical artery passes along the lateral surface of the jugular vein and lies between the brachiocephalicus muscle and the omo-hyoideus muscle.

The descending cervical artery passes ventrolaterally across the superficial pectoral muscle and the brachiocephalic muscle to the infraspinatus muscle; here it divides one branch going ventrad, the other dorsad.

A short distance beyond the inferior cervical trunk, the internal thoracic artery is given off caudad above the first rib. It is imbedded under the pleura, lying in the groove formed by the junction of the sternal cartilage and rib, and after the second intercostal space it is covered by muscles. It gives off branches to the intercostal spaces. (plate XI, 7)

The external thoracic found in most mammals was not present in the lamb.

The last artery to be given off from the subclavian artery before it enters the shoulder region is the anterior circumflex artery of the humerus. It is a large branch, given off obliquely, which supplies

the shoulder region, sending branches to the pectoral muscle, latissimus dorsi muscle, serratus ventralis muscle and finally dividing on the proximal end of the biceps muscle into a lateral and medial branch thus surrounding that muscle. (plates XI, 8 and IX, 1)

The subscapular artery (plate IX, 2) is a large trunk given off simultaneously with the deep brachial trunk from the brachial artery. It arises at the posterior border of the subscapularis muscle and ascends in the interstice between that muscle and the teres major muscle on the medial surface of the long head of the triceps muscle. It turns around the posterior border of the scapula and gives branches to the deltoideus muscle, the infraspinatus muscle, and the lateral side of the latissimus dorsi muscle.

From the subscapular artery arise two branches, (1) the thoraco-dorsal artery and (2) the circumflex artery of the scapula.

The thoraco-dorsal artery (plate IX, 3) is a long artery, given off about one eighth of an inch from the origin of the subscapular artery. It crosses the medial face of the teres major and passes upward and

backward on the latissimus dorsi, giving branches to it and the teres major.

The second branch given off from the subscapular artery is the circumflex artery of the scapula. (plate IX, 4) It arises about three eighths of an inch from the thoraco-dorsal artery. It passes through the center of the tendon of the long head of the triceps muscle to the lateral side of the scapula and there supplies the infraspinatus muscles.

In the horse, it divides in two branches one a medial which supplies the subscapularis muscle. I did not find this branch in the lamb.

The deep brachial trunk which is given off simultaneously with the subscapular trunk from the brachial artery immediately divides into the deep brachial artery and the posterior circumflex artery of the humerus.

The deep brachial artery extends distally giving branches to the shoulder and coraco-brachialis muscle; it then passes under the tendons of the teres major and latissimus dorsi muscles, giv-

ing branches to those muscles, the brachialis anconeus muscle and the humerus; then it passes around the latter to the medial surface of the lateral head of the triceps muscle. Here, it divides; one branch runs in the muscula-spiral groove with the radial nerve to the front of the elbow joint to supply the extensor carpi muscle; the other descends to the flexor carpi radialis and ulnar head of the deep flexor. It anastomoses with the recurrent branch of the common interosseus and ulnar arteries. (plate X, a, 6)

The subclavian artery continues its course crossing the ventral border of the scalenus muscle; it passes ventrally and turns downward, through the serratus ventralis and across the subscapularis muscle at the medial side of the shoulder joint. From the shoulder to the elbow this artery is known as the brachial artery. (plate IX, D') At the posterior border of the subscapularis muscle the brachial artery gives off (1) the subscapular artery, (2) the deep pectoral artery, (3) the ulnar artery, after which it passes diagonally across the humerus, over the radial

attachment of the biceps and under the long medial ligament; from here onward it is known as the median artery. (plate X, D") The median nerve overlies the brachial artery throughout its course.

The posterior circumflex artery of the humerus arises from a common trunk with the deep brachial artery. (plate IX, 5) It passes outward behind the shoulder joint between the coraco-brachialis muscle and the lateral head of the triceps muscle with the axillary nerve. It gives branches to those muscles and the teres minor, the deltoideus, biceps and supraspinatus muscles.

The anterior radial (plates IX, 6 and X, 1) branches from the brachial at the distal end of the humerus, which it bends around giving branches to the brachialis muscle and extending distally to the extensor carpi radialis and, along the radius, finally anastomoses with the dorsal interosseus.

The ulnar artery is given off from the brachial just above the elbow joint. (plates IX, 7 and X, 2) It passes to the ulna where it anastomoses with the deep brachial and recurrent interosseus. (plate Xa, 1)

The median artery is a direct continuation of the brachial artery. (plate X, D'') This artery passes under the long medial ligament under which it gives off (1) the common interosseus artery and (2) the medial volar metacarpal artery.

It lies under the medial nerve for two thirds of its course then comes out to one side of it and continues its course to the carpus region; from there to the hoof it is known as the carpus. (plate X, D''')

The common interosseus artery branches from the median artery at the interosseus space through which it passes outward. (plate Xa, 2) Before it enters the interosseus space, however, it gives off the volar interosseus (plate Xa, 3) which goes to the radial head of the deep flexor. After coming through the interosseus space it gives off a branch which ascends and anastomoses with the ulnar and deep brachial arteries. This is the recurrent interosseus artery. (plate Xa, 6) The dorsal interosseus artery is the branch going down the groove to the distal interosseus space through which it passes and descends on the lateral

side of the carpus. (plate Xa, 5)

The medial volar metacarpal artery (plate X, 5) arises at an acute angle from the median artery. It passes under the flexor carpi radialis then over its attachment and down the medial side of the carpus and is imbedded by the posterior annular ligament of carpus, passing from under this and down the hoof to give off a branch to the hoof which passes under the deep flexor tendon to supply the other side of the hoof.

On the left side, we find the arrangement of these arteries somewhat different from that on the right. The first branch from the left subclavian artery is given off posteriorly. It is the subcostal (plate XII, 3); however, it is a much larger artery than the right subcostal artery.

Just beyond the subcostal artery another branch is given off posteriorly; it leaves the thorax passing over the first rib to the brachioplexus to the medial side of the serratus ventralis muscle and rhomboideus muscle to which it gives off branches; it also supplies the ligamentum nuchae.

The branch corresponds to the transversa colli branch of the dorsal artery. (plate XII, 2)

From this, a branch is given off which passes under the seventh cervical vertebra to become the vertebral artery. (plate XII, 4)

The combination of these two arteries, the transversa colli and the vertebral, makes this appear to be the dorso-ventral trunk of the right side. (plate XII, 1)

The subclavian continues its path across the body cavity for a distance of one inch when from it cephalad arises the inferior cervical artery or trunk. The ascending branch covers the same territory as the ascending branch on the right. In the descending branch there is another variation. It makes a posterior turn, supplying the deep pectoral muscle, but it does not have all the ramifications of the right so it does not reach the infraspinatus muscle. However, the blood supply of this muscle and left superficial pectoral muscle is taken care of by an artery I will designate as artery X. (plate XII, X) This artery arises just before the subclavian makes its downward turn to the arm. This artery

has a large ramification as it appears to be its function to carry the extra supply of blood to the superficial pectoral which was the muscle involved with the abnormal arm.

Just below the point where the inferior cervical leaves the subclavian artery a very large trunk is given off obliquely. (plate XII, 8) Immediately from this trunk, a branch, which is the internal thoracic, is given off. It follows the same route as the internal thoracic of the right side. (plate XII, 7)

An eighth of an inch beyond, a second branch is given off; this passes caudad down the median line of the sternum sending branches right and left; this is the muscular phrenic artery. This was not paired as it is in some of the Ungulates. In the horse this artery arises from the internal thoracic artery. (plate XII, 9)

The main trunk continues its path to the shoulder region passing through the superficial pectoral muscle to the head of the abnormal humerus. (plate XI, 8) It passes down the medial side of the humerus to a

point just above the elbow joint where it divides into two branches. As will be explained later, in this abnormal arm there are present two ulnae and two fused radii; these lie between the parallel ulnae. (plate XVIII, 4) The above mentioned branches or arteries pass over the elbow joint and continue their courses in the grooves formed by the junction of the radii and ulnae. As these branches approach the wrist joint they again divide passing over the carpus and down the paired metacarpals (plate VIII) to the paired hoofs (plate XVIII).

Comparing plates XI and XII, which are diagrammatic drawings, it can easily be seen that this main trunk appears to be the anterior circumflex of the humerus diverted to take care of the abnormal arm. It arises somewhat earlier than that on the right side but it also appears to take over some of the carrying load of the subclavian artery as from it arise the internal thoracic and the muscular phrenic; probably in a normal lamb, the latter would come from the subclavian rather than from the anterior circumflex of the humerus as it is an unpaired artery; there is nothing

comparable to it on the right side. The origin of the anterior circumflex from the subclavian artery earlier than is normal forced the internal thoracic to be a branch of it and probably did the same for the muscular phrenic. The muscles, pectoral, latissimus dorsi, serratus ventralis, oblique abdominalis and biceps which normally get at least a part if not all their blood supply from the anterior circumflex of the humerus are taken care of by an artery arising from the subclavian opposite artery X. I will designate this artery as artery Y. (plate XII, Y)

Briefly recounting the anomalies in the arteries due to this abnormality there would be: the diversion of one artery to the abnormal arm, the curtailing of ramifications of one artery and the arising of two arteries to take the place of the diverted and curtailed arteries.

In the left usual leg all arteries followed the normal course.

## THE SKELETON

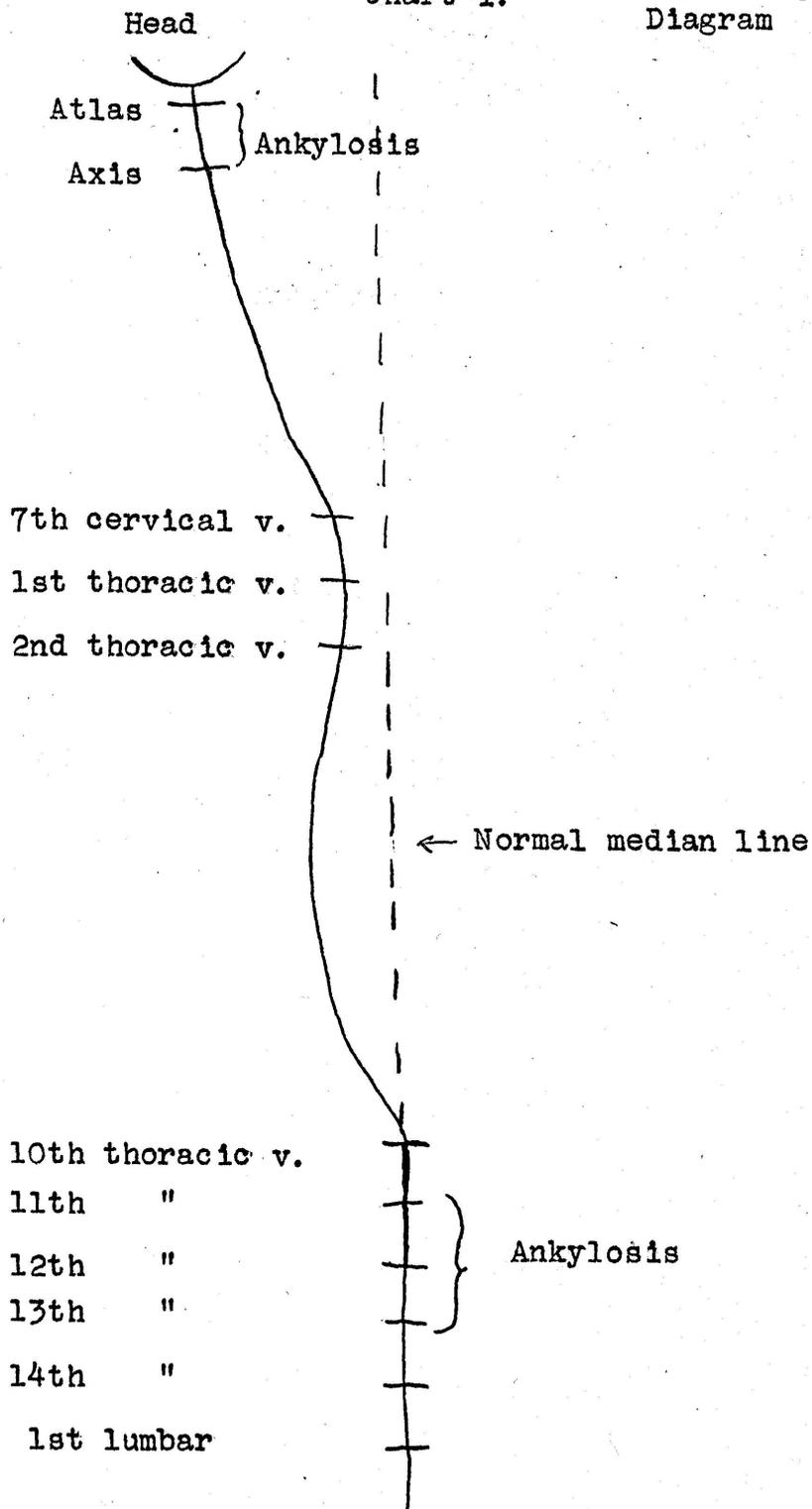
The skeleton shows more variation than either of the other systems studied. There was the usual number of seven cervical vertebrae. Though there were fourteen dorsals this number could not be considered an anomaly since, as Sisson says, fourteen are frequently found in the sheep.

There is a decided left lateral curvature of the spine, beginning with the tenth dorsal vertebra. The arc which this curvature inscribes is not true as it bends back toward the usual median line of the body at the second dorsal; the first dorsal is almost parallel with it but at the seventh cervical it again bends to the left and continues this bend to the head. The head joins the vertebrae at a point one inch from the true or usual median line of the body. (See chart 1)

There is an ankylosis of the atlas and axis, which are twisted and abnormal. (plate XIII, 1-2) Between the eleventh, twelfth and thirteenth dorsal vertebrae is another ankylosis. (plate XIV D-11, 12, 13)

The first nine ribs on the left are normal. The shafts of rib #10 and rib #11 fuse one fourth inch

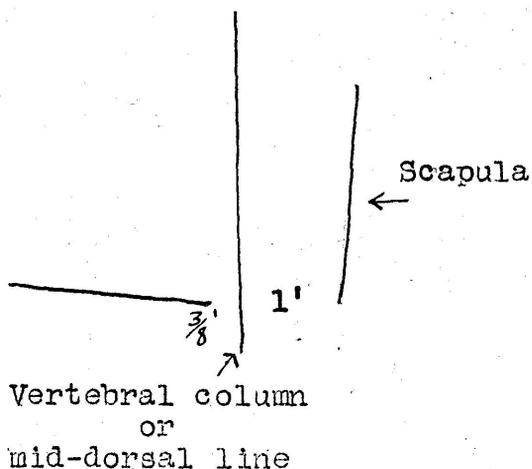
Chart I. Curvature of Spine.  
Diagram



from the vertebra; one half inch beyond, they again divide. Rib #10 is twice as wide as rib #11. Just before the fusion takes place, the anterior edge of the shaft of rib #10 bends posteriorly forming a groove which continues for three fourths of its length. (plate XIV, R 10 to R 11) There is a variation in the size of L. rib #12 in comparison with R. rib #12 since it is about one half its size. Rib #13 is double with an interosseous space in the central third of the shaft. The anterior of these overlaps the junction of rib #12 with the costal cartilage. (plate XIV, R #12 and R #13)

From the mamillary process on vertebra #11, a structure, the width of a rib, arises and extends diagonally over the ribs and attaches above the junction of rib #10 with the costal cartilage. This structure appears to be at least partly of ectodermal origin as it is a muscular roll with wool in the center. (plate XIV, R #10 and R #11)

The position of the scapula on the left varies from that on the right. The anterior angle is one inch from the mid-dorsal line of the body with the



anterior border lying not quite parallel to the vertebral column or mid-dorsal line. On the left the scapula is placed in almost a vertical position with the anterior angle three eighths of an

inch from the mid-dorsal line.

On the left scapula, the supraspinatus fossa is not as broad as on the right. The spine is bent more toward the anterior border and the acromion extends farther on the neck than does that of the right. This bending of the spine appears to be due to the fact that the weight of the extra, or abnormal, arm would pull it over, as it is to the spine the abnormal arm is attached.

For the abnormal arm, the only rudiment of a scapula is a small, cone-shaped bone which possibly represents the glenoid cavity and the neck of a scapula. The anterior point of the posterior surface has

attached to it, a small triangular bone which apparently articulates with the spine of the left usual scapula. This "would be" scapula and extra bone probably originated from the epiphyses of the abnormal humerus. (plates XV, 3 and 4; XVI, 3 and 4b, b' and c)

All bones of the usual left arm are normal. (plates VI, 1 and 2; XVII, 1 and 2; XVIII, 1 and 2)

In the abnormal arm, the skeleton is most interesting for it reveals points which were not discernible until the very tough fascia which covered the entire structure was removed. The paired hoof suggested a double or paired arm. There is positive evidence of this in all parts except in the humerus. The humerus, however, appears to be a double structure very well fused on the volar surfaces and along their whole extent. This might be what J.S. Horseley terms an "intimate fusion". The shaft is more or less triangular in shape. At the proximal end it has been flattened out while at the distal end it is almost an isosceles triangle with rounded corners. If this be paired humeri, fused, the nutriment foramina

are in their proper location. Another evidence to substantiate the paired idea is the fact that there are four epiphyses on the proximal end of the humerus. The two have already been described, one as the abnormal scapula, and the other as the small bone which appears to aid in the articulation with or attachment to the spine of the usual scapula. The other two do not show any unusual or marked variations; they are simply smaller than normal epiphyses, but are in proportion to the size of their humerus. (plate XVI, 3 and 4)

From the humerus distally there is a distinct right and left arm fused. There are two radii with double fused ulna lying between them. The radii though slightly smaller in size than the normal are almost perfect in their formation when compared with the normal radii. (plate XVII, 3-4 R)

The ulnae were fused throughout their extent on their volar surfaces; that is, they are lying face to face. This fused ulna has a short olecranon, the highest point of which does not extend beyond the epiphyses of the radii. (plate XVII, 4a and b) The distal end

of the ulna is very much flattened and is practically the same length as the radii. The entire shape is very much like the ray flower of a shasta daisy considering the olecranon as the point of attachment of the ray flower to the central disk. (plate XVII, 4)

The normal carpus consists of six bones: four in the proximal row and two in the distal with the accessory slender and egg-shaped articulating with the ulnar carpal only. (plate XVIII, 1 and 2)

The abnormal arm has almost a complete double carpus. The proximal row contains two radials (plate XVIII, 3-4), and two intermediates (plate XVIII, 3-4 C.i.) in proper location with reference to the two radials. A single ulnar (plate XVIII, 3 C.u.) lies between the intermediates; this appears to be two fused as there are present two accessory carpals to articulate with this single ulnar carpal (XVIII, 4 C.a.). The distal row is also double, the carpals lying in the usual location in reference to the metacarpals. (plate XVIII, 3-2, 3,4)

The double or paired metacarpals and phalanges are fused together; the typical volar surfaces are in a

straight line. The chief digits corresponding to the metacarpals and phalanges are fused.

The metacarpals, phalanges and digits are all slightly smaller in size and shorter in length than those of the normal arm.

To recount briefly the anomalies of the skeleton due to this abnormality, there are: all variations occur on the left side of the median line except the ankylosis of certain vertebrae and spinal curvature; an extra appendage which is composed of a distinct right and left member or component; a doubling of ribs from the tenth to the fourteenth; in this same region a peculiar ectodermal growth; the relocating of the scapula. The latter and the curvature of the spine undoubtedly were brought about by the extra weight of additional parts.

## SUMMARY

1. The presence of the abnormal arm did not greatly affect the muscular development of the usual left arm.

A few muscles in the shoulder were not so well developed as the comparable normal muscles. One was completely lacking.

The musculature of the abnormal limb was very limited, there being only one muscle in it.

2. The arteries showed more variation, proportionally than the muscles. The main veins and arteries were larger than normal, and the walls of the veins were much heavier.

All regions on the left were fully supplied with blood either by the usual arteries or by arteries arising to take the place of the diverted arteries.

An artery of secondary importance to the usual arm was diverted to become the only artery to the abnormal arm and share the main load of blood, with the subclavian, as branches which normally arise from the subclavian come from this artery and organs normally supplied by this artery are supplied by new arteries

which arise from the subclavian at points near these organs.

3. The skeletal system showed a greater variation than either the muscular or arterial systems.

This variation appeared in the vertebrae, the ribs, and the location of the left scapula which had attached to it a second appendage. This appendage was a paired or fused double appendage. These paired parts were distinctly right and left, even though ossified or fused together.

## A GENERAL CONCLUSION

A left lateral curvature of the vertebral column, a paired appendage at left of medial line, a bit of ectoderm tissue attached on left of median line to a dorsal vertebra and costal cartilage, slight variations in the muscular and circulatory systems to the left support the interpretation of this monster in terms of a side to side pectoral fusion of twin primordia, with complete resorption of other portions. A variant of this might be a single ovum with incomplete fission or bifurcation of the embryonic mass. A second variant might be postregeneration, as Wilder quotes Tonier, that in lower animals an injury or wound in a location where loss usually occurs yet insufficient to cause loss of the part, will occasion the growth of a new member in the same manner as though the original had been actually lost, thus producing duplicity. From this Tonier holds that while such phenomena may occur in lower animals only, they may occur before birth in birds and mammals, as a result of a lesion affecting the fetus. Wilder considers this plausible

when confined to hyperdactylism. This monstrosity is not confined to hyperdactylism so, according to Wilder, this could not apply in this case.

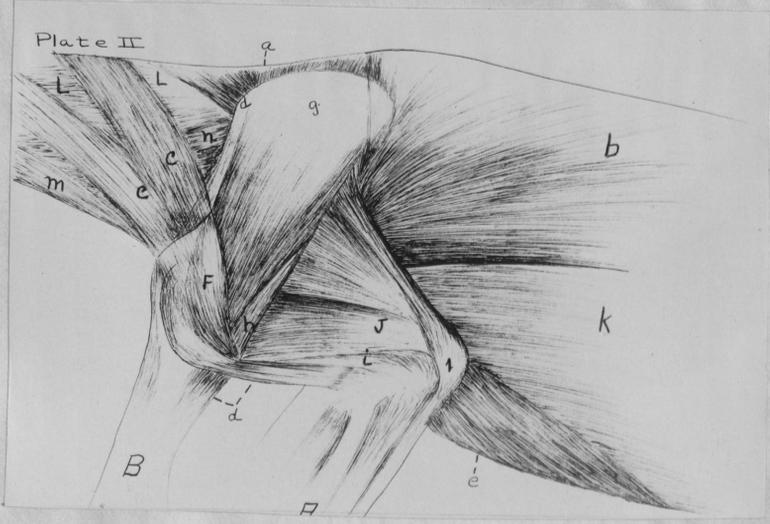
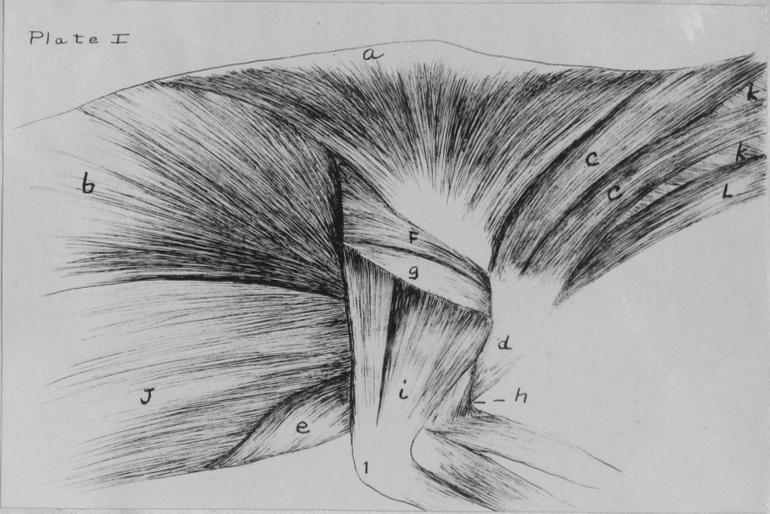
Keibal and Mall state, "the embryonic tissues become mixed (sic), which is generally due to malnutrition followed by some cytolis,... The repair of a simple wound in the embryo is always associated with further development of the surrounding parts". This appears to me to be a restatement of the post-regeneration theory.

Franklin P. Mall, in his article on "The Origin of Human Monsters", makes this statement: "Certain varieties (monsters) like those of the extremities of anatomical anomalies are known to be germinal and are hereditary." If it be true however, it would completely overthrow the postregeneration theory.

Castle states, "Probably the hereditary element in twinning is very small while that of environment is large". This would seem to agree with the post-regeneration theory and Keibal and Mall's of malnutrition as both malnutrition and injury to fetus would certainly be environmental.

If this be not satisfactory it brings us back

to one of the two solutions suggested first, that of fusion or of incomplete fission. With the data on hand it is not possible to decide positively between the two but it would appear that the data favor that of fusion.



## PLATE I

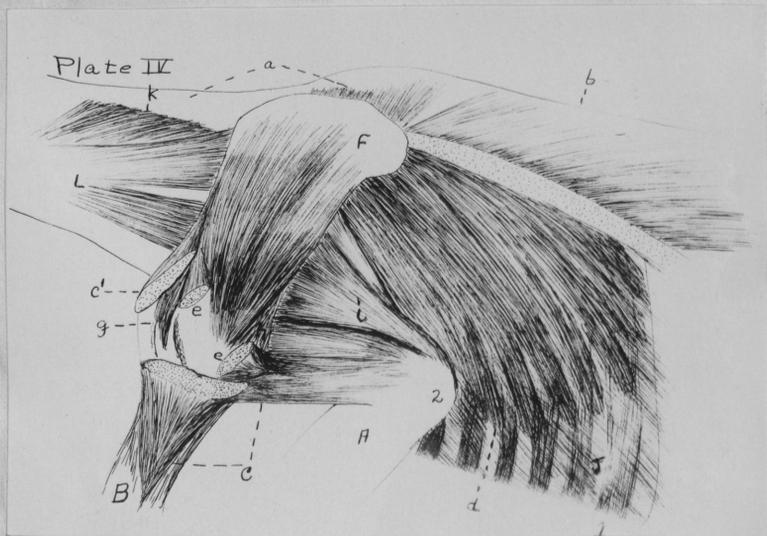
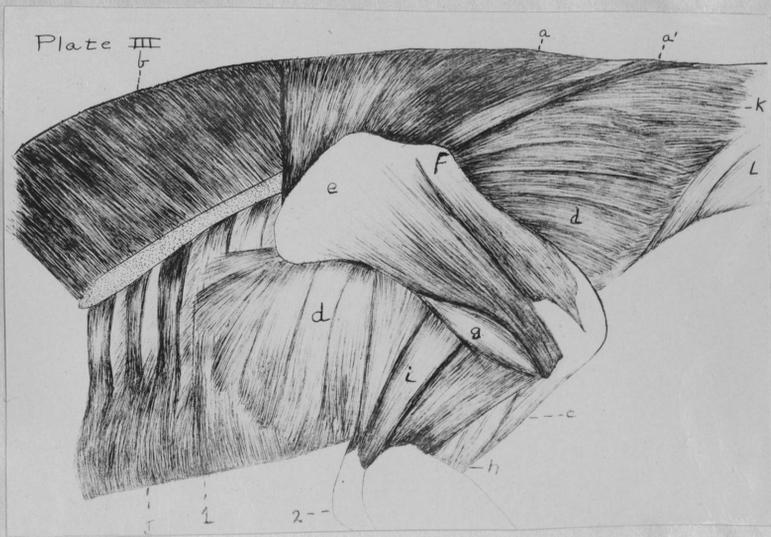
Superficial Muscles of Lamb  
Right - Normal Side

- a- Trapezius.
- b- Latissimus dorsi.
- c- Brachiocephalicus.
- d- Superficial pectoral.
- e- Deep pectoral.
- f- Deltoideus.
- g- Teres minor.
- h- Brachialis.
- i- Triceps.
- j- Obliquus abdominis externalis.
- k- Splenius.
- L- Sternocephalicus.
- l- Olecranon.

## PLATE II

Superficial Muscles of Lamb  
Left - Abnormal Side

- A- Usual arm.
- B- Abnormal arm.
- a- Rhomboideus.
- b- Latissimus dorsi.
- c- Brachiocephalicus.
- d- Superficial pectoral.
- e- Deep pectoral.
- f- Deltoideus.
- g- Infraspinatus.
- h- Teres minor.
- i- Brachialis.
- j- Triceps.
- k- Obliquus abdominis externalis.
- L- Splenius.
- m- Sternocephalicus.
- n- Serratus ventralis.
- l- Olecranon.



## PLATE III

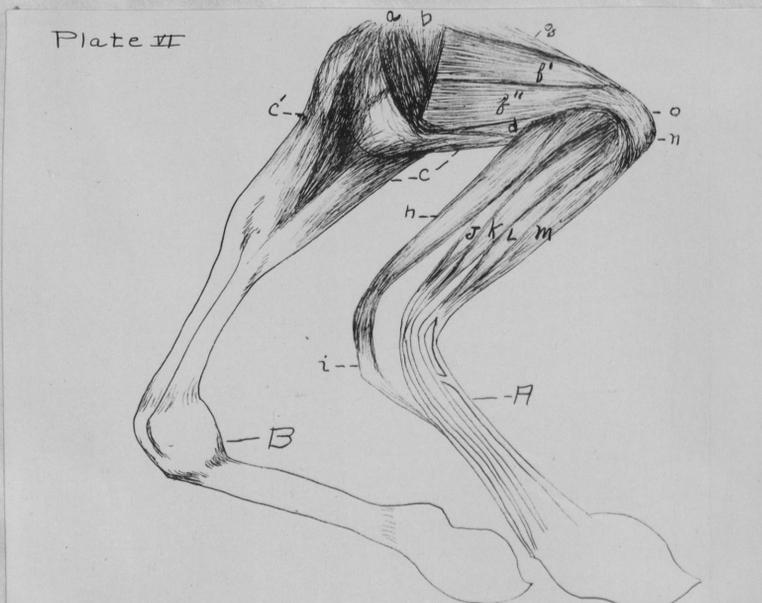
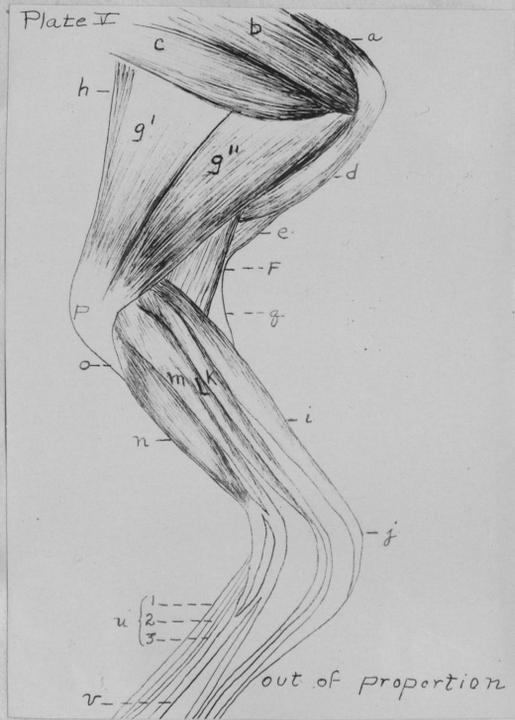
Deeper Muscles of the Lamb  
Right - Normal Side

- a- Rhomboideus cervicalis.
- a'- Rhomboideus thoracalis.
- b- Latissimus dorsi.
- c- Superficial pectoral.
- d- Serratus ventralis.
- e- Infraspinatus.
- f- Supraspinatus.
- g- Teres minor.
- h- Biceps.
- i- Triceps.
- j- Obliquus abdominis externalis.
- k- Splenius.
- L- Scalenus.
- 1- Seventh rib.
- 2- Olecranon.

## PLATE IV

Deeper Muscles of the Lamb  
Left - Abnormal Side

- A- Usual left arm.
- B- Abnormal left arm.
- a- Rhomboideus.
- b- Latissimus dorsi.
- c, c'- Superficial pectoral.
- d- Serratus ventralis.
- e- Deltoideus.
- f- Infraspinatus.
- g- Supraspinatus.
- h- Teres minor.
- i- Triceps.
- j- Obliquus abdominis externalis.
- k- Splenius.
- L- Scalenus.
- 1- Ninth rib.
- 2- Olecranon.



## PLATE V

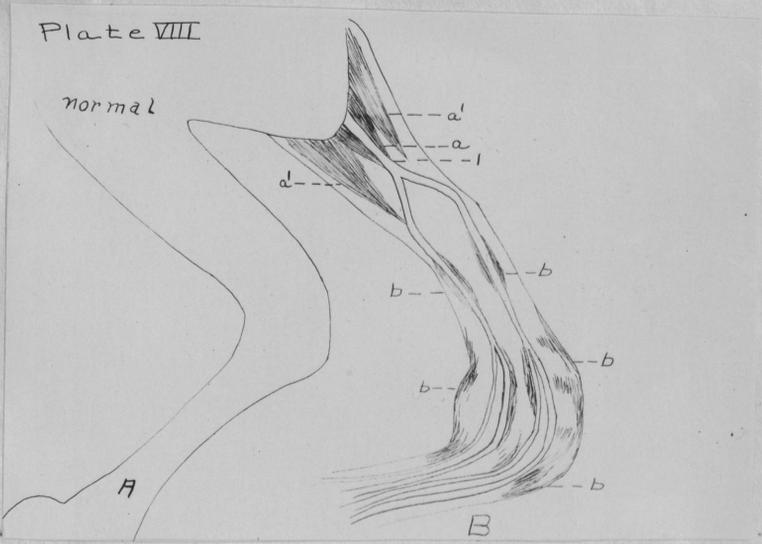
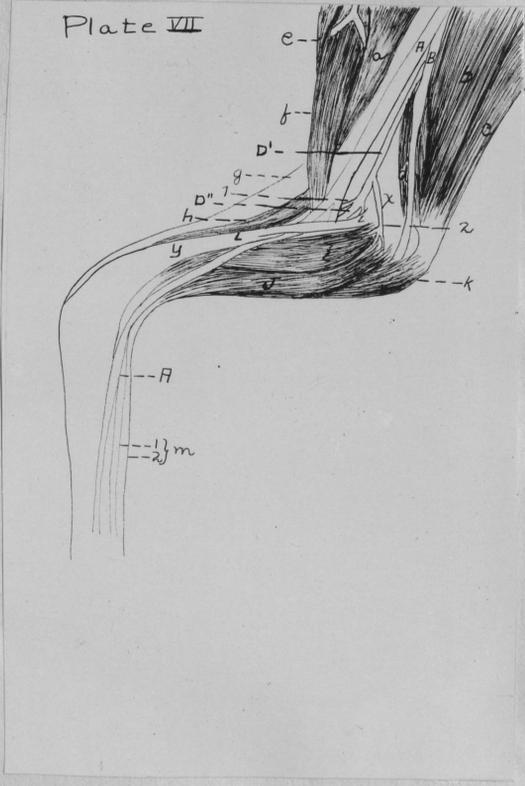
Muscles of the Right or Normal Arm  
Lateral View

- a- Brachiocephalicus.
- b- Deltoideus.
- c- Teres minor.
- d- Superficial pectoral.
- e- Biceps brachii.
- f- Brachialis.
- g' - Triceps - long head.
- g'' - Triceps - lateral head.
- h- Tensor fasciae antibrachii.
- i- Extensor carpi radialis.
- j- Metacarpel tuberosity.
- k- Extensor digiti tertii.
- L- Extensor digitalis communis.
- m- Extensor digiti quartii.
- n- Ulnaris lateralis.
- o- Ulnar head of deep flexor.
- p- Olecranon.
- q- Long tendon of biceps.
- u- Flexor tendons.
- v- Tendon from common lateral extensor.

## PLATE VI

Muscles of the Usual Left and Abnormal Arm  
Lateral View

- A- Usual arm.
- B- Abnormal arm.
- a- Deltoideus.
- b- Teres minor.
- c, c' - Superficial pectoral.
- d- Biceps brachii.
- f' - Triceps - long head.
- f'' - Triceps - lateral head.
- g- Tensor fasciae antibrachii.
- h- Extensor carpi radialis.
- i- Metacarpel tuberosity.
- j- Extensor digiti tertii.
- k- Extensor digitalis communis.
- L- Extensor digiti quartii.
- m- Ulnaris lateralis.
- n- Ulnar head of deep flexor.
- o- Olecranon.



## PLATE VII

Muscles of the Right or Normal Arm  
Medial View

- x- Humerus.
- y- Radius.
- a- Coraco-brachialis.
- b- Medial head of triceps.
- c- Tensor fasciae antibrachialis.
- d- Anconeus.
- e- Anterior superficial pectoral.
- f- Biceps.
- g- Long tendon of biceps.
- h- Extensor carpi radialis.
- i- Flexor carpi radialis.
- j- Flexor carpi ulnaris.
- k- Ulnar head of deep flexor.
- L- Long medial ligament.
- m- Superficial flexor tendons.

- A- Medial nerve.
- B- Ulnar nerve.
- D<sup>1</sup>- Brachial artery.
- D<sup>2</sup>- Medial artery.

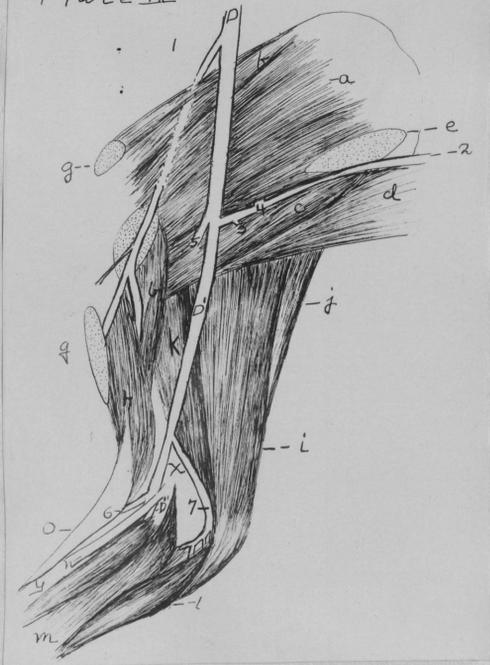
- 1- Anterior radial artery.
- 2- Ulnar artery.

## PLATE VIII

Muscles and Blood Vessels of the Abnormal Arm  
Medial View

- A- Usual left arm.
  - B- Abnormal arm.
  - a- Superficial pectoral, developed tissue.
  - a<sup>1</sup>- Superficial pectoral, undeveloped tissue.
  - b- Undeveloped muscle in patches.
- 1- Diverted circumflex artery of the humerus.

Plate IX



## PLATE IX

Deep Muscles of Shoulder and Upper Arm and Medial  
Arteries  
Right - Normal Side - Medial View

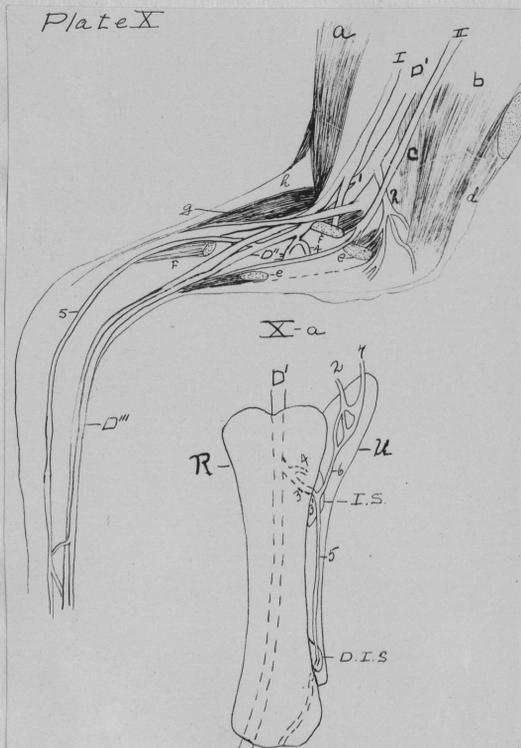
Muscles

- a- Subscapularis.
- b- Coraco-brachialis.
- c- Teres major.
- d- Latissimus dorsi.
- e- Serratus ventralis.
- f- Supraspinatus.
- g- Superficial pectoral.
- h- Biceps.
- i- Medial head of triceps.
- j- Tensor fascia antibrachii.
- k- Anconeus.
- L- Flexor carpi ulnaris.
- m- Flexor carpi radialis.
- n- Long median ligament.
- o- Long tendon of biceps.
- x- Humerus.
- y- Radius.

Arteries

- D- Subclavian.
- D'- Brachial.
- D''- Median.
- 1- Anterior circum-  
flex or humerus.
- 2- Subscapular.
- 3- Thoraco-dorsal.
- 4- Circumflex A. of  
scapula.
- 5- Deep brachial  
trunk (Deep brachial.  
(Posterior cir-  
(cumflex of  
(humerus.
- 6- Anterior radial.
- 7- Ulnar.

Plate X



## PLATE X

## Muscles and Arteries of Forearm. Right - Normal View

Muscles

- a- Biceps.
- b- Medial head of triceps.
- c- Anconeus.
- d- Tensor fasciae antibrachii.
- e- Humeral head of flexor carpi.
- f- Flexor carpi radialis.
- g- Extensor carpi radialis.
- h- Long tendon of biceps.
- i- Long median ligament.

Arteries

- D'- Brachial.
- D''- Median.
- D'''- Carpus.
- 1- Anterior radial.
- 2- Ulnar.
- 3- Common interosseus.
- 4- Volar interosseus.
- 5- Medial volar meta-carpal.

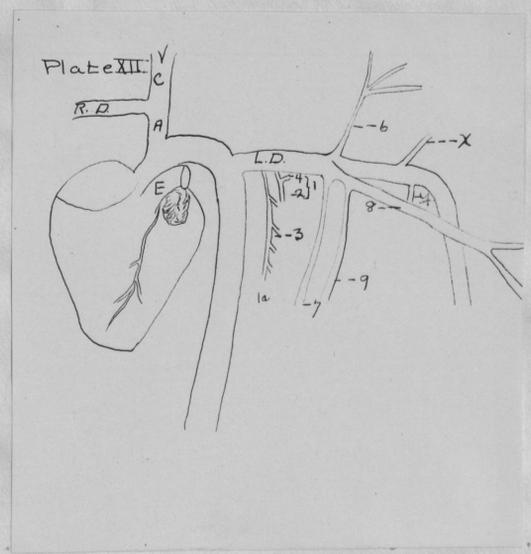
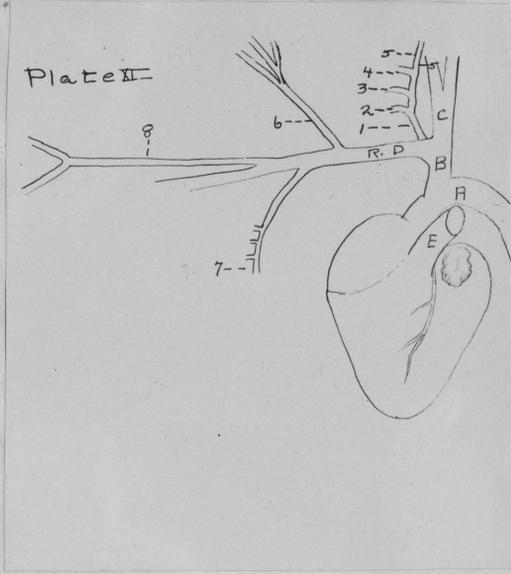
Nerves

- I Medial
- II Ulnar

## PLATE X'a

Lateral View Radius and Ulna, All Muscles Removed  
Showing Branches of Common Interosseus Artery

- R- Radius.
- U- Ulna.
- I.S. Interosseus space.
- D.I.S. Distal interosseus space.
- 2- Ulnar.
- 3 - 3'- Common interosseus.
- 4- Volar interosseus.
- 5- Dorsal " .
- 6- Recurrent " .
- 7- Deep brachial.



## PLATE XI

Diagrammatic Drawing To Show the Heart and Arteries  
Right - Normal - 1

- A- Aorta.
- B- Innominate.
- C- Carotid.
- D- Subclavian.
- E- Pulmonary vein.
- 1- Dorso-vertebral trunk.
- 2- Transverse colli.
- 3- Subcostal.
- 4- Vertebral.
- 5- Thymus.
- 6- Inferior cervical.
- 7- Internal thoracic.
- 8- Anterior circumflex A. of humerus.

## PLATE XII

Diagrammatic Drawing To Show the Heart and Arteries  
Left - Abnormal - 2

- A- Aorta.
- B- Innominate.
- C- Carotid.
- D- Subclavian.
- E- Pulmonary vein.
- 1- Dorso-vertebral trunk.
- 2- Transverse colli.
- 3- Subcostal.
- 4- Vertebral.
- 5-
- 6- Inferior cervical.
- 7- Internal thoracic.
- 8- Diverted anterior circumflex of humerus.
- 9- Muscular phrenic.
- x- Artery x.
- y- Artery y.

Plate XIII

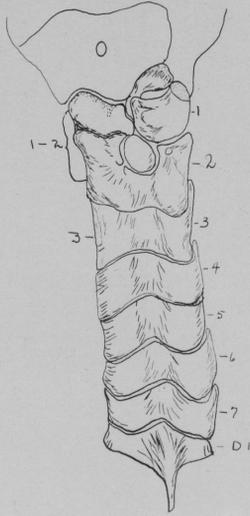
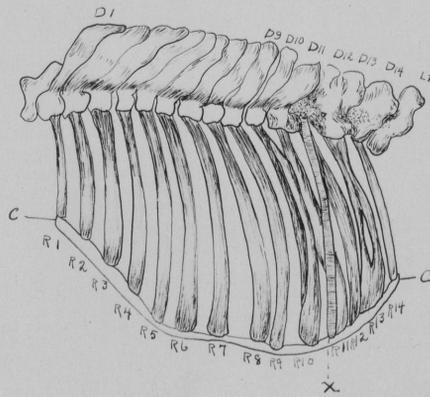


Plate XIV



## PLATE XIII

## Cervical Vertebrae

- O- Occipital.
- 1- Atlas vertebra.
- 2- Axis vertebra.

## PLATE XIV

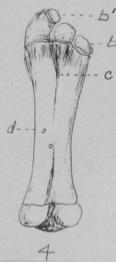
## Dorsal Vertebrae and Ribs

- D.1- D.14- Dorsal vertebra.
- L.1- Lumbar vertebra.
- R.1- R.14- Ribs.
- x- Muscle tissue.
- C- Costal cartilage.

Plate XV



Plate XVI



## PLATE XV

## Scapula

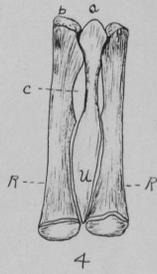
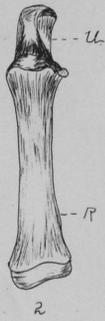
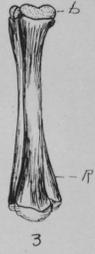
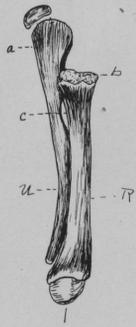
- 1- Normal, lateral view.
- 2- Normal, posterior view.
- 3- Abnormal, lateral view.
- 4- Abnormal, posterior view.

## PLATE XVI

## Humerus

- 1- Normal, lateral view.
- 2- Normal, posterior view.
- 3- Abnormal, lateral view.
- 4- Abnormal, posterior view.
- a- Olecranon fossa.
- b- Epiphyses.
- b'- Epiphyses converted into abnormal scapula.
- c- Slight groove, indicating medial fusion of humerus.
- d- Nutrient foramen.

Plate VII

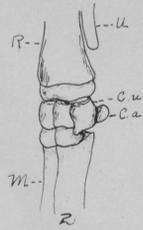
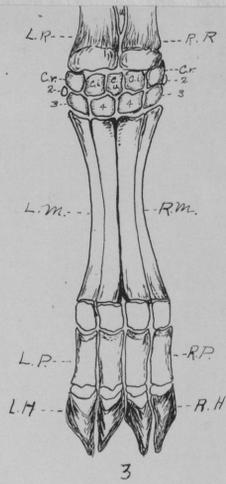
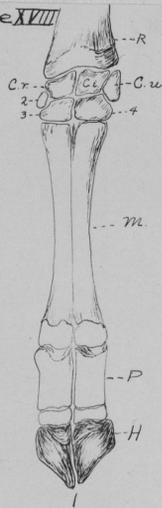


## PLATE XVII

## Radius and Ulna

- 1- Normal, posterior medial view.
  - 2- Normal, anterior view.
  - 3- Abnormal, posterior medial view.
  - 4- Abnormal, anterior view.
- R- Radius.  
U- Ulna.  
a- Olecranon.  
b- Epiphyses.  
c- Interosseus space.

Plate XVIII



## PLATE XVIII

## Wrist and Foot

- 1- Normal wrist and foot - Front view.
  - 2- Normal wrist - Lateral view.
  - 3- Abnormal wrists and feet - Front view.
  - 4- Abnormal wrists - Lateral view.
- R- Radius.  
U- Ulna.  
M- Metacarpal.  
P- Phalanges.  
H- Hoof.  
C.r.- Radial carpal.  
C.I.- Intermediate carpal.  
C.u.- Ulnar carpal.  
2- Second carpal.  
3- Third carpal.  
4- Fourth carpal.  
C.a.- Accessory carpal.

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