

Historical Perspectives

Spinal and Pelvic Orthopedic Health, Treatment, Care and Surgery

First Edition



Commentary and selected excerpts from the renowned 1858 *Anatomy: Descriptive and Surgical* by Henry Gray and H.V. Carter; 1764 *De Ischiade Nervosa Commentarius* by Domenico Cotugno; 1885 *The Surgical Diseases of Children* and 1890 *A Manual of Anatomy for Senior Students* by Edmund Owen; 1888 *Tuberculosis of the Sacro-Iliac Joint* by Weller Van Hook; 1906 *Manual of Anatomy, Volume 1* by Alexander M. Buchanan; 1892 *Surgery: Its Theory and Practice* by William Johnson Walsham; and, 1921 *Arthrodesis of the Sacroiliac Joint. A New Method of Approach* by Dr. Smith-Petersen

Disclaimer: The information herein does not constitute medical advice and is for historical reference only.

*Libertas quæ sera tamen respexit inertem
Respexit tamen & longo post tempore venit*

VIRGILIUS Bucol, Ecl. I.

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Purpose

The purpose of this First Edition of the *Historical Perspectives: Spinal and Pelvic Orthopedic Health, Treatment and Care, and Surgery* is to provide a cursory look into a small part of the history concerning various aspects of spinal and pelvic orthopedic health, treatment, care and surgery and with a particular focus on issues surrounding the sacroiliac joints. Subsequent editions will build upon this unique work to better provide the reader a more comprehensive investigation into the body of knowledge around the world concerning these aforementioned topics. In no case should this body of work be considered medical advice or to be used as a clinical reference—it is provided solely as a historical reference.

Introduction

The history of medicine likely goes back far earlier than that documented in our recorded history or findings in the field. Fortunately, there were those who were generous enough to contribute to an early but rapidly growing body of knowledge for the benefit of their contemporaries and in our case, posterity. There is much to be learned, or at least appreciated, by these early clinicians, surgeons, anatomists, scientists, et al. This work presents selected excerpts from the 18th, 19th and 20th centuries' literature with accompanying commentary. In this First Edition, the author will attempt to minimize his commentary and proffer directly the knowledge of these early contributors via, at times lengthy, reproductions of illustrations and text.

History

Dr. Weller Van Hook, M.D., a distinguished surgeon who studied and graduated from the Chicago College of Physicians and Surgeons in 1885 and was Professor of Surgery in Northwestern University Medical School, was a valuable contributor to medical literature. Of particular interest here is his 1888 paper titled *Tuberculosis of the Sacro-Iliac Joint*, in which he presents, among other things, a partial yet detailed account of historical literature regarding sacroiliac joint disease:

TUBERCULOSIS OF THE SACRO-ILIAC JOINT.

By WELLER VAN HOOK, M.D.,

OF CHICAGO.

HISTORY.—If we may judge from the literature which we have inherited, the existence of sacro-iliac tuberculosis was unknown prior to the present century. True, the ancient and mediæval leeches from Hippocrates to Ambroise Paré found delight in the study of the condition of the pelvic symphyses during pregnancy and parturition. And Louis records some traumatic lesions of the sacro-iliac joint occurring in the practice of Philippe de Chartres; while L'Heritier had a case which Delens thinks was probably one of preternatural mobility of that articulation compensatory to ankylosis of the hip-joint.

But it is not until we reach Boyer that we really find an account of the disease in hand. In 1821 Boyer described sacro-iliac disease as a chronic affection of the sacro-iliac joint, distinctly indicating his opinion that the disease was of scrofulous origin, and that it was pathologically similar to "spontaneous luxation" of the hip-joint.

Attention having been called to the possibility of disease at this location, Velpeau three years later drew attention to suppuration there during the puerperium, and considered the sacro-iliac joint as the point of origin of other suppurations found at autopsies. In later years Velpeau described in his clinics cases of true sacro-iliac disease distinguished clearly from puerperal metastatic infection. One of his internes wrote a monograph upon this subject a few years later.

Larrey described the affection briefly under the term sacro-coxalgie, which he was the first to use. He compares it with tumor albus of other joints.

In 1833 Langier published an article in the *Dictionnaire Medicale* which has been much read; and in the same year

Hahn published in German an important monograph which was quite a complete résumé of the subject.

Sacro-iliac disease has been a favorite topic for theses of the Faculty of Paris, among which are those of Frère (1838), Girault de Nolhac (1840) and Delineau (1842), who, inspired by the lectures of Larrey, made an important contribution. Then come the names of Joyeux (1842), Maisonneuve, who (1844) detailed the chief points in the differential diagnosis between sacro-iliac disease and morbus coxarius; and Nélaton (1847), who gives a résumé of the history of the study, which had hitherto been much neglected.

Gurlt, in 1853, gives many valuable facts in his treatise on joint affections.

But to Erichsen, of England, belongs the credit of having formulated in a lecture published in the *Lancet* (1859, 9, p. 25) a clinical account of the disease, which at that early and important date directed the course of investigation, and clearly fixed many of the chief points in the differential diagnosis.

Three years later Boissarie collected some observations and made a study of the disease, while Velpeau again directed attention to the subject by a lecture.

Lectures by Gosselin and Broca in 1868 contributed to the elucidation of the diagnosis of the disease, while in the same year Duplay gave in his *Traité de Pathologie* a complete study of the subject.

Holmes' "System of Surgery," 1870, contains an excellent article by A. Johnstone on acute and chronic sacro-iliac disease.

In 1873 the theses of the Faculty of Paris again afford a paper on this subject by Delens, who has presented a monograph which is a model of scrupulous care in the collection of material, and of almost judicial firmness in the exclusion of irrelevant or imperfectly substantiated evidence. With such scientific conscientiousness has the work been done that I can only criticise the facts that the work of foreign writers has not been completely presented, and that some cases of disease of the sacro-iliac joint due to infection by other microbes than that of tuberculosis, although clearly diagnosed, have been given a place, not only in the list of cases, but are even intro-

duced to illustrate the symptomatology and diagnosis of the disease.

In 1875, A. Bounaix presented to the Faculty of Paris a thesis on the same subject, describing four instructive cases of the disease, three of which were examined *post-mortem*.

In the following year, Heath published in English an account of several cases more or less complete, chiefly with a view to illustrate a special method of treatment.

Poore, in 1878, published in the *American Journal of Medical Sciences* a review of the subject from a clinical point of view, followed by a collection of literary references. The chief bulk of this paper is taken up with the analysis of 58 cases which he has collected. It is, however, unfortunate that the writer has not given specific reference to each case in order that later students might examine them with the added knowledge of recent pathology and of modern surgical treatment. Especially is this true since the writer has introduced numerous examples of gonorrhoeal as well as primary and secondary suppurative affections of the joint. His statistics being thus vitiated lose much of their scientific value.

Prof. L. A. Sayre, from the abundance of his experience was able in 1879 to refer in a clinical lecture to eighteen cases of sacro-iliac disease with only one death. Besides the case taken from his Orthopedic Surgery, I am fortunately able, through the courtesy of Prof. Sayre, to present the details of a number of cases which were merely referred to in the clinical lecture. In his orthopedic surgery the same distinguished writer has referred to the disease, and has given an account of the operative interference to which he has resorted in certain cases where abscesses had formed.

In St. Petersburg, G. Tiling published in 1883, in the *Medicinische Wochenschrift* of that city, an account of four cases in two of which operations were made that were intended to be as nearly radical as possible. The article is, therefore, of considerable value, and will be referred to again.

Only last year F. J. Gant reported two cases in which he had performed *évidement* with a successful result.

It will thus be seen that the subject of sacro-iliac disease has not received the same degree of attention that has been

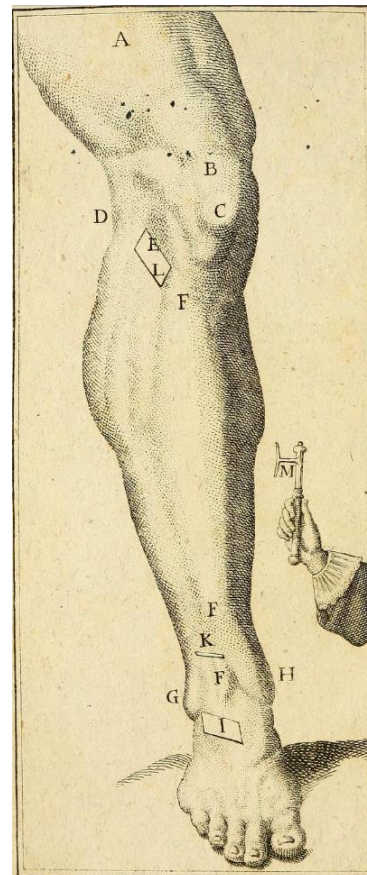
given to tubercular affections of other joints. This is to be accounted for both by the fact that the disease is quite rare, and also that the diagnosis is often so difficult that doubtless many cases have escaped detection.

Sciatica

Undoubtedly, Domenico Cotugno, an Italian physician, is one of the most well-known early writers on the topic of sciatica, broadly speaking “pain in the lower back, buttocks, hips, or adjacent parts.” In his classic 1764 *De Ischiade Nervosa Commentarius* he writes of sciatic neuralgia and also about the free circulation between the cranial and spinal dura of cerebrospinal fluid (CSF), a hitherto mostly unobserved humor. As Cotugno states, “anatomists have not observed this large collection of water in the spine and around the brain because of the ridiculous method usually employed for the dissection of bodies...they cut off the head with the neck...all the fluid collected around the brain and spinal marrow is at once lost... and the anatomist is misled by the appearance of empty spaces.” The same remarkable scientist and clinician who solved certain mysteries surrounding CSF was the same man who *differentiated sciatic nerve pain from arthritis of the hip*, hence the eponym “Cotugno’s syndrome.”



DOMENICO COTUGNO
(1736–1822)

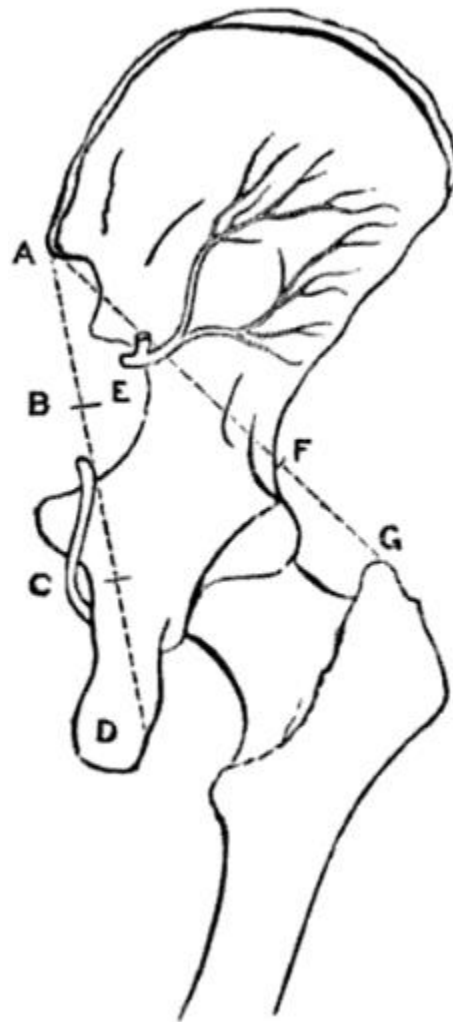


William Johnson Walsham's 1892 *Surgery: Its Theory and Practice* makes a brief but important observation on sacroiliac joint disease and its correlation with sciatica:

DISEASE OF THE SACRO-ILIAC JOINT also requires a separate, brief notice. It is generally of tubercular origin, but is sometimes apparently due to injury. It usually occurs in young adults, rarely, if ever, in children. There is pain, swelling, and later redness over the joint, followed by the formation of abscesses which may open posteriorly or through the sciatic notch, above Poupart's ligament, in the ischio-rectal fossa, or in the rectum. The pain may be reflected along the sciatic nerve, simulating sciatica, or along the obturator nerve to the hip or knee, and may then be increased on moving the hip. The thigh, moreover, in consequence of the irritation of the psoas, may be slightly flexed. The disease may thus have to be diagnosed from hip-disease and spinal caries. On fixing the pelvis, however, the hip and spine move freely and without pain, but pain is felt on making pressure inwards or outwards on the iliac crests or over the sacro-iliac joint. When sinuses have formed carious bone may sometimes be detected on probing. The *prognosis* is unfavourable. The *treatment* consists in keeping the parts at absolute rest by fixing the pelvis and thigh in a moulded leather splint reaching to the knee, and after sinuses have formed, in scraping and gouging away as much as possible the tuberculous granulations and carious bone and dressing with iodoform.

The Art of Differential Diagnosis

Dr. Edmund Blackett Owen FRCS was an English surgeon of the late 19th century who wrote, among other works, the 1885 *The Surgical Diseases of Children* and the 1890 *A Manual of Anatomy for Senior Students*. They are extensive works covering many topics and they include information concerning painful sacroiliac joints with a description of common symptoms, differential diagnosis, treatment and prognosis:



page 374 from *A Manual of Anatomy for Senior Students*

The **sacro-iliac joint** is formed by the auricular surfaces of the sacrum and ilium, each of which is covered with a layer of cartilage. The anterior sacro-iliac ligament is thin, the posterior is thick and strong, and, in addition, contains a large amount of interosseous fibres. The joint is supplied by branches of the gluteal and ilio-lumbar arteries, and by nerves from the superior gluteal, the sacral plexus, and perhaps from the obturator.

Disease of the joint may follow injury, or parturition, or may be secondary to spinal caries. The local tenderness may be detected by following the iliac crest round to the sacrum, and pressing below the posterior superior spine.

In addition to the constant pain at the bottom of the back, there may be peripheral pains referred to the knee, on account of the obturator nerve sometimes giving a twig to the sacro-iliac joint, and to the thigh, on account of associations between the nerves of that joint and other branches of the sacral and lumbar plexuses. There is pain on pressing the fronts of the iliac crests together, and defæcation may cause distress. *Abscess* from the joint may open on to the back, or into the pelvis, or into the sheath of the psoas, or into the rectum.

pages 360-361 from *A Manual of Anatomy for Senior Students*

CHAPTER XXX.

DISEASE OF THE SACRO-ILIAC JOINT.

SACRO-ILIAC disease comes on insidiously after a fall or other injury, especially in the unhealthy or strumous subject. In some cases there may be nothing to account for the onset of the trouble. Though it may be a primary affection, it is often secondary to disease of the vertebræ, os innominatum, or pelvis, but in any case it is a rare affection.

Symptoms.—The child complains of feeling tired after exercise, and of his back aching. He walks with caution, so as not to jar the diseased articulation, and he does not care to run or stand about; he will not dare to jump. There is also a feeling of “weakness” about the back. The pain may be constant if the disease be advanced, and at all times a cough, a shake of the bed, or a stumble, greatly intensifies it. The pain being confined to the bottom of the back is an important point as regards the *differentiation* from disease of the spine and of the hip. In disease of the spine the pains are referred to the area of distribution of the nerves whose trunks pass by the carious region of the column (page 239): in disease of the hip joint the first pains are in the knee or thigh (page 407). If, however, the trunk of the obturator nerve happen

to give a branch to the diseased sacro-iliac joint, there might be complaints of pain down the limb as in hip joint disease. As in hip joint disease, also, the limb is wasted ; but on squaring the pelvis no alteration in the length of the limbs is found. The limb assumes no characteristic position, but most probably lies extended.

Further points in the differentiation from spinal disease will be the absence of symmetrical pains in the thighs and legs (page 241), the absence of stiffness, straightness, or deformity (page 239) in the lumbar region. But the great feature in sacro-iliac disease is the pain on pressure over the neighbourhood of the posterior iliac spines, and possibly a puffiness of that region.

The differential diagnosis from hip joint disease may be effected with certainty by flexing the thigh upon the abdomen and gently rotating the head of the femur in the acetabulum ; also by gently abducting and at the same time everting the extended limb. No child with hip joint disease would be able to submit to such examination. (*See* page 409.) But when the sacro-iliac disease has been caused by spinal caries the diagnosis may be obscured. Pains about the knee, it may be remarked, may be secondary to disease of spinal column, sacro-iliac joint, pelvis, hip, or of the knee itself.

On pressing the iliac crests together with the palms of the hands, or on cautiously thrusting them asunder by grasping the anterior iliac spines between the fingers and thumbs, the disturbance at the articulation of the haunch bone with the sacrum elicits complaints. Striking the heel or the great trochanter would cause pain, but as pain would also result were the case one of hip or spine disease, this rough method of diagnosis is useless. By tracing the iliac crest backwards, and following it to the neighbourhood.

of the posterior iliac spines the finger detects a spot where pressure causes deep-seated pain.

In the more advanced stage of the disease there is sometimes a localised puffy swelling at that part, and in time the skin over it becomes discoloured, and eventually yields to the pressure of increasing abscess. Nothing is gained by probing the joint when the abscess is opened.

A typically strumous boy is now under treatment for advanced sacro-iliac disease ; a point of interest in his case is that he showed but little lameness at the onset of his trouble. In due course abscess formed, for which repeated aspiration failed to give permanent relief ; it was then incised and drained. The general health is suffering, and it would not be surprising if the poor child fell a victim to tubercular disease, pneumonia, or metastatic abscesses.

Treatment.—The child should be put to bed and kept there in the horizontal position ; he must not be allowed to sit up, as that attitude disturbs the relative position of the sacrum and ilium. Thus the confinement is more strict than it might be for either disease of the spine or of the hip joint. If the weather be fine and warm, he may be carried out into the open air, if this can be done without disturbance of his position. With rest in bed, neuralgic pains will probably pass away ; but should they persist, a few leeches might be applied over the tender spot, and the patient be subsequently kept lying on his face. Possibly a belladonna plaister, or some form of counter-irritant might be found of service. For chronic joint pains a touch or two with the thermo-cautery may afford relief. I doubt if much is gained by enclosing the pelvis in a stiff bandage whilst the child is being kept in bed, for there is practically no movement permitted at the joint, whilst the material used cannot but get in the way and render the horizontal posture

less pleasant. Armlets (page 414) and a stirrup may be useful in teaching a refractory patient the necessity of absolute quiet.

If after a certain amount of this treatment the progress of the disease be apparently arrested, and the patient be deemed sufficiently trustworthy for the purpose, he may be fitted with a Thomas's hip splint, and allowed to get about on crutches, as shown in Fig. 77. When not on crutches, however, he should be kept lying flat on a couch or hearth-rug, and any return of neuralgic pain should be taken as an indication that he should be put back to bed. To stave off suppuration is the great aim of the treatment. But if pus be detected it should be removed, as it is apt to find its way through into the interior of the pelvis, or into the rectum, the ischio-rectal fossa, or the thigh. If for this purpose aspirations fail, a free opening should be made, and the abscess dealt with on such principles as those enunciated on page 255.

The drugs will comprise cod-liver oil, iron, quinine, and possibly small doses of opium.

Prognosis is always grave if abscess supervene; but if the child's health be good, and absolute rest in bed have been secured early in the course of the disease, the trouble may pass quietly and completely away. This happy result has been recently obtained in a case under treatment. But if abscess have formed, recovery can take place on the occurrence of ankylosis. Probably most museums contain a preparation of firm synostosis of the os innominatum and sacrum, the result of disease. Ankylosis of the joint scarcely, if at all, interferes with its subsequent usefulness. If abscess form, and continue to discharge, the child's health becomes undermined, and death is apt to follow from exhaustion, pneumonia, phthisis, metastatic abscess, or even from waxy degeneration of the kidneys and liver.

Anatomy

Dr. Buchanan

Below are certain reproductions of illustrations from the 1906 *Manual of Anatomy, Volume 1* by Alexander M. Buchanan, M.A., M.D., C.M., F.F.P.S., Professor of Anatomy in Anderson's College, Glasgow. Dr. Buchanan was known all over the world as "an accomplished scholar, grand anatomist, exquisite demonstrator and a master of lucidity." The selected illustrations are of particular interest in the spinal and pelvic fields:

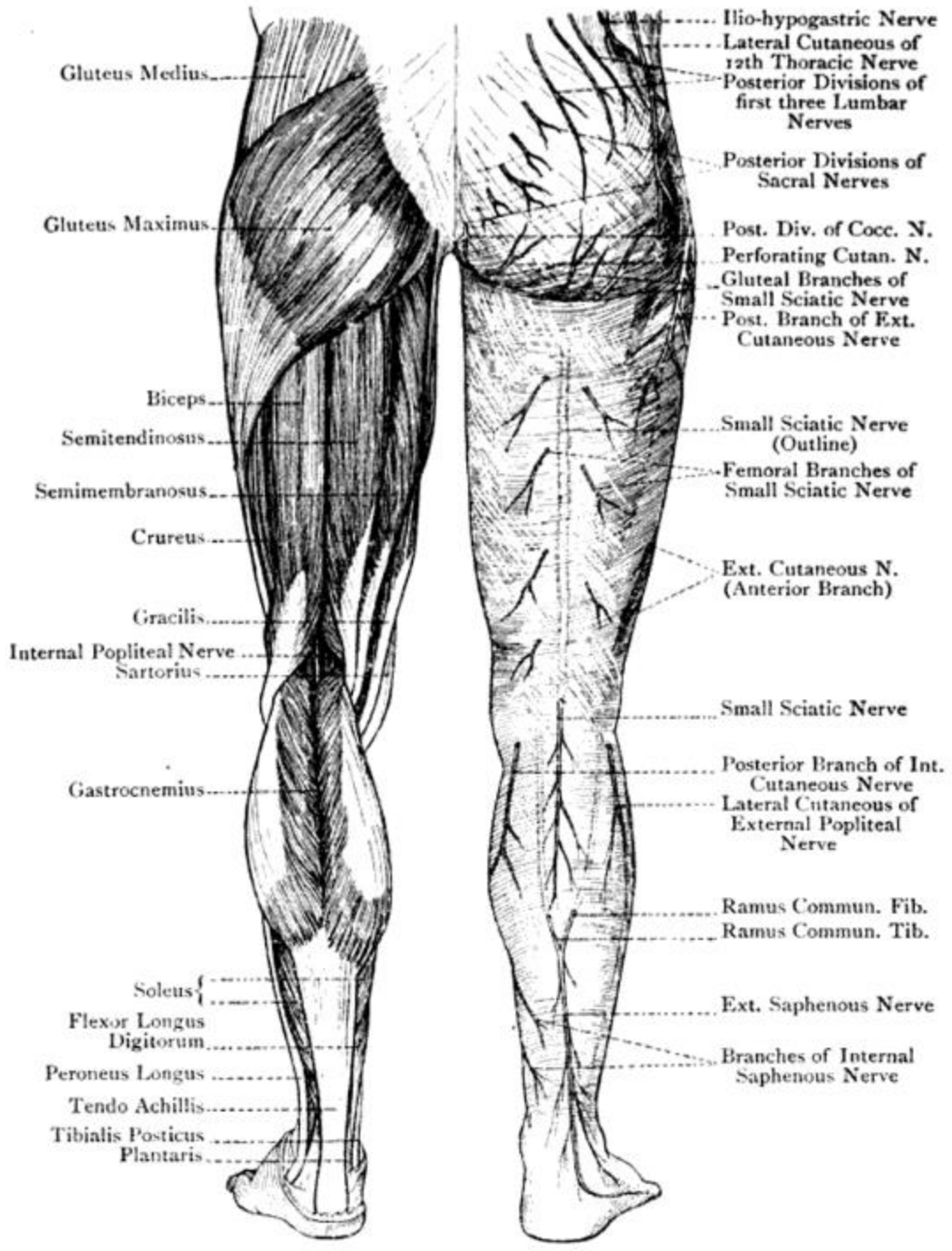


FIG 215.—MUSCLES AND CUTANEOUS NERVES OF THE LOWER LIMB (POSTERIOR ASPECT).

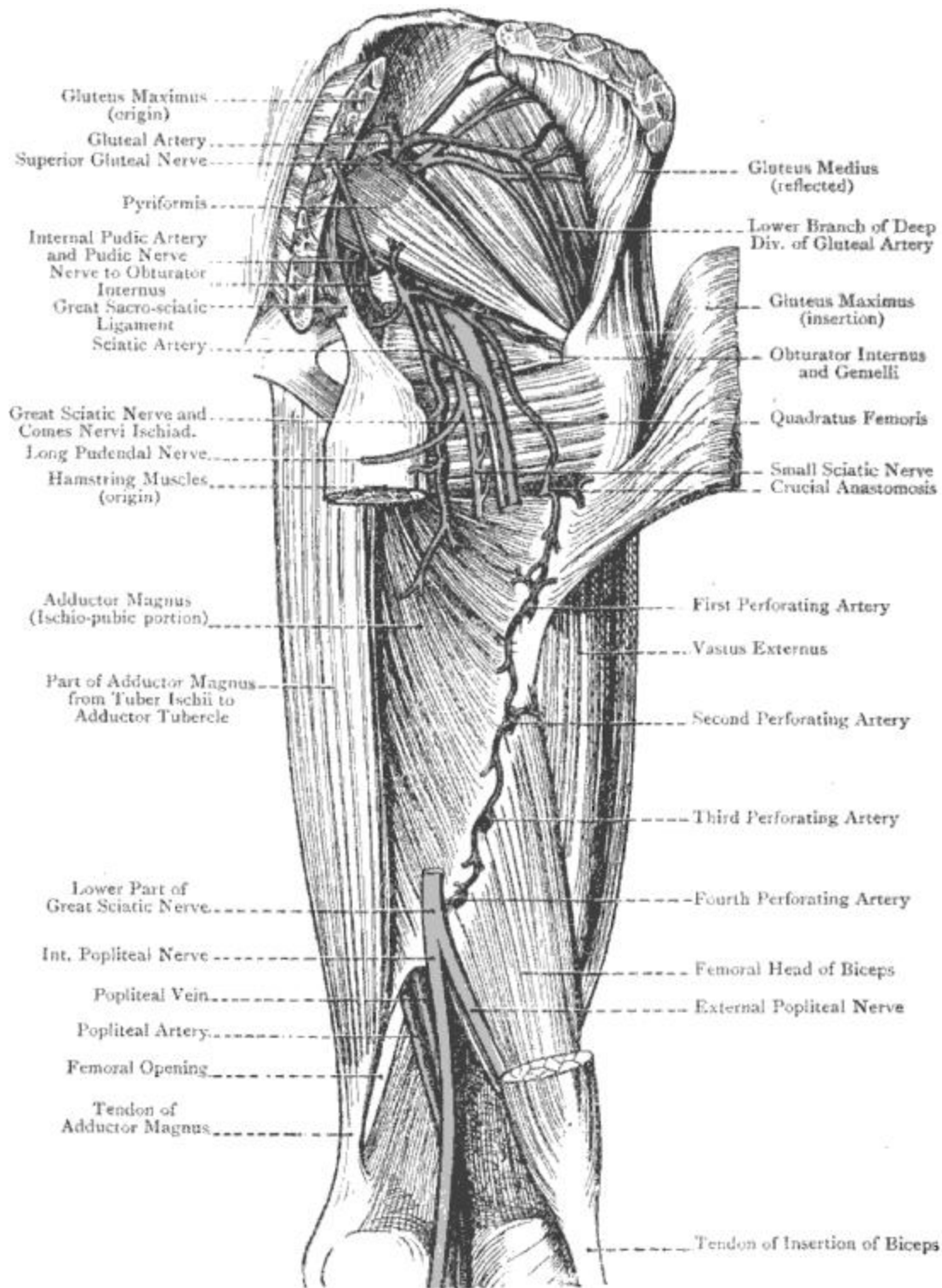


FIG. 216.—THE GLUTEAL REGION AND BACK OF THE THIGH (DEEP DISSECTION).

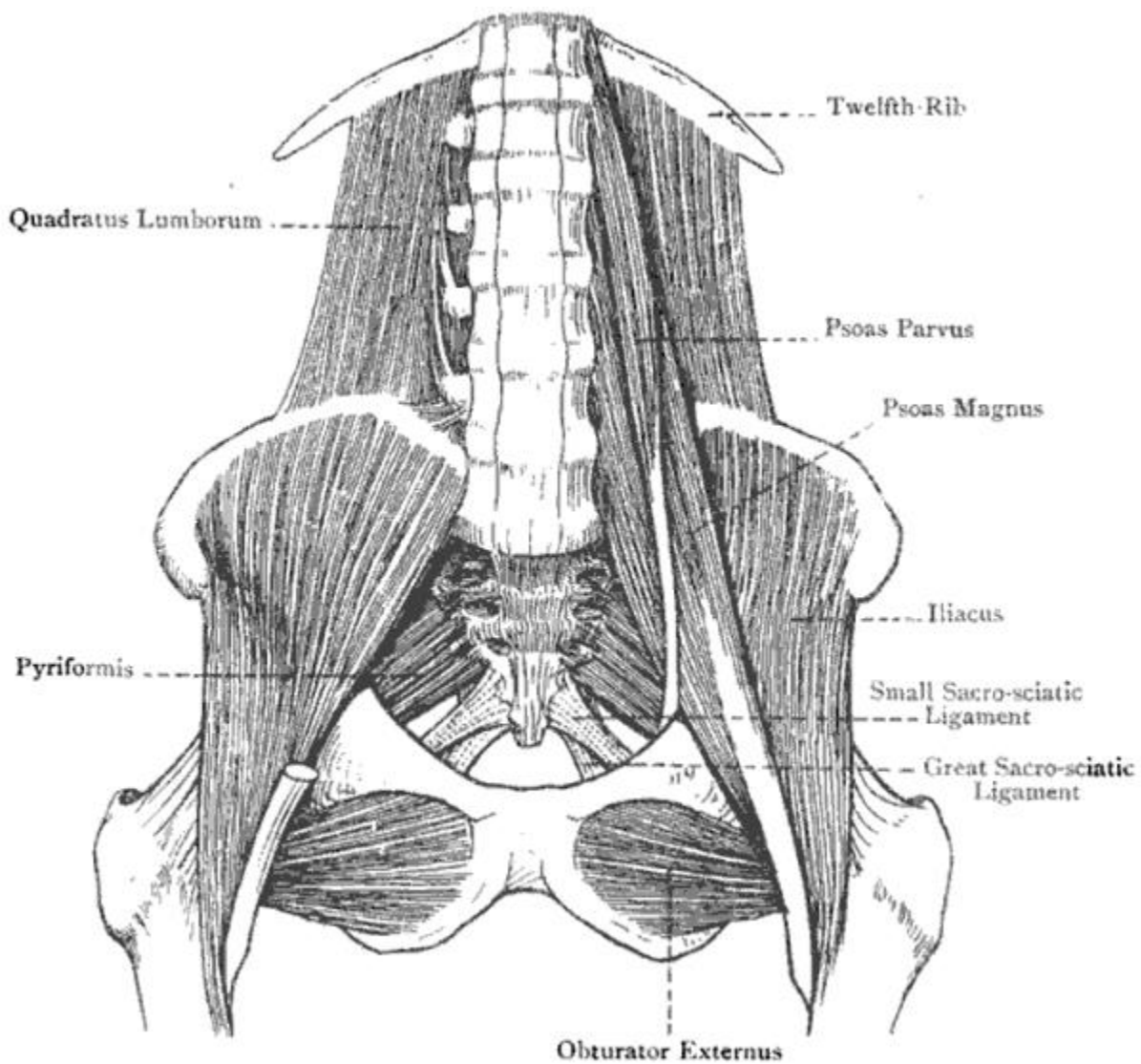


FIG. 223.—THE PSOAS, ILIACUS, AND QUADRATUS LUMBORUM MUSCLES.

pg 439

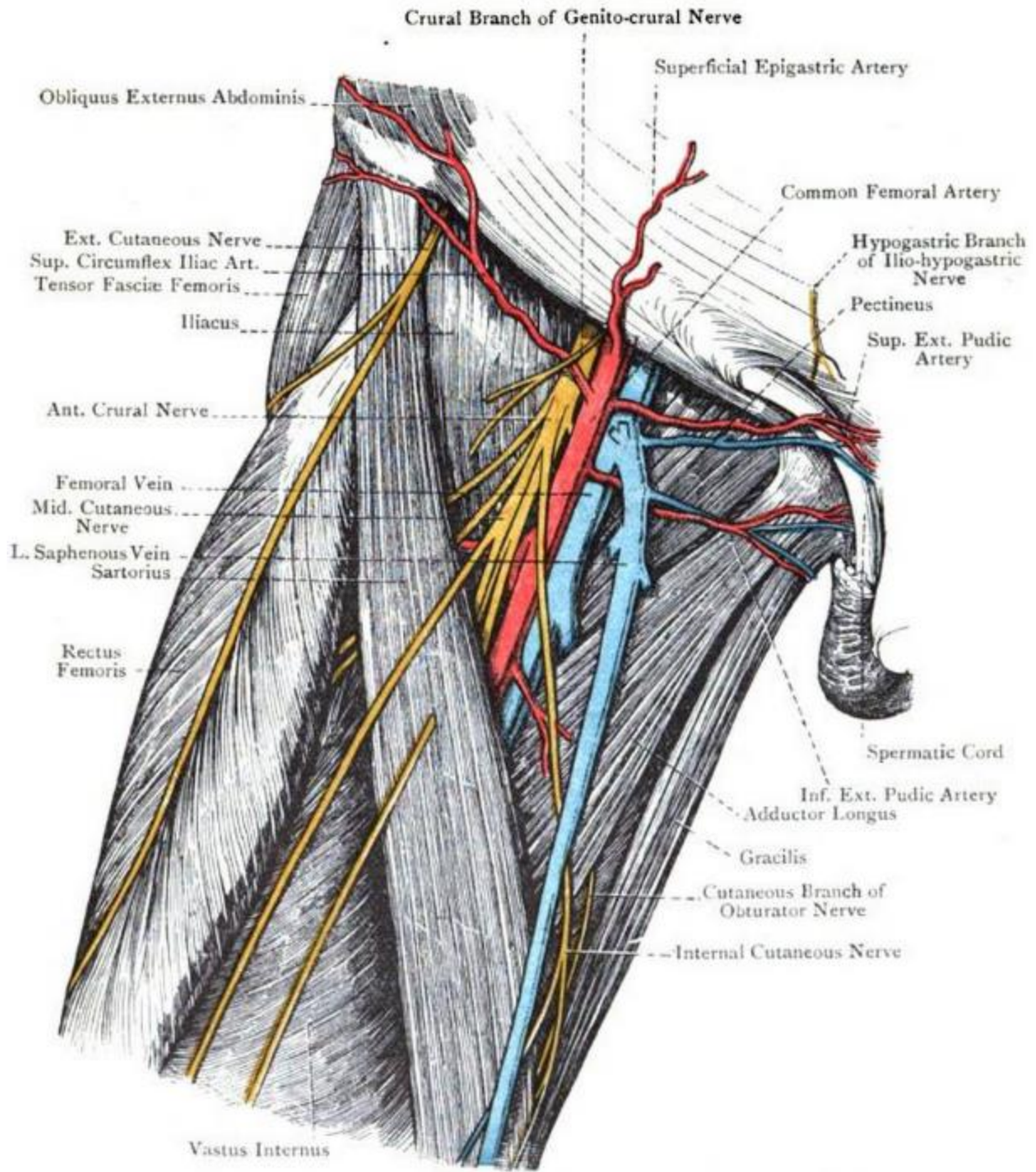


FIG. 227.—THE FRONT OF THE THIGH (SCARPA'S TRIANGLE).

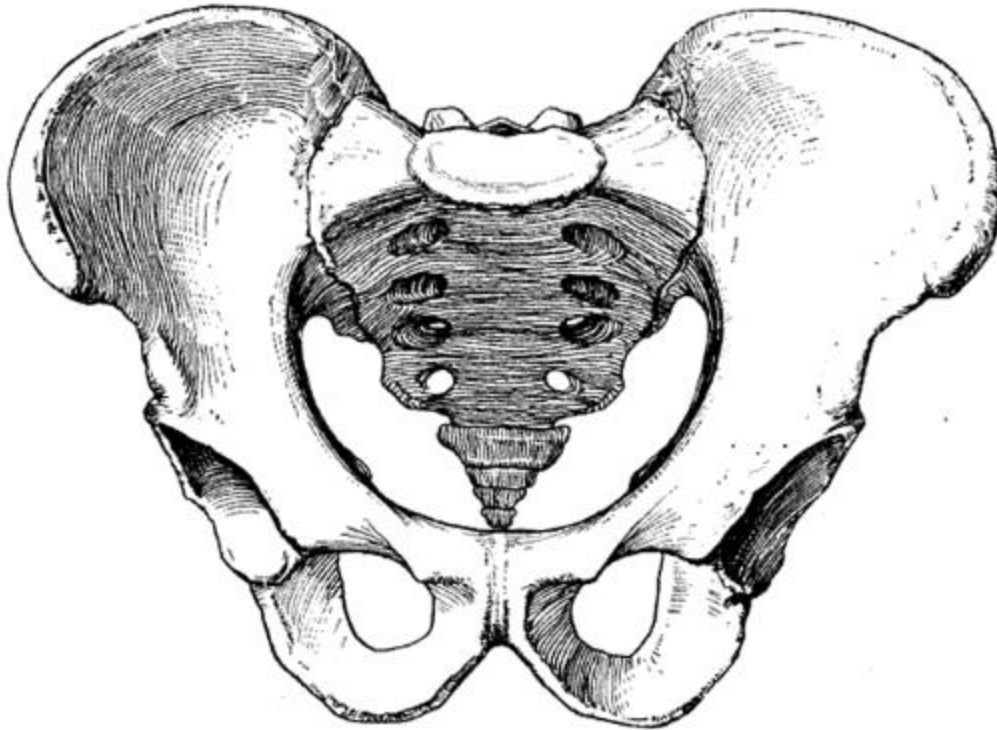


FIG. 131.—THE MALE PELVIS.

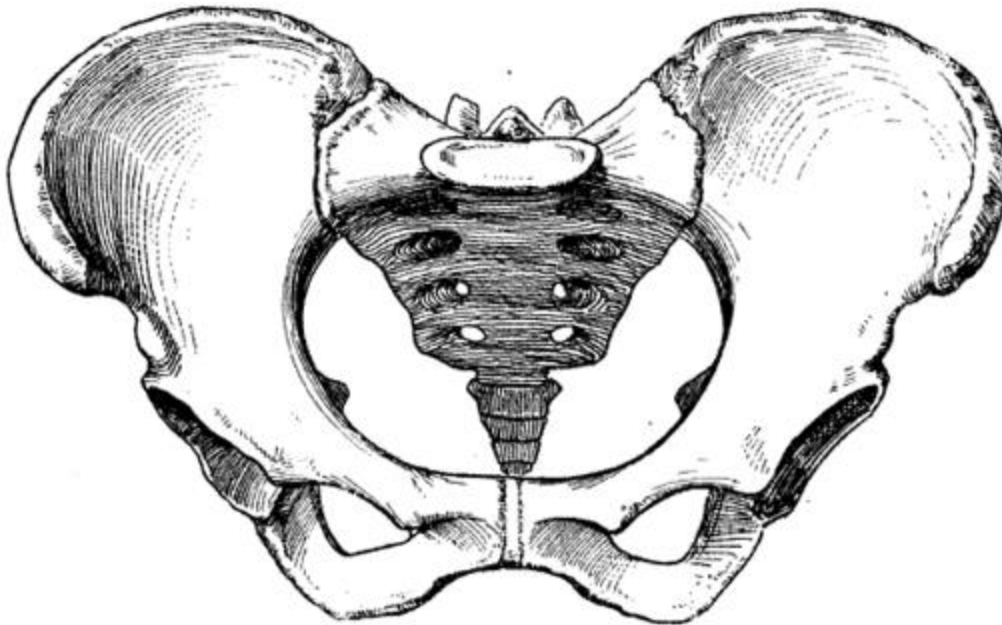


FIG. 132.—THE FEMALE PELVIS.

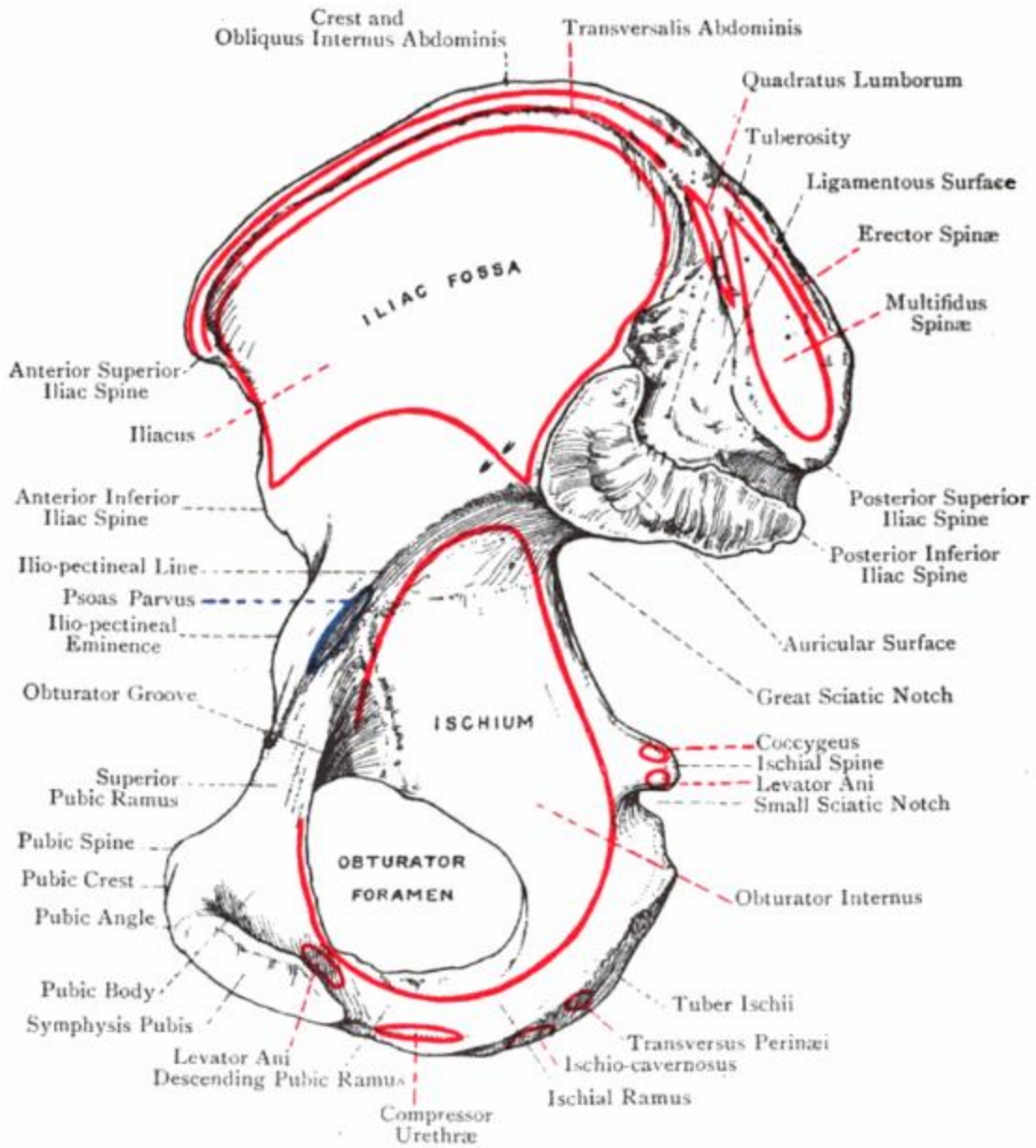


FIG. 128.—THE RIGHT OS INNOMINATUM (INTERNAL VIEW).

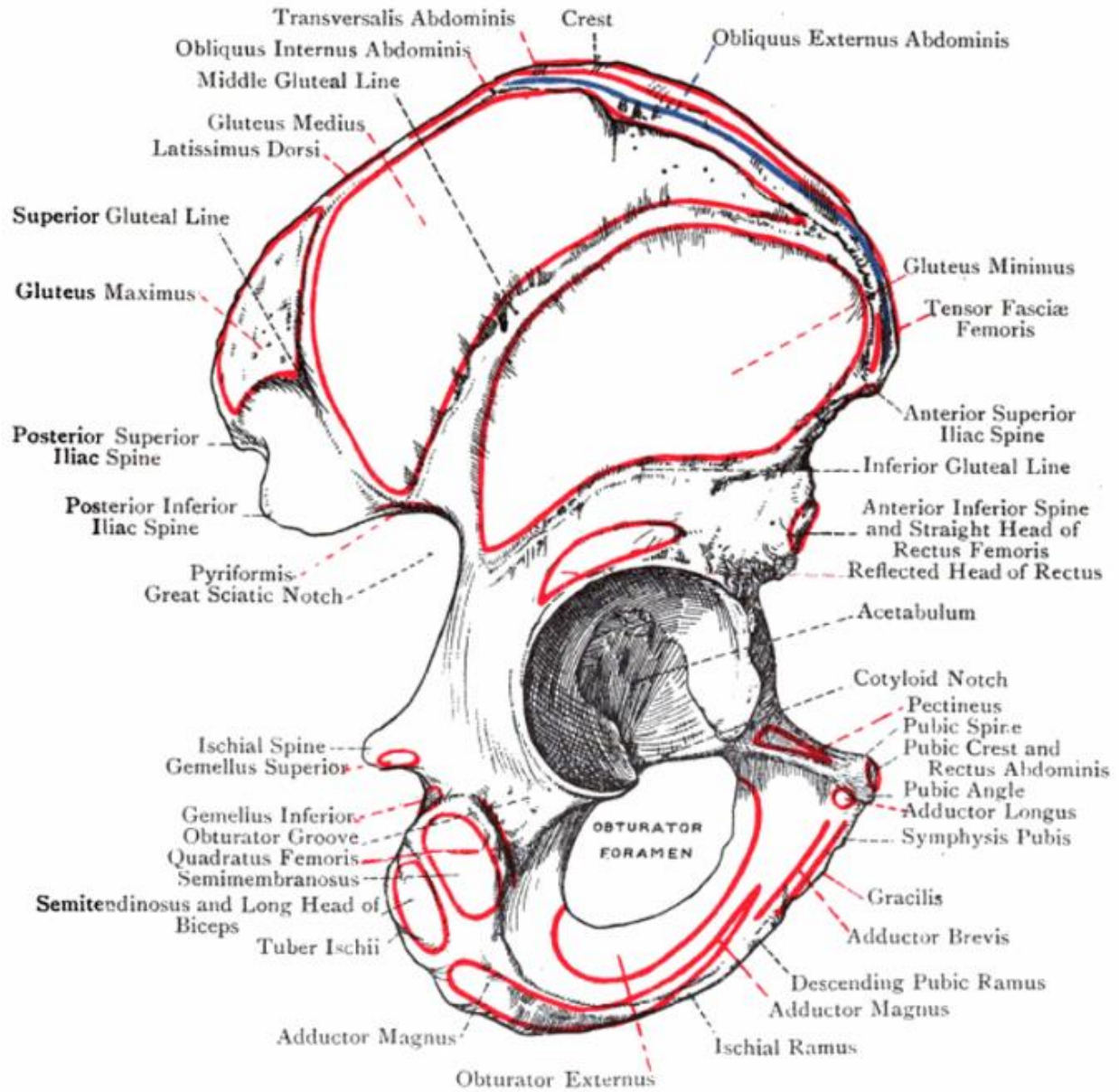


FIG. 127.—THE RIGHT OS INNOMINATUM (EXTERNAL VIEW).

Gray's Anatomy

Often called “Gray’s Anatomy,” the famous work from 1858 entitled *Anatomy: Descriptive and Surgical* by Henry Gray and H.V. Carter needs little introduction for most. Below are selected excerpts of text and illustrations covering spinal and pelvic anatomy.

The *Atlas* (fig. 10) is developed by *three* centres. One (sometimes two) for the anterior arch, and one for each lateral mass. The ossific centres for each lateral mass commence before birth. At birth, the anterior arch is altogether cartilaginous, and the two lateral pieces are separated from one another behind. The nucleus for the anterior arch appears in the first year, between the second and third years the two lateral pieces unite, and join the anterior part at the age of five or six years. There is frequently a separate epiphysis for the rudimentary spine.

The *Axis* (fig. 11) is developed by *five* centres; three for its anterior part, and two for the posterior. The three anterior centres are, one for the lower part of the body, and two for the odontoid process and upper part of the body; the two posterior ones are, one for each lamella. At about the sixth month of foetal life, those for the body and odontoid process make their appearance, the two for the odontoid process joining before birth. At birth the bone consists of four pieces, two anterior and two lateral. At the fourth year the body and odontoid process are completely joined.

The Seventh Cervical. The anterior or costal part of the transverse process of the seventh cervical, is developed from a separate osseous centre at about the sixth month of foetal life, and joins the body and posterior division of the transverse process between the fifth and sixth years. Sometimes this process continues as a separate piece, and becoming lengthened outwards, constitutes what is known as a cervical rib.

The Lumbar Vertebrae (fig. 12) have *two additional centres* (besides those peculiar to the vertebrae generally), for the tubercles, which project from the back part of the superior articular processes. The transverse process of the first lumbar is sometimes developed as a separate piece, which may remain permanently unconnected with the remaining portion of the bone; thus forming a lumbar rib, a peculiarity which is sometimes, though rarely, met with.

PROGRESS OF OSSIFICATION IN THE SPINE GENERALLY. Ossification of the laminae of the vertebrae commences at the upper part of the spine, and proceeds gradually downwards; hence the frequent occurrence of spina bifida in the lower part of the spinal column. Ossification of the bodies, on the other hand, commences a little below the centre of the spinal column, and extends both upwards and downwards. Although, however, the ossific nuclei make their first appearance in the lower dorsal vertebrae (about the ninth), the lumbar and first sacral are those in which these nuclei are largest at birth.

THE FALSE VERTEBRÆ.

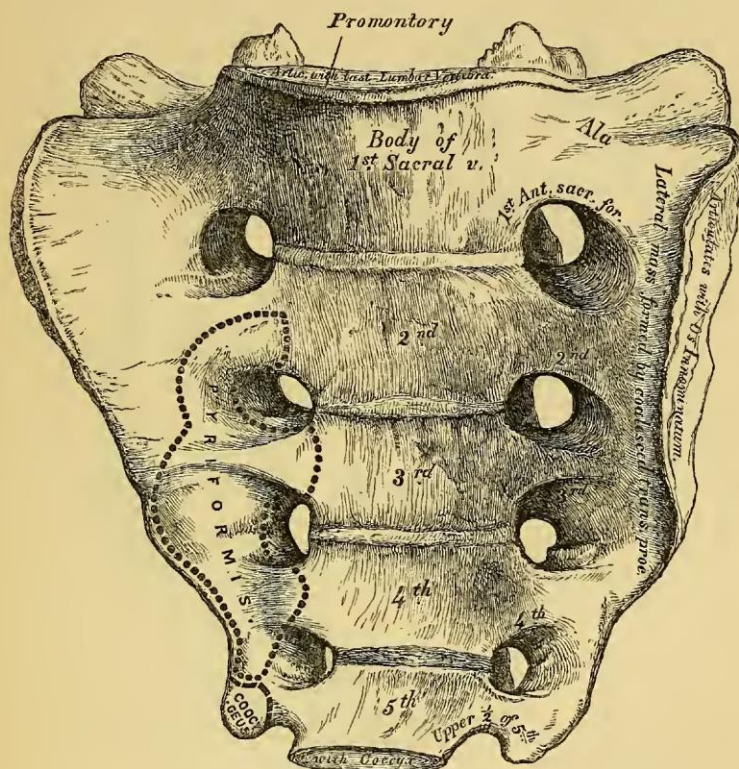
The False Vertebrae consist of nine pieces, which are united so as to form two bones, five entering into the formation of the sacrum, four the coccyx.

THE SACRUM (fig. 13) is a large triangular bone, situated at the lower part of the vertebral column, and at the upper and back part of the pelvic cavity, where it is inserted like a wedge between the two ossa innominata; its upper part, or base, articulating with the last lumbar vertebra, its apex with the coccyx. The sacrum is curved upon itself, and placed very obliquely, its upper extremity projecting forwards, forming, with the last lumbar vertebra, a very prominent angle, called the *promontory* or *sacro-vertebral angle*, whilst its central part is directed backwards, so as to give increased capacity to the pelvic cavity. It presents for examination an anterior and posterior surface, two lateral surfaces, a base, an apex, and a central canal.

The Anterior Surface is deeply concave from above downwards, and slightly so from side to side. In the middle are seen four transverse lines, indicating the original division of the bone into five separate pieces. The portions of bone intervening between the lines correspond to the bodies of the vertebrae; they are slightly concave longitudinally, and diminish in size from above downwards. At the extremities of each of these lines, are seen the *anterior sacral foramina*, analogous to the intervertebral foramina, four in number on each side, somewhat rounded in

form, diminishing in size from above downwards, and directed outwards and forwards; they transmit the anterior branches of the sacral nerves. External to these foramina, is the *lateral mass*, formed by the coalesced *transverse processes*

13.—Sacrum, Anterior Surface.

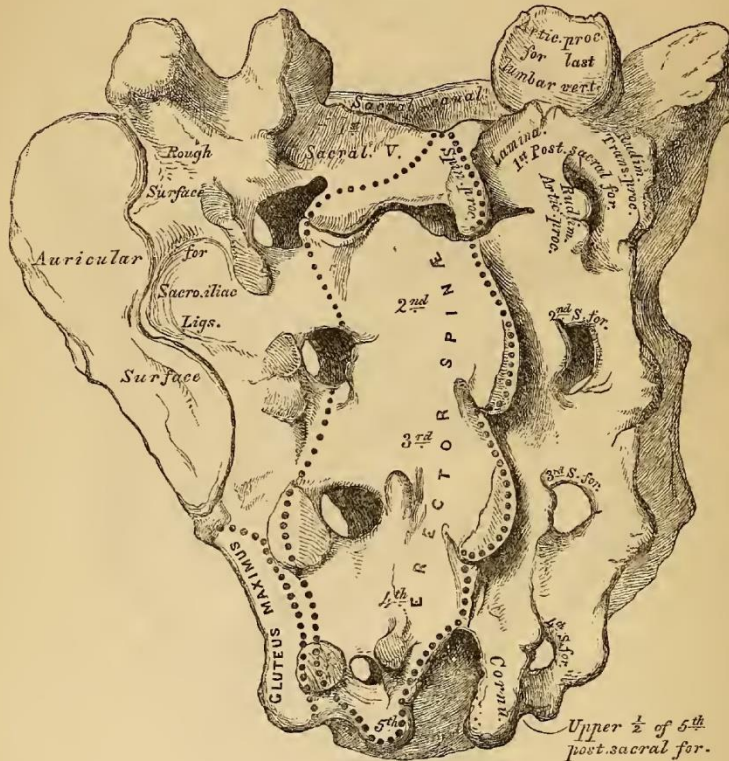


of the sacral vertebrae, traversed by four broad shallow grooves, which lodge the anterior sacral nerves as they pass outwards, the grooves being separated by prominent ridges of bone, which give attachment to the slips of the Piriformis muscle.

The *Posterior Surface* (fig. 14) is convex, and much narrower than the anterior. In the middle line, are three or four tubercles, sometimes connected together, which represent the rudimentary spinous processes. Of these tubercles, the first is usually very prominent, and perfectly separate from the rest; the second, third, and fourth, existing either separate, or united into a ridge, which diminishes in size as it descends; the fifth, and sometimes the fourth, remaining undeveloped, and exposing below, the lower end of the sacral canal. External to the spinous processes on each side, are the *laminae*, broad and well marked in the three first pieces; the lower part of the fourth, and the whole of the fifth, being undeveloped: in this situation the sacral canal is exposed. External to the laminae are a linear series of indistinct tubercles representing the *articular processes*; the upper pair are well developed; the second and third are small; the fourth and fifth (usually blended together) are situated on each side of the sacral canal: they are called the *sacral cornua*, and articulate with the cornua of the coccyx. External to the articular processes are the four *posterior sacral foramina*; they are smaller in size, and less regular in form than the anterior, and transmit the posterior branches of the sacral nerves. On the outer side of the posterior sacral foramina are a series of tubercles, representing the rudimentary *transverse processes*. The first pair of transverse tubercles are very distinct, and correspond with each superior

angle of the bone; the second, small in size, enter into the formation of the sacro-iliac articulation; the third give attachment to the oblique sacro-iliac ligaments;

14.—Sacrum Posterior Surface.



and the fourth and fifth to the great sacro-ischiatric ligaments. The interspace between the spinous and transverse processes of the sacrum, presents a wide shallow concavity, called the *sacral groove*; it is continuous above with the vertebral groove, and lodges the origin of the Erector Spinae.

The *Lateral Surface*, broad above, becomes narrowed into a thin edge below. Its upper half presents in front a broad ear-shaped surface for articulation with the ilium. This is called the *auricular* or *ear-shaped* surface, and in the fresh state is coated with cartilage. It is bounded posteriorly by deep and rough impressions, for the attachment of the sacro-iliac ligaments. The lower half is thin and sharp, and gives attachment to the greater and lesser sacro-ischiatric ligaments; below, it presents a deep notch, which is converted into a foramen by articulation with the transverse process of the upper piece of the coccyx, and transmits the anterior branch of the fifth sacral nerve.

The *Base* of the sacrum, which is broad and expanded, is directed upwards and forwards. In the middle is seen an oval articular surface, which corresponds with the under-surface of the body of the last lumbar vertebra, bounded behind by the large triangular orifice of the sacral canal. This orifice is formed behind by the spinous process and laminae of the first sacral vertebra, whilst projecting from it on each side are the superior articular processes; they are oval, concave, directed backwards and inwards, like the superior articular processes of a lumbar vertebra; in front of each articular process is an intervertebral notch, which forms the lower half of the last intervertebral foramen. Lastly, on each side of the articular surface is a broad and flat triangular surface of bone, called the *ala*

of the sacrum; they extend outwards, and are continuous on each side with the iliac fossæ.

The *Apex*, directed downwards and forwards, presents a small oval concave surface for articulation with the coccyx.

The *Sacral Canal* runs throughout the greater part of the bone; it is large and triangular in form above, small and flattened from before backwards below. In this situation, its posterior wall is incomplete, from the non-development of the laminae and spinous processes. It lodges the sacral nerves, and is perforated by the anterior and posterior sacral foramina, through which these pass out.

Structure. It consists of much loose spongy tissue within, invested externally by a thin layer of compact tissue.

DIFFERENCES IN THE SACRUM OF THE MALE AND FEMALE. The sacrum in the female is usually wider than in the male, and it is much less curved, the upper half of the bone being nearly straight, the lower half presenting the greatest amount of curvature. The bone is also directed more obliquely backwards; which increases the size of the pelvic cavity, and forms a more prominent sacro-vertebral angle. In the male the curvature is more evenly distributed over the whole length of the bone, and is altogether greater than in the female.

PECULIARITIES OF THE SACRUM. This bone, in some cases, consists of six instead of five pieces; occasionally the number is reduced to four. Sometimes the bodies of the first and second vertebræ are not joined, or the laminae and spinous processes have not coalesced with the rest of the bone. Occasionally the superior transverse tubercles are not joined to the rest of the bone on one or both sides; and, lastly, the sacral canal may be open for nearly the lower half of the bone, in consequence of the imperfect development of the laminae and spinous processes. The sacrum also varies considerably with respect to its degree of curvature. From the examination of a large number of skeletons, it would appear, that, in one set of cases, the anterior surface of this bone was nearly straight, the curvature, which was very slight, affecting only its lower end. In another set of cases, the bone was curved throughout its whole length, but especially towards its middle. In a third set, the degree of curvature was less marked, and affected especially the lower third of the bone.

Development of Sacrum (fig. 15). The sacrum, formed by the union of five vertebræ, has *thirty-five* centres of ossification. Each of the three first pieces is developed by seven centres; viz., three for the body, one for its central part, one for each epiphysal lamella on its upper and under surface, and one for each of the laminae: so far the first three sacral vertebræ, as well as the two last, are developed like the other pieces of the vertebral column. One of the characteristic points in the development of this bone, consists in the existence of two additional centres for each of the first three pieces, which appear one on each side, close to the anterior sacral foramina, and correspond to the transverse processes of the lumbar vertebræ.

15.—Development of Sacrum.

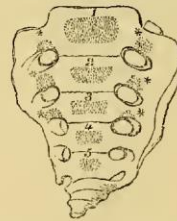
Formed by union of 5 Vertebræ.

2 characteristic points.

1st

2 Additional centres for the first 3 pieces *

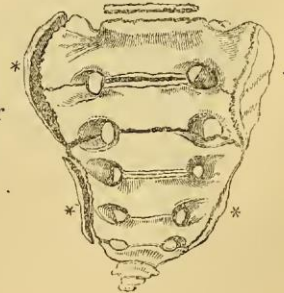
at birth



2nd.

2 Epiphysal laminae for each lateral surface. *

at 25th yr



Each of the two last pieces is developed by five centres: three for the body; viz., one for its central part, and one for each of the epiphysal lamellæ; and one for each of the laminae.

A second characteristic point in the development of this bone consists in each lateral surface of the sacrum being developed by two epiphysal points, one for the auricular surface, and one for the thin lateral border of the bone.

Period of Development. At about the eighth or ninth week of foetal life, ossification of the central part of the bodies of the three first vertebræ commences, and, at a somewhat later period, that of the two last. Between the sixth and eighth months, ossification of the lamellæ takes place; and at about the same period the characteristic osseous tubercles for the three first sacral vertebræ make their appearance. The lateral pieces join to form the arch, and are united to the bodies, first, in the lowest vertebræ. This occurs about the second year, the uppermost segment appearing as a single piece about the fifth or sixth year. About the sixteenth year the epiphysal lamellæ for the bodies are formed; and between the eighteenth and twentieth years those for each lateral surface of the sacrum make their appearance. At about this period, the two last segments are joined to one another; and this process gradually extending upwards, all the pieces become united, and the bone completely formed from the twenty-fifth to the thirtieth year of life.

Articulations. With four bones; the last lumbar vertebra, coccyx, and the two ossa innominata.

Attachment of Muscles. The Pyriformis and Coccygeus on either side, behind the Gluteus maximus and Erector Spinae.

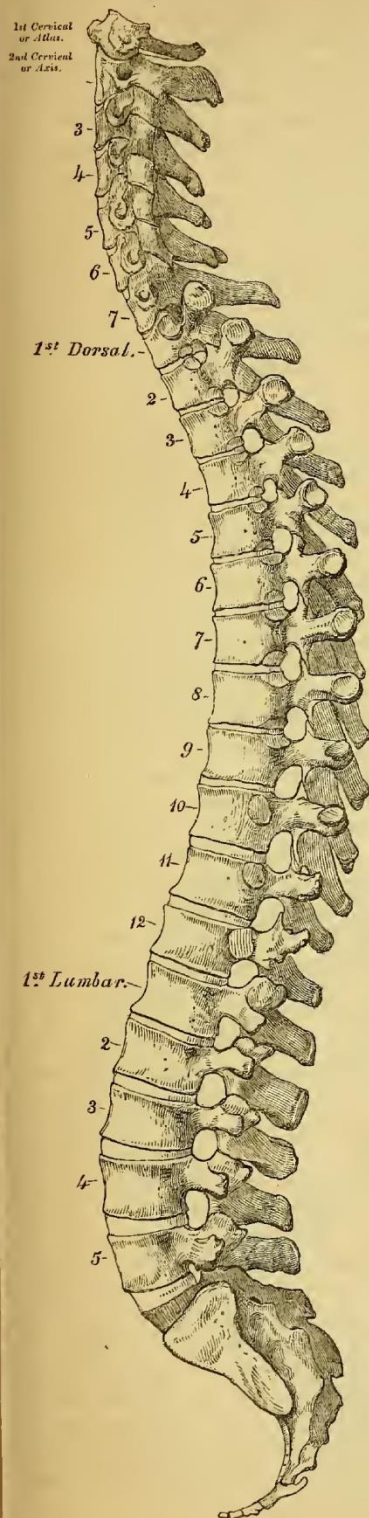
THE COCCYX.

The Coccyx (*κόκκυξ*, cuckoo), so called from resembling a cuckoo's beak, (fig. 16) is formed of four small segments of bone, the most rudimentary parts of the vertebral column. Of these, the first is the largest, and often exists as a

separate piece, the three last diminishing in size from above downwards, are blended together so as to form a single bone. The gradual diminution in the size of the pieces gives this bone a triangular form, articulating by its base with the apex of the sacrum. It presents for examination an anterior and posterior surface, two borders, a base, and an apex. The *anterior surface* is slightly concave, and marked with three transverse grooves, indicating the points of junction of the different pieces. It has attached to it the anterior sacro-coccygeal ligament and levator ani muscle, and supports the lower end of the rectum. The *posterior surface* is convex, marked by grooves similar to those on the anterior surface, and presents on each side a linear row of tubercles, which represent the articular processes of the coccygeal vertebræ. Of these, the superior pair are very large; they are called the *cornua of the coccyx*, and projecting upwards, articulate with the cornua of the sacrum, the junction between these two bones completing the fifth sacral foramen for the transmission of the posterior branch of the fifth sacral nerve. The lateral borders are thin, and present a series of small eminences, which represent the transverse processes of the coccygeal vertebræ. Of these, the first on each side is of large size, flattened from before backwards, and often ascends upwards to join the lower part of the thin lateral edge of the sacrum, thus completing the fifth sacral foramen: the others diminish in size



17.—Lateral View of Spine.



from above downwards, and are often wanting. The borders of the coccyx are narrow, and give attachment on each side to the sacro-sciatic ligaments and Coccygeus muscle. The *base* presents an oval surface for articulation with the sacrum. The *apex* is rounded, and has attached to it the tendon of the external Sphincter ani muscle. It is occasionally bifid, and sometimes deflected to one or other side.

Development. The coccyx is developed by four centres, one for each piece. Occasionally one of the three first pieces of this bone is developed by two centres, placed side by side. The periods when the ossific nuclei make their appearance is the following: in the first segment, at birth; in the second piece, at from five to ten years; in the third, from ten to fifteen years; in the fourth, from fifteen to twenty years. As age advances, these various segments become united in the following order: the two first pieces join, then the third and fourth; and, lastly the bone is completed by the union of the second and third. At a late period of life, especially in females, the coccyx becomes joined to the end of the sacrum.

Articulation. With the sacrum.

Attachment of Muscles. On either side, the Coccygeus; behind, the Gluteus maximus; at its apex, the Sphincter ani; and in front, the Levator ani.

OF THE SPINE IN GENERAL.—The spinal column, formed by the junction of the vertebræ, is situated in the median line, at the posterior part of the trunk: its average length is about two feet two or three inches; the lumbar region contributing seven parts, the dorsal eleven, and the cervical five.

Viewed in front, it presents two pyramids joined together at their bases, the upper one being formed by all the true vertebræ from the second cervical to the last lumbar; the lower one by the false vertebræ, the sacrum, and coccyx. Viewed somewhat more closely, the uppermost pyramid is seen to be formed of three smaller pyramids. Of these the most superior one consists of the six lower cervical vertebræ, its apex being formed by the axis or second cervical, its base by the first dorsal. The second pyramid, which is inverted, is formed by the four upper dorsal vertebræ, the base being at the first dorsal, the smaller end at the fourth. The third pyramid commences at the fourth dorsal, and gradually increases in size to the fifth lumbar.

Viewed laterally (fig. 17), the spinal column presents several curves. In the dorsal region, the seat of the principal curvature, the spine

to the Transversalis and Diaphragm muscles. Of the two borders, the superior is concave, the inferior, convex; they afford attachment to the Intercostal muscles, the upper border of the sixth giving attachment to the Pectoralis major muscle. The contiguous borders also of the sixth, seventh, and eighth, and sometimes the ninth and tenth costal cartilages present smooth oblong surfaces at the points where they articulate. Of the two extremities, the outer one is continuous with the osseous tissue of the rib to which it belongs. The inner extremity of the first is continuous with the sternum; the six next have rounded extremities, which are received into shallow concavities on the lateral margins of the sternum. The inner extremities of the eighth, ninth and tenth costal cartilages are pointed, and lie in contact with the cartilage above. Those of the eleventh and twelfth are free and pointed.

In the male, the first costal cartilage becomes more or less ossified in the adult, and is often connected to the sternum by bone. Ossification of the remaining cartilages also occurs to a variable extent after the middle of life, those of the true ribs being first ossified. In the female, the process of ossification does not take place until old age. The costal cartilages are most elastic in youth, those of the false ribs being more so than the true. In old age they become of a deep yellow colour.

Attachment of Muscles. The Subclavius, Sterno-thyroid, Pectoralis major, Internal oblique, Transversalis, Rectus, Diaphragm, Triangularis sterni, Internal and External intercostals.

THE PELVIS.

The *Pelvis* is composed of four bones. The two *Ossa Innominata*, which bound it in front and at the sides, and the Sacrum and Coccyx, which complete it behind.

THE OS INNOMINATUM.

The *Os Innominatum*, so called from bearing no resemblance to any known object, is a large irregular-shaped bone, which, with its fellow of the opposite side, forms the sides and anterior wall of the pelvic cavity. In young subjects, it consists of three separate parts, which meet and form the large cup-like cavity, situated near the middle of the outer side of the bone; and, although in the adult these have become united, it is usual to describe the bone as divisible into three portions, the ilium, the ischium, and the pubes.

The *ilium* is the superior broad and expanded portion which runs upwards from the upper and back part of the acetabulum, and forms the prominence of the hip.

The *ischium* is the inferior and strongest portion of the bone; it proceeds downwards from the acetabulum, expands into a large tuberosity, and then curving upwards, forms with the descending ramus of the pubes a large aperture, the obturator foramen.

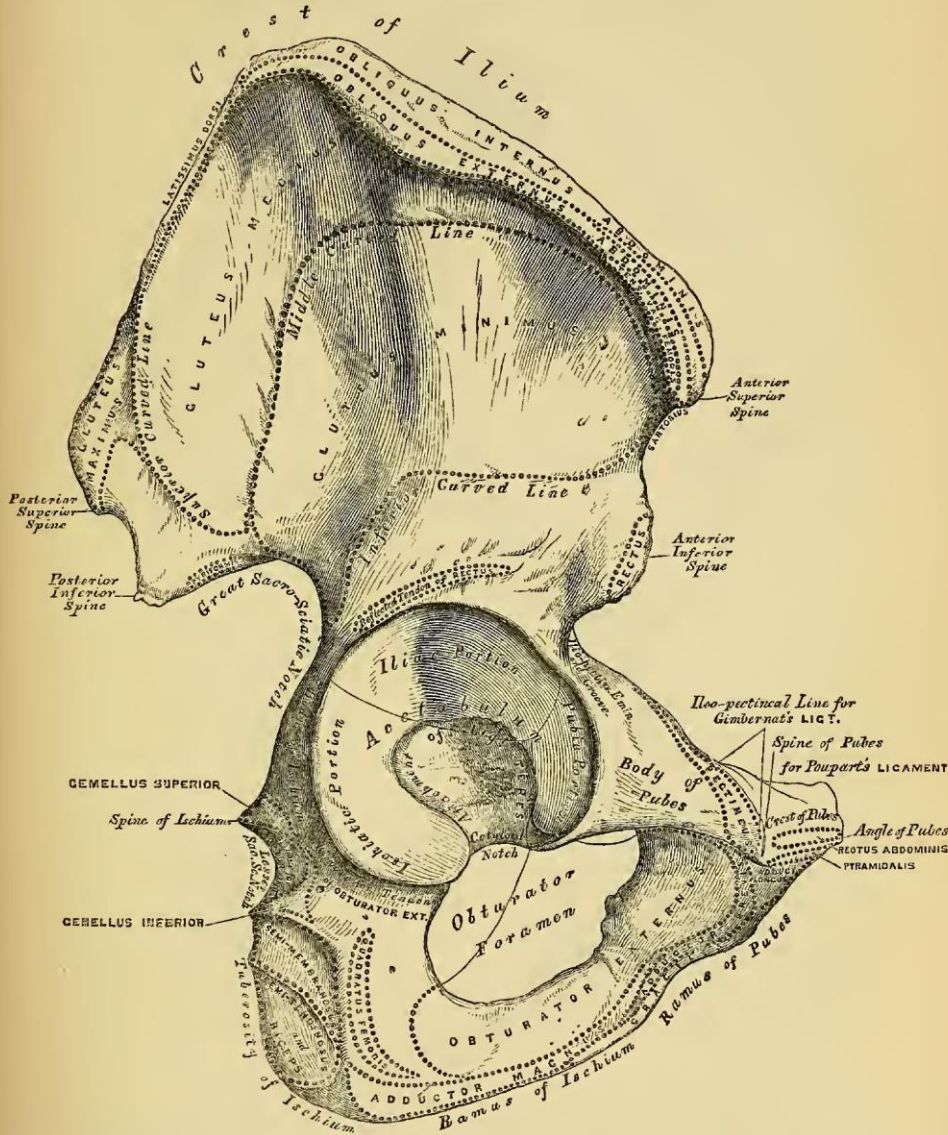
The *pubes* is that portion which runs horizontally inwards from the inner side of the acetabulum for about two inches, then makes a sudden bend, and descends to the same extent: it forms the front of the pelvis, and supports the external organs of generation.

The *Ilium* presents for examination two surfaces, an external and an internal, a crest, and two borders, an anterior and a posterior.

External Surface or Dorsum of the Ilium (fig. 69). The back part of this surface is directed backwards, downwards, and outwards; its front part forwards, downwards and outwards. It is smooth, convex in front, deeply concave behind; bounded above by the crest, below by the upper border of the acetabulum, in front and behind by the anterior and posterior borders. This surface is crossed in an arched direction by three semicircular lines, the superior, middle, and inferior curved lines. The superior curved line, the shortest of the three, commences at the crest, about two inches in front of its posterior extremity; it is at first distinctly marked, but as it passes downwards and outwards to the back part of the great sacro-sciatic notch, where it terminates, it becomes less marked, and is often altogether lost. The rough surface

included between this line and the crest, affords attachment to part of the Gluteus maximus above, a few fibres of the Piriformis below. The middle curved line, the longest of the three, commences at the crest, about an inch behind its

69.—Right Os Innominatum. External Surface.

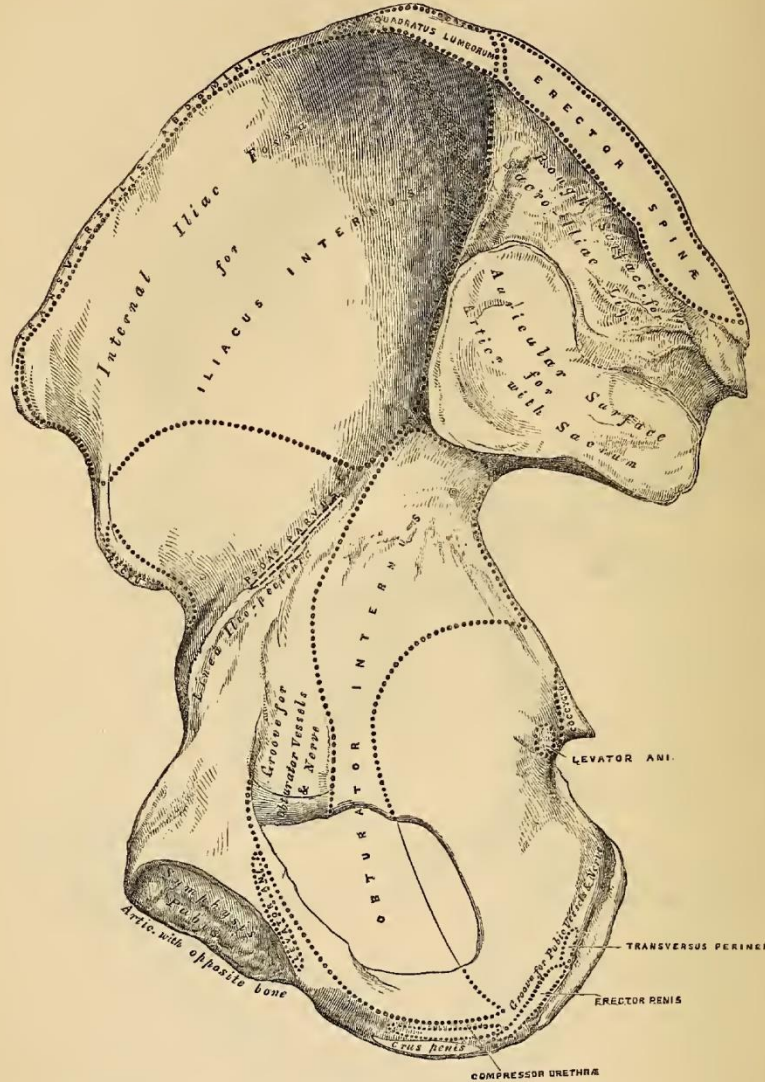


anterior extremity, and, taking a curved direction downwards and backwards, terminates at the upper part of the great sacro-sciatic notch. The space between the middle, the superior curved lines, and the crest, is concave, and affords attachment to the Gluteus medius muscle. Near the central part of this line may often be observed the orifice of a nutritious foramen. The inferior curved line, the least distinct of the three, commences in front at the upper part of the anterior inferior spinous process, and taking a curved direction backwards and downwards, terminates at the anterior part of the great sacro-sciatic notch. The surface of bone included between the middle and inferior curved lines, is concave from above downwards, convex from before backwards, and affords attachment to

the Gluteus minimus muscle. Beneath the inferior curved line, and corresponding to the upper part of the acetabulum, is a smooth eminence (sometimes a depression), to which is attached the reflected tendon of the Rectus femoris muscle.

The *Internal Surface* (fig. 70) of the ilium is bounded above by the crest,

70.—Right Os Innominatum. Internal Surface.



below by a prominent line, the linea-ileo pectinea, and before and behind by the anterior and posterior borders. It presents anteriorly a large smooth concave surface called the *internal iliac fossa*, or *venter of the ilium*; it lodges the Iliac muscle, and presents at its lower part, the orifice of a nutritious canal. Behind the iliac fossa is a rough surface, divided into two portions, a superior and an inferior. The inferior, or auricular portion, so called from its resemblance to the external ear, is coated with cartilage in the recent state, and articulates with a similar shaped surface on the side of the sacrum. The superior portion is concave and rough for the attachment of the posterior sacro-iliac ligaments.

The crest of the ilium is convex in its general outline and sinuously curved, being bent inwards anteriorly, outwards posteriorly. It is longer in the female

than in the male, very thick behind, and thinner at the centre than at the extremities. It terminates at either end in a prominent eminence, the anterior superior, and posterior superior spinous process. The surface of the crest is broad, and divided into an external lip, an internal lip, and an intermediate space. To the external lip is attached the Tensor vaginae femoris, Obliquus externus abdominis, and Latissimus dorsi, and by its whole length the fascia lata; to the interspace between the lips, the Internal oblique; to the internal lip, the Transversalis, Quadratus lumborum, and Erector spinae.

The anterior border of the ilium is concave. It presents two projections separated by a notch. Of these, the uppermost, formed by the junction of the crest and anterior border, is called the anterior superior spinous process of the ilium, the outer border of which gives attachment to the fascia lata, and the origin of the Tensor vaginae femoris, its inner border, to the Iliacus internus, whilst its extremity affords attachment to Poupart's ligament and the origin of the Sartorius. Beneath this eminence, is a notch which gives attachment to the Sartorius muscle, and across which passes the external cutaneous nerve. Below the notch is the anterior inferior spinous process, which terminates in the upper lip of the acetabulum; it gives attachment to the straight tendon of the Rectus femoris muscle. On the inner side of the anterior inferior spinous process, is a broad shallow groove, over which passes the Iliacus muscle. The posterior border, shorter than the anterior, also presents two projections separated by a notch, the posterior superior, and the posterior inferior spinous processes. The former corresponds with that portion of the posterior surface of the ilium, which serves for the attachment of the sacro-iliac ligaments, the latter, to the auricular portion which articulates with the sacrum. Below the posterior inferior spinous process, is a deep notch, the great sacro-sciatic.

The *Ischium* forms the inferior and posterior part of the os innominatum. It is divisible into a thick and solid portion, the body, and a thin ascending part, the ramus. The body, somewhat triangular in form, presents three surfaces, an external, internal, and posterior, and three borders. The external surface corresponds to that portion of the acetabulum formed by the ischium; it is smooth and concave above, and forms a little more than two-fifths of that cavity; its outer margin is bounded by a prominent rim or lip, to which the cotyloid-fibrocartilage is attached. Below the acetabulum, between it and the tuberosity, is a deep groove, along which the tendon of the Obturator externus muscle runs, as it passes outwards to be inserted into the digital fossa of the femur. The internal surface is smooth, concave, and forms the lateral boundary of the true pelvic cavity; it is broad above, and separated from the venter of the ilium by the linea ileo-pectinea, narrow below, its posterior border being encroached upon a little below its centre, by the spine of the ischium, above and below which are the greater and lesser sacro-sciatic notches; in front it presents a sharp margin, which forms the outer boundary of the obturator foramen. This surface is perforated by two or three large vascular foramina, and affords attachment to part of the Obturator internus muscle.

The *posterior surface* is quadrilateral in form, broad and smooth above, narrow below where it becomes continuous with the tuberosity; it is limited in front by the margin of the acetabulum, behind by the front part of the great sacro-sciatic notch. This surface supports the Piriformis, the two Gemelli, and the Obturator internus muscles, in their passage outwards to the great trochanter. The body of the ischium presents three borders, posterior, inferior, and internal. The posterior border presents, a little below the centre, a thin and pointed triangular eminence, the spine of the ischium, more or less elongated in different subjects. Its external surface gives attachment to the Gemellus superior, its internal surface to the Coccygeus and Levator ani, whilst to the pointed extremity is connected the lesser sacro-sciatic ligament. Above the spine is a notch of large size, the great sacro-sciatic, converted into a foramen by the lesser sacro-sciatic ligament; it transmits the Piriformis muscle, the gluteal vessels and nerve

passing out above this muscle, the sciatic, and internal pudic vessels and nerve, and a small nerve to the Obturator internus muscle below it. Below the spine is a smaller notch, the lesser sacro-sciatic; it is smooth, coated with cartilage in the recent state, the surface of which presents numerous markings corresponding to the subdivisions of the tendon of the Obturator internus which winds over it. It is converted into a foramen by the sacro-sciatic ligaments, and transmits the tendon of the Obturator internus, the nerve which supplies this muscle, and the pudic vessels and nerve. The inferior border is thick and broad: at its point of junction with the posterior, is a large rough eminence upon which the body rests in sitting; it is called the tuberosity of the ischium. The internal border is thin, and forms the outer circumference of the obturator foramen.

The *tuberosity*, situated at the junction of the posterior and inferior borders, presents for examination an external lip, an internal lip, and an intermediate space. The external lip gives attachment to the Quadratus femoris and part of the Adductor magnus muscles. The inner lip is bounded by a sharp ridge for the attachment of a falciform prolongation of the great sacro-sciatic ligament, presents a groove on the inner side of this for the lodgment of the internal pudic vessels and nerve, and more anteriorly has attached the Transversus perinei, Erector penis, and Compressor urethræ muscles. The intermediate surface presents four distinct impressions. Two of these seen at the front part of the tuberosity are rough, elongated, and separated from each other by a prominent ridge; the outer one gives attachment to the Adductor magnus, the inner one to the great sacro-sciatic ligament. Two situated at the back part are smooth, larger in size and separated by an oblique ridge: from the upper and outer arises the Semi-membranosus; from the lower and inner, the Biceps and Semi-tendinosus. The most superior part of the tuberosity gives attachment to the Gemellus inferior.

The *ramus* is the thin flattened part of the ischium, which ascends from the tuberosity upwards and inwards, and joins the ramus of the pubes, their point of junction being indicated in the adult by a rough eminence. Its outer surface is rough for the attachment of the Obturator externus muscle. Its inner surface forms part of the anterior wall of the pelvis. Its inner border is thick, rough, slightly everted, forms part of the outlet of the pelvis, and serves for the attachment of the crus-penis. Its outer border is thin and sharp, and forms part of the inner margin of the obturator foramen.

The *Pubes* forms the anterior part of the os innominatum; it is divisible into a horizontal ramus or body, and a perpendicular ramus.

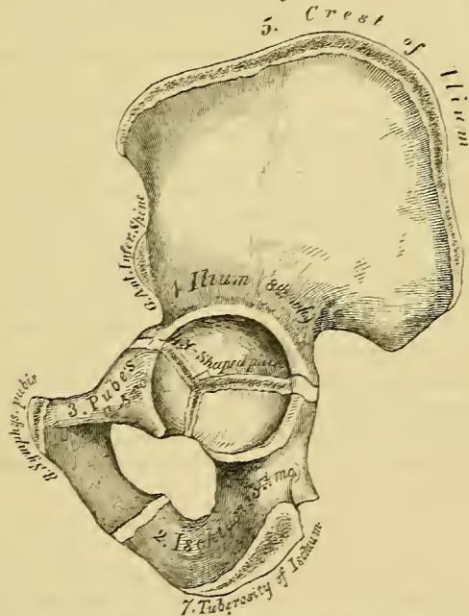
The *body*, or horizontal ramus, presents for examination two extremities, an outer and an inner, and four surfaces. The *outer extremity*, the thickest part of the bone, forms one-fifth of the cavity of the acetabulum: it presents above, a rough eminence, the ilio-pectineal, which serves to indicate the point of junction of the ilium and pubes. The *inner extremity* of the body of the bone is the symphysis; it is oval, covered by eight or nine transverse ridges, or a series of nipple-like processes arranged in rows, separated by grooves; they serve for the attachment of the interarticular fibro-cartilage, placed between it and the opposite bone. Its *upper surface*, triangular in form, wider externally than internally, is bounded behind by a sharp ridge, the pectineal line, or linea-ilio-pectinea, which, running outwards, marks the brim of the true pelvis. The surface of bone in front of the pubic portion of the linea-ilio-pectinea, serves for the attachment of the Pectineus muscle. This ridge terminates internally at a tubercle, which projects forwards, and is called the *spine* of the pubes. The portion of bone included between the spine and inner extremity of the pubes is called the *crest*; it serves for the attachment of the Rectus, Pyramidalis, and conjoined tendon of the Internal oblique and Transversalis. The point of junction of the crest with the symphysis is called the *angle of the pubes*. The *inferior surface* presents externally a broad and deep oblique groove, for the passage of the obturator vessels and nerve; and internally a sharp margin,

which forms part of the circumference of the obturator foramen. Its *external surface* is flat and compressed, and serves for the attachment of muscles. Its *internal surface*, convex from above downwards, concave from side to side, is smooth, and forms part of the anterior wall of the pelvis. The descending ramus of the pubes passes outwards and downwards, becoming thinner and narrower as it descends, and joins with the ramus of the ischium. Its *external surface* is rough, for the attachment of muscles. Its *inner surface* is smooth. Its *inner border* is thick, rough, and everted, especially in females. In the male it serves for the attachment of the crus penis. Its *outer border* forms part of the circumference of the obturator foramen.

The *cotyloid cavity* or *acetabulum*, is a deep cup-shaped hemispherical depression; formed internally by the pubes, above by the ilium, behind and below by the ischium, a little less than two-fifths being formed by the ilium, a little more than two-fifths by the ischium, and the remaining fifth by the pubes. It is bounded by a prominent uneven rim, which is thick and strong above, and serves for the attachment of a fibro-cartilaginous structure, which contracts its orifice and deepens the surface for articulation. It presents on its inner side a deep notch, the cotyloid notch, which transmits the nutrient vessels into the interior of the joint, and is continuous with a deep circular depression at the bottom of the cavity: this depression is perforated by numerous apertures, lodges a mass of fat, and its margins serve for the attachment of the ligamentum teres. The notch is converted, in the natural state, into a foramen by a dense ligamentous band

71.—Plan of the Development of the Os Innominatum.

By 8 Centres } 3 Primary (Ilium, Ischium, & Pubes)
5 Secondary



The 3 Primary centres unite through Y Shaped piece, about puberty
Epiphyses appear about puberty, & unite about 25th year

which passes across it. Through this foramen the nutrient vessels and nerves enter the joint.

The *obturator* or *thyroid foramen* is a large aperture, situated between the ischium and pubes. In the male it is large, of an oval form, its longest diameter being obliquely from above downwards; in the female smaller, and more triangu-

lar. It is bounded by a thin uneven margin, to which a strong membrane is attached; and presents at its upper and outer part a deep groove, which runs from the pelvis obliquely forwards, inwards, and downwards. It is converted into a foramen by the obturator membrane, and transmits the obturator vessels and nerve.

Structure. This bone consists of much cancellous tissue, especially where it is thick, enclosed between two layers of thick and dense compact tissue. In the thinner parts of the bone, as at the bottom of the acetabulum, and centre of the iliac fossa, it is usually semi-transparent, and composed entirely of compact tissue.

Development (fig. 71). By *eight* centres: three primary—one for the ilium, one for the ischium, and one for the pubes; and *five* secondary—one for the crest of the ilium its whole length, one for the anterior inferior spinous process (said to occur more frequently in the male than the female), one for the tuberosity of the ischium, one for the symphysis pubis (more frequent in the female than the male), and one for the Y-shaped piece at the bottom of the acetabulum. These various centres appear in the following order: First, in the ilium, at the lower part of the bone, immediately above the sciatic notch, at about the same period that the development of the vertebræ commences. Secondly, in the body of the ischium, at about the third month of foetal life. Thirdly, in the body of the pubes, between the fourth and fifth months. At birth, these centres are quite separate; the crest, the bottom of the acetabulum, and the rami of the ischium and pubes, being still cartilaginous. At about the sixth year, the rami of the pubes and ischium are almost completely ossified. About the thirteenth or fourteenth year, the three divisions of the bone have extended their growth into the bottom of the acetabulum, being separated from each other by a Y-shaped portion of cartilage, which now presents traces of ossification. The ilium and ischium then become joined, and lastly the pubes, through the intervention of the portion above mentioned. At about the age of puberty, ossific matter appears in each of the remaining portions, and they become joined to the rest of the bone about the twenty-fifth year.

Articulations. With its fellow of the opposite side, the sacrum and femur.

Attachment of Muscles. Ilium. To the outer lip of the crest, the Tensor vaginæ femoris, Obliquus externus abdominis, and Latissimus dorsi; to the internal lip, the Transversalis, Quadratus lumborum, and Erector spinæ; to the interspace between the lips, the Obliquus internus. To the outer surface of the ilium, the Gluteus maximus, Gluteus medius, Gluteus minimus, reflected tendon of Rectus, portion of Pyliformis; to the internal surface, the Iliacus; to the anterior border, the Sartorius and straight tendon of the Rectus. To the ischium. Its outer surface, the Obturator externus; internal surface, Obturator internus and Levator ani. To the spine. The Gemellus superior, Levator ani, and Coccygeus. To the tuberosity, the Biceps, Semi-tendinosus, Semi-membranosus, Quadratus femoris, Adductor magnus, Gemellus inferior, Transversus perinæi, Erector penis. To the pubis, the Obliquus externus, Obliquus internus, Transversalis, Rectus, Pyramidalis, Psoas parvus, Pectineus, Adductor longus, Adductor brevis, Gracilis, Obturator externus and internus, Levator ani, Compressor urethræ, and occasionally a few fibres of the Accelerator urinæ.

THE PELVIS.

The pelvis is stronger and more massively constructed than either of the other osseous cavities already considered; it is connected to the lower end of the spine, which it supports, and transmits its weight to the lower extremities, upon which it rests. It is composed of four bones—the two ossa innominata, which bound it on either side and in front; and the sacrum and coccyx, which complete it behind.

The pelvis is divided by a prominent line, the linea ileo pectinea, into a false and true pelvis.

The *false pelvis* is all that expanded portion of the pelvic cavity which is situated above the linea ileo pectinea. It is bounded on each side by the ossa ilii;

in front it is incomplete, presenting a wide interval between the anterior superior spinous processes of the ilia on either side, filled up in the recent state by the parietes of the abdomen; behind, in the middle line, is a deep notch. This broad shallow cavity is admirably adapted to support the intestines, and to transmit part of their weight to the anterior wall of the abdomen.

The *true pelvis* is all that part of the pelvic cavity which is situated beneath the linea ileo pectinea. It is smaller than the false pelvis, but its walls are more perfect. For convenience of description, it may be divided into a superior circumference or inlet, an inferior circumference or outlet, and a cavity.

The *superior circumference* forms the margin or brim of the pelvis, the included space being called the *inlet*. It is formed by the linea ileo pectinea, completed in front by the spine and crest of the pubes, and behind by the anterior margin of the base of the sacrum and sacro-vertebral angle.

The *inlet* of the pelvis is somewhat cordate in form, obtusely pointed in front, diverging on either side, and encroached upon behind by the projection forwards of the promontory of the sacrum. It has three principal diameters: antero-posterior (sacro-pubic), transverse, and oblique. The antero-posterior extends from the sacro-vertebral angle to the symphysis pubis; its average measurement is four inches. The transverse extends across the greatest width of the pelvis, from the middle of the brim on one side, to the same point on the opposite; its average measurement is five inches. The oblique extends from the margin of the pelvis corresponding to the ileo pectineal eminence on one side, to the sacro-iliac symphysis on the opposite side; its average measurement is also five inches.

The *cavity* of the true pelvis is bounded in front by the symphysis pubis; behind, by the concavity of the sacrum and coccyx, which, curving forwards above and below, contracts the inlet and outlet of the canal; and laterally it is bounded by a broad, smooth, quadrangular plate of bone, corresponding to the inner surface of the body of the ischium. This cavity is shallow in front, measuring at the symphysis an inch and a half in depth, three inches and a half in the middle, and four inches and a half posteriorly. From this description, it will be seen that the cavity of the pelvis is a short, curved canal, considerably deeper on its posterior than on its anterior wall, and broader in the middle than at either extremity, from the projection forwards of the sacro-coccygeal column above and below. This cavity contains, in the recent subject, the rectum, bladder, and part of the organs of generation. The rectum is placed at the back of the pelvis, and corresponds to the curve of the sacro-coccygeal column, the bladder in front, behind the symphysis pubis. In the female, the uterus and vagina occupy the interval between these parts.

The *lower circumference* of the pelvis is very irregular, and forms what is called the *outlet*. It is bounded by three prominent eminences: one posterior, formed by the point of the coccyx; and one on each side, the tuberosities of the ischia. These eminences are separated by three notches; one in front, the *pubic arch*, formed by the convergence of the rami of the ischia and pubes on each side. The other notches, one on each side, are formed by the sacrum and coccyx behind, the ischium in front, and the ilium above: these are called the *greater* and *lesser sacro-sciatic notches*; in the natural state they are converted into foramina by the lesser and greater sacro-sciatic ligaments.

The diameters of the outlet of the pelvis are two, antero-posterior and transverse. The *antero-posterior* extends from the tip of the coccyx to the lower part of the symphysis pubis; and the *transverse* from the posterior part of one ischiatic tuberosity, to the same point on the opposite side: the average measurement of both is four inches. The antero-posterior diameter varies with the length of the coccyx, and is capable of increase or diminution, on account of the mobility of this bone.

Position of the Pelvis. In the erect posture, the pelvis is placed obliquely with regard to the trunk of the body; the pelvic surface of the symphysis pubis looking upwards and backwards, the concavity of the sacrum and coccyx looking down-

wards and forwards. The base of the sacrum, in well-formed female bodies, being nearly four inches above the upper border of the symphysis pubis, and the apex of the coccyx a little more than half an inch above its lower border. This obliquity is much greater in the fœtus, and at an early period of life, than in the adult.

Axes of the Pelvis. The plane of the inlet of the true pelvis will be represented by a line drawn from the base of the sacrum to the upper margin of the symphysis pubis. A line carried at right angles with this at its middle, would correspond at one extremity with the umbilicus, and by the other with the middle of the coccyx; the axis of the inlet is therefore directed downwards and backwards. The axis of the outlet produced upwards, would touch the base of the sacrum; and is therefore directed downwards and forwards. The axis of the cavity is curved like the cavity itself: this curve corresponds to the concavity of the sacrum and coccyx, the extremities being indicated by the central points of the inlet and outlet.

Differences between the Male and Female Pelvis. In the *male*, the bones are heavier, stronger, and more solid, and the muscular impressions and eminences on their surfaces more strongly marked. It is altogether more massive in its general form; its cavity is deeper and narrower, and its apertures small. In the *female*, the bones are lighter and more delicate, the muscular impressions on its surface only slightly marked, and the pelvis generally is less massive in structure. The iliac fossæ are large, and the ilia widely expanded; hence the great prominence of the hips. The cavity is shallow, but capacious, being very broad both in the antero-posterior and transverse diameters; the inlet and outlet are also large. The obturator foramen is triangular; the tuberosities of the ischia are widely separated; the sacrum is wider and less curved; the symphysis pubis not so deep; and the arch of the pubis is greater, and its edges more everted.

In the *fœtus*, and for several years after birth, the cavity of the pelvis is small; the viscera peculiar to this cavity in the adult, being situated in the lower part of the abdomen.

THE UPPER EXTREMITY.

The Upper Extremity consists of four parts—the shoulder, the arm, the forearm, and the hand. The *shoulder* consists of two bones, the clavicle and the scapula.

THE CLAVICLE.

The *Clavicle* (*clavis*, a 'key'), or collar-bone, is a long bone, curved somewhat like the italic letter *f*, and placed horizontally at the upper and lateral part of the thorax, immediately above the first rib. It articulates internally with the upper border of the sternum, and with the acromion process of the scapula by its outer extremity; serving to sustain the upper extremity in the various positions which it assumes, whilst at the same time it allows it great latitude of motion. The horizontal plane of the clavicle is nearly straight; but in the vertical plane it presents a double curvature, the convexity being in front at the sternal end, and behind at the scapular end. Its inner two-thirds are of a triangular prismatic form, and extend, in the natural position of the bone, from the sternum to the coracoid process of the scapula; the outer fourth being flattened from above downwards, and extending from the coracoid process to the acromion. It presents for examination two surfaces, two borders, and two extremities.

The *superior surface* (fig. 72), for the inner three-fourths of its extent, is narrow, smooth, of equal diameter throughout, and presents near the sternal end impressions for the attachment of the Sterno-mastoid muscle behind, the Pectoralis major in front. Its outer fourth is broad, flat, uneven, perforated by numerous foramina, and covered by the fibres of the Deltoid and Trapezius muscles, which encroach upon it considerably in front and behind.

The *inferior surface* (fig. 73) is also narrow for the inner three-fourths of its extent, broader and more flattened externally. Commencing at the sternal extre-

Gomphosis (γομφος, a nail) is an articulation formed by the insertion of a conical process into a socket, as a nail is driven into a board; and is illustrated in the articulation of the teeth in the alveoli of the maxillary bones.

2. AMPHIARTHROSIS. MIXED ARTICULATIONS.

Amphiarthrosis (αμφι 'on all sides,' αρθρον a 'joint'), or *Mixed Articulation*. In this form of articulation, the contiguous osseous surfaces are connected together by broad flattened discs of fibro-cartilage, which adhere to the ends of both bones, as in the articulation between the bodies of the vertebræ, and first two pieces of the sternum; or the articulating surfaces are covered with fibro-cartilage, lined by a partial synovial membrane, and connected together by external ligaments, as in the sacro-iliac and pubic symphyses; both these forms being capable of limited motion in every direction. The former resemble the synarthrodial joints in the continuity of their surfaces, and absence of synovial sac; the latter, the diarthrodial. These joints occasionally become obliterated in old age: this is frequently the case in the inter-pubic articulation, and occasionally in the intervertebral and sacro-iliac.

3. DIARTHROSIS. MOVEABLE ARTICULATIONS.

Diarthrosis (δια 'through,' αρθρον 'a joint'). This form of articulation includes the greater number of the joints in the body, mobility being their distinguishing character. They are formed by the approximation of two contiguous bony surfaces, covered with cartilage, connected by ligaments, and having a synovial sac interposed. The varieties of joints in this class, have been determined by the kind of motion permitted in each; they are four in number: Arthrodia, Enarthrosis, Ginglymus, Diarthrosis Rotatorius.

Arthrodia is that form of joint which admits of a gliding movement; it is formed by the approximation of plane surfaces, or one slightly concave, the other slightly convex; the amount of motion between them being limited by the ligaments, or osseous processes, surrounding the articulation; as in the articular processes of the vertebræ, temporo-maxillary, sterno and acromio-clavicular, inferior radio-ulnar, carpal, carpo-metacarpal, superior tibio-fibular, tarsal, and tarso-metatarsal articulations.

Enarthrosis is that form of joint which is capable of motion in all directions. It is formed by the reception of a globular head into a deep cup-like cavity (hence the name 'ball and socket'), the parts being kept in apposition by a capsular ligament strengthened by accessory ligamentous bands, and the contiguous cartilaginous surfaces having a synovial sac interposed. Examples of this form of articulation are found in the hip and shoulder-joints.

Ginglymus, *Hinge-joint* (γυγγλυμος, a hinge). In this form of joint, the articular surfaces are moulded to each other in such a manner, as to permit motion only in one direction, forwards and backwards, the extent of motion at the same time being considerable. The articular surfaces are connected together by strong lateral ligaments, which form their chief bond of union. The most perfect forms of ginglymi are the elbow and ankle; the knee is less perfect, as it allows a slight degree of rotation in certain positions of the limb: there are also the metatarso-phalangeal and phalangeal joints in the lower extremity, metacarpophalangeal and phalangeal joints in the upper extremity.

Diarthrosis rotatorius (Lateral Ginglymus). Where the mobility is limited to rotation, the joint is formed by a pivot-like process turning within a ring, or the ring on the pivot, the ring being formed partly of bone, partly of ligament. In the articulation of the odontoid process of the axis with the atlas, the ring is formed in front by the anterior arch of the atlas; behind, by the transverse ligament; here the ring rotates around the odontoid process. In the superior radio-ulnar articulation, the ring is formed partly by the lesser sigmoid cavity of the ulna; in the rest of its extent, by the orbicular ligament; here, the neck of the radius rotates within the ring.

The *anterior sternal ligament* consists of a layer of fibres, having a longitudinal direction; they blend with the fibres of the anterior costo-sternal ligaments on both sides, and with the aponeurosis of origin of the Pectoralis major. This ligament is rough, irregular, and much thicker at the lower than at the upper part of this bone.

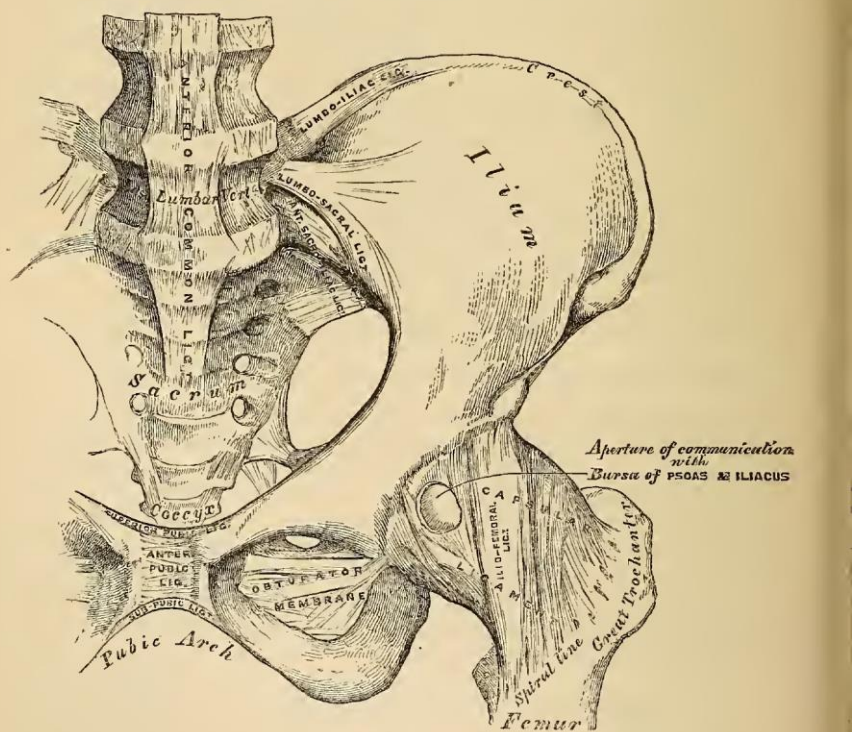
The *posterior sternal ligament* is disposed in a somewhat similar manner on the posterior surface of the articulation.

9. ARTICULATION OF THE PELVIS WITH THE SPINE.

The ligaments connecting the last lumbar vertebra with the sacrum are similar to those which connect the segments of the spine with each other, viz. 1. The continuation downwards of the anterior and posterior common ligaments. 2. The inter-vertebral substance connecting the flattened oval surfaces of the two bones, thus forming an amphiarthrodial joint. 3. Ligamenta subflava, connecting the arch of the last lumbar vertebra with the posterior border of the sacral canal. 4. Capsular ligaments and synovial membranes connecting the articulating processes and forming a double arthrodia. 5. Inter- and supra-spinous ligaments.

The two proper ligaments connecting the pelvis with the spine are the lumbo-sacral and lumbo-iliac.

110.—Articulations of Pelvis and Hip. Anterior View.



The *Lumbo-sacral Ligament* (fig. 110) is a short, thick, triangular fasciculus, connected above to the lower and front part of the transverse process of the last lumbar vertebra, and passing obliquely outwards, is attached below to the lateral surface of the base of the sacrum; becoming blended with the anterior sacro-iliac ligament. This ligament is in relation anteriorly with the Psoas muscle.

The *Lumbo-iliac Ligament* (fig. 110) passes horizontally outwards from the

chief bond of connexion between these bones. It consists of numerous strong fasciculi, which pass between the bones in various directions. Three of these are of large size; the *two superior*, nearly horizontal in direction, arise from the first and second transverse tubercles on the posterior surface of the sacrum, and are inserted into the rough uneven surface at the posterior part of the inner surface of the ilium. The third fasciculus, oblique in direction, is attached by one extremity to the third or fourth transverse tubercle on the posterior surface of the sacrum, and by the other to the posterior superior spine of the ilium; it is sometimes called the *oblique sacro-iliac ligament*.

2. ARTICULATION OF THE SACRUM AND ISCHIUM.

The Great Sacro-Sciatic (Posterior).

The Lesser Sacro-Sciatic (Anterior).

The *Great* or *Posterior Sacro-Sciatic Ligament* is situated at the posterior and inferior part of the pelvis. It is thin, flat, and triangular in form; narrower in the middle than at the extremities; attached by its broad base to the posterior inferior spine of the ilium, to the third and fourth transverse tubercles on the sacrum, and to the lower part of the lateral margin of that bone and the coccyx; passing obliquely downwards, outwards, and forwards, it becomes narrow and thick; and at its insertion into the inner margin of the tuberosity, it increases in breadth, and is prolonged forwards along the inner margin of the ramus forming the falciform ligament. The free concave edge of this ligament has attached to it the obturator fascia, with which it forms a kind of groove, protecting the internal pudic vessels and nerve. One of its surfaces is turned towards the perinæum, the other towards the Obturator internus muscle.

The *posterior surface* of this ligament gives origin, by its whole extent, to fibres of the Gluteus maximus. Its *anterior surface* is united to the lesser sacro-sciatic ligament. Its *superior border* forms the lower boundary of the lesser sacro-sciatic foramen. Its *lower border* forms part of the boundary of the perinæum. This ligament is pierced by the coccygeal branch of the sciatic artery.

The *Lesser* or *Anterior Sacro-Sciatic Ligament*, much shorter and smaller than the preceding, is thin, triangular in form, attached by its apex to the spine of the ischium, and internally, by its broad base, to the lateral margins of the sacrum and coccyx, anterior to the attachment of the great sacro-sciatic ligament, with which its fibres are intermingled.

It is in relation, *anteriorly*, with the Coccygeus muscle; *posteriorly*, it is covered by the posterior ligament, and crossed by the pudic vessels and nerves. Its *superior border* forms the lower boundary of the great sacro-sciatic foramen. Its *inferior border*, part of the lesser sacro-sciatic foramen.

These two ligaments convert the sacro-sciatic notches into foramina. The *superior* or *larger* sacro-sciatic foramen is bounded, in front and above, by the posterior border of the os innominatum; behind, by the great sacro-sciatic ligament; and below, by the lesser ligament. It is partially filled up, in the recent state, by the Pyriformis muscle. Above this muscle, the gluteal vessels and nerve emerge from the pelvis; and below it, the ischiatic vessels and nerves, the internal pudic vessels and nerve, and the nerve to the Obturator internus. The *inferior* or *smaller* sacro-sciatic foramen is bounded, in front, by the tuber ischii; above, by the spine and lesser ligament; behind, by the greater ligament. It transmits the tendon of the Obturator internus muscle, its nerve, and the pudic vessels and nerve.

3. ARTICULATION OF THE SACRUM AND COCCYX.

This articulation is an amphiarthrodial joint, formed between the oval surface on the summit of the sacrum, and the base of the coccyx. It is analogous to the

joints between the bodies of the vertebræ, and is connected by similar ligaments. They are the

Anterior Sacro-Coccygeal.
Posterior Sacro-Coccygeal.
Inter-articular Fibro-Cartilage.

The *Anterior Sacro-Coccygeal Ligament* consists of a few irregular fibres, which descend from the anterior surface of the sacrum to the front of the coccyx, becoming blended with the periosteum.

The *Posterior Sacro-Coccygeal Ligament* is a flat band of ligamentous fibres, of a pearly tint, which arises from the margin of the lower orifice of the sacral canal, and descends to be inserted into the posterior surface of the coccyx. This ligament completes the lower and back part of the sacral canal. Its superficial fibres are much longer than the deep-seated; the latter extend from the apex of the sacrum to the upper cornua of the coccyx. Anteriorly, it is in relation with the arachnoid membrane of the sacral canal, a portion of the sacrum, and almost the whole of the posterior surface of the coccyx; posteriorly, with some aponeurotic fibres from the *Gluteus maximus*.

An *Inter-articular Fibro-Cartilage* is interposed between the contiguous surfaces of the sacrum and coccyx; it differs from that interposed between the bodies of the vertebræ, in being thinner, and its central part more firm in texture. It is somewhat thicker in front and behind, than at the sides. Occasionally a synovial membrane is found where the coccyx is freely movable, which is more especially the case during pregnancy.

The different segments of the coccyx are connected together by an extension downwards of the anterior and posterior sacro-coccygeal ligaments, a thin annular disc of fibro-cartilage being interposed between each of the bones. In the adult male, all the pieces become ossified; but in the female, this does not commonly occur until a later period of life. The separate segments of the coccyx are first united, and at a more advanced age the joint between the sacrum and the coccyx.

Actions. The movements which take place between the sacrum and coccyx, and between the different pieces of the latter bone, are slightly forwards and backwards; they are very limited. Their mobility increases during pregnancy.

4. ARTICULATION OF THE PUBES.

The articulation between the ossa pubis is an amphiarthrodial joint, formed by the junction of the two oval surfaces which have received the name of the *symphysis*. The ligaments of this articulation are the

Anterior Pubic. Posterior Pubic.
Superior Pubic. Sub-Pubic.
Inter-articular Fibro-Cartilage.

The *Anterior Pubic Ligament* consists of several superimposed layers, which pass across the anterior surface of the articulation. The superficial fibres pass obliquely from one bone to the other, decussating and forming an interlacement with the fibres of the aponeurosis of the External oblique muscle. The deep fibres pass transversely across the symphysis, and are blended with the inter-articular fibro-cartilage.

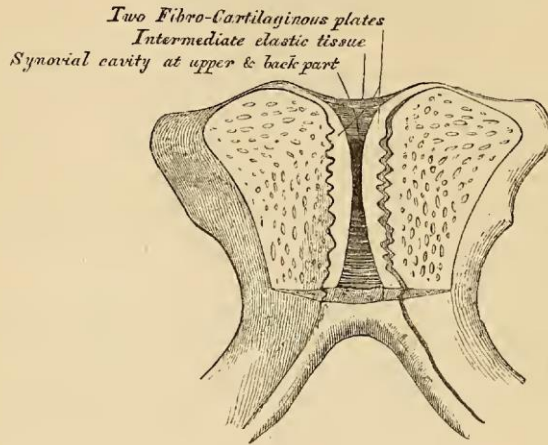
The *Posterior Pubic Ligament* consists of a few thin, scattered fibres, which unite the two pubic bones posteriorly.

The *Superior Pubic Ligament* is a band of fibres, which connects together the two pubic bones superiorly.

The *Sub-Pubic Ligament* is a thick, triangular arch of ligamentous fibres, connecting together the two pubic bones below, and forming the upper boundary of the pubic arch. Above, it is blended with the inter-articular fibro-cartilage; laterally, with the rami of the pubes. Its fibres are of a yellowish colour, closely connected, and have an arched direction.

The *Inter-articular Fibro-Cartilage* consists of two oval-shaped plates, one covering the surface of each symphysis pubis. They vary in thickness in different subjects, and project somewhat beyond the level of the bones, especially behind. The outer surface of each is firmly connected to the bone by a series of nipple-like processes, which accurately fit within corresponding depressions on the osseous surface. Their opposed surfaces are connected, in the greater part of their extent, by an intermediate fibrous elastic-tissue; and by their circumference to the various ligaments surrounding the joint. An interspace is left between the two plates at the upper and back part of the articulation, where the

112.—Vertical Section of the Symphysis Pubis.
Made near its Posterior Surface.



fibrous-tissue is deficient, and the surface of the fibro-cartilage lined by epithelium. This space is found at all periods of life, both in the male and female; but it is larger in the latter, especially during pregnancy, and after parturition. It is most frequently limited to the upper and back part of the joint; but it occasionally reaches to the front, and may extend the entire length of the cartilages. This structure may be easily demonstrated, by making a vertical section of the symphysis pubis near its posterior surface.

The *Obturator Ligament* is a dense membranous layer, consisting of fibres which interlace in various directions. It is attached to the circumference of the obturator foramen, which it closes completely, except at its upper and outer part, where a small oval canal is left for the passage of the obturator vessels and nerve. It is in relation, in front, with the Obturator externus; behind, with the Obturator internus; both of which muscles are in part attached to it.

ARTICULATIONS OF THE UPPER EXTREMITY.

The articulations of the Upper Extremity may be arranged into the following groups:—1. Sterno-clavicular articulation. 2. Scapulo-clavicular articulation. 3. Ligaments of the Scapula. 4. Shoulder-joint. 5. Elbow-joint. 6. Radio-ulnar articulation. 7. Wrist-joint. 8. Articulation of the Carpal bones. 9. Carpo-metacarpal articulation. 10. Metacarpo-phalangeal articulation. 11. Articulation of the Phalanges.

I. STERNO-CLAVICULAR ARTICULATION.

The *Sterno-Clavicular* is an arthrodial joint. The parts entering into its formation are the sternal end of the clavicle, the upper and lateral part of the

Surgery

Dr. Marius Nygaard Smith-Petersen is perhaps one of the most well-known and innovative orthopedic surgeons of the early 20th century. He served as an Instructor, Assistant Clinical Professor, and Clinical Professor of Orthopaedic Surgery at Harvard. In 1929 he was appointed Chief of Orthopaedic Surgery at the Massachusetts General Hospital. His notable works include a new approach to treating fractures of the neck of the femur, mould arthroplasty, osteotomy of the spine, and continuous irrigation for osteomyelitis. He is also known for his early work with sacroiliac joint operations. Dr. Smith-Petersen's 1921 *Arthrodesis of the Sacroiliac Joint. A New Method of Approach* is a foundational work and is presented in its entirety below:

ARTHRODESIS OF THE SACROILIAC JOINT. A NEW METHOD OF APPROACH

BY M. N. SMITH-PETERSEN, M.D., BOSTON, MASS.

UP to the present time, operative work on the sacroiliac joint has been decidedly unsatisfactory. The reason is quite plain; the joint is very deeply located in a region which excludes any approach from anterior and superior aspects. This leaves only two possible avenues of approach; the posterior and the lateral. The different methods of approach from the posterior aspect all offer great difficulties, and only in the case of Dr. Painter's¹ approach is an actual exposure of the joint accomplished. Dr. Painter's approach, which consists in turning back a flap of bone from the posterior portion of the ilium, is too extensive to undertake except as a last resort.

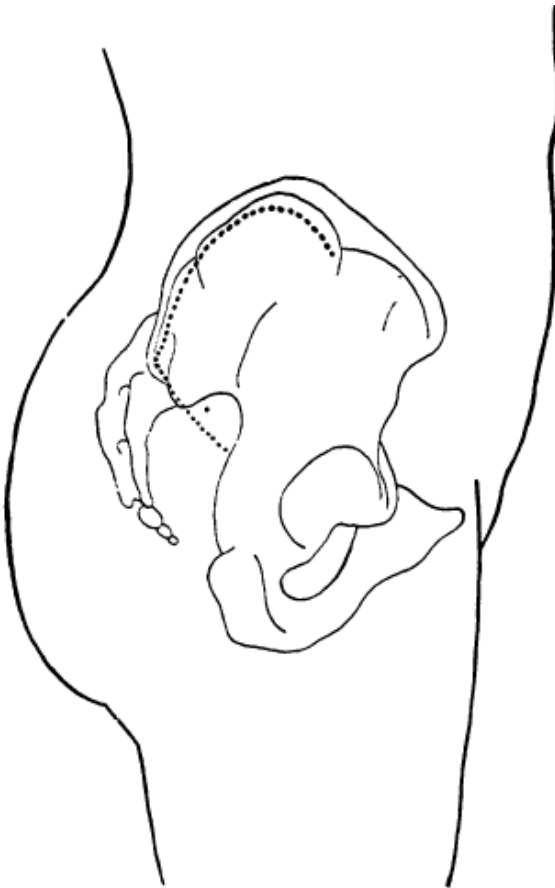


FIG. 1.—Dotted line represents incision in its relation to the ilium; curved limb of the incision extends from the posterior superior spine two-thirds of the distance to the anterior superior spine. Straight limb from the posterior superior spine in the direction of the fibers of the gluteus maximus muscles for a distance of approximately three to four inches.

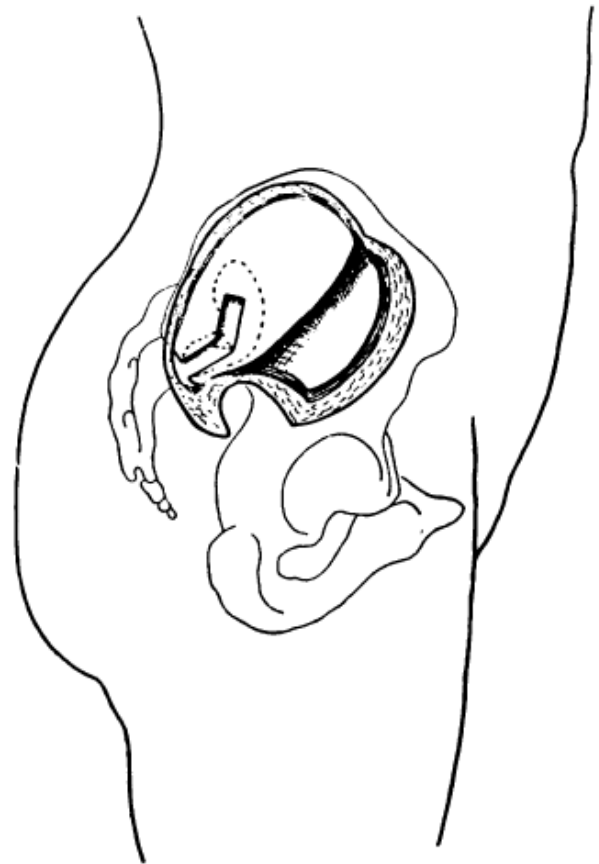


FIG. 2.—Flap reflected by subperiosteal dissection from lateral surface of the ilium. Dotted line shows sacro-iliac joint projected on the lateral surface of the ilium with windows cut in two different planes.

How about the lateral approach to the joint? What chance of exposure does this allow? In the literature on the sacroiliac joint, no article or reference to this route has been encountered, and yet it seems the most logical approach. This method has been used in a number of cases during the past three years, and the experience of the operator has been the same in every case: an anatomically easy approach with no trauma to important structures, resulting in good exposure of the cartilagenous joint surfaces of the ilium and the sacrum. The principle of the operation is similar to that described for the hip joint,²—a sub-periosteal approach.

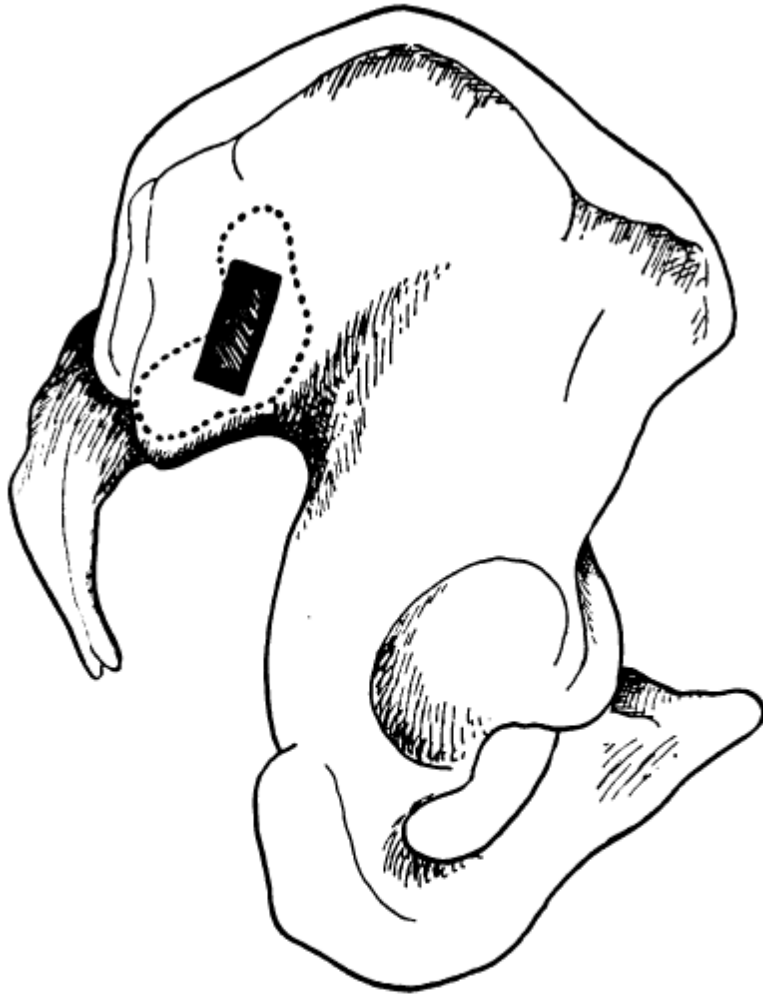


FIG. 3.—Dotted line represents sacroiliac joint projected on the lateral surface of the ilium. Window removed as described for cases of tuberculosis or of relaxation of the sacroiliac joint. Note that the window is well posterior to the median gluteal line and just above the sacrosciatic notch.

The steps of the operation are as follows:

1. Curved incision from the posterior superior spine along the crest of the ilium, two thirds of the distance to the anterior superior spine. This incision is carried down to the bone and the reflection of the periosteum started. (Fig. 1.)

2. Incision from the posterior superior spine in the direction of the fibers of the gluteus maximus for a distance of three to four inches. (Fig. 1.) This incision is carried down through the subcutaneous fat and gluteal fascia and the muscle fibers of the gluteus maximus separated by blunt dissection, until the junction of the ilium and sacrum, between the posterior superior and posterior inferior spines is reached. In carrying out the dissection, one point should be kept in mind: the superior gluteal nerve and artery emerge at the anterior portion of the sacro-sciatic notch and give off posterior branches which are en-

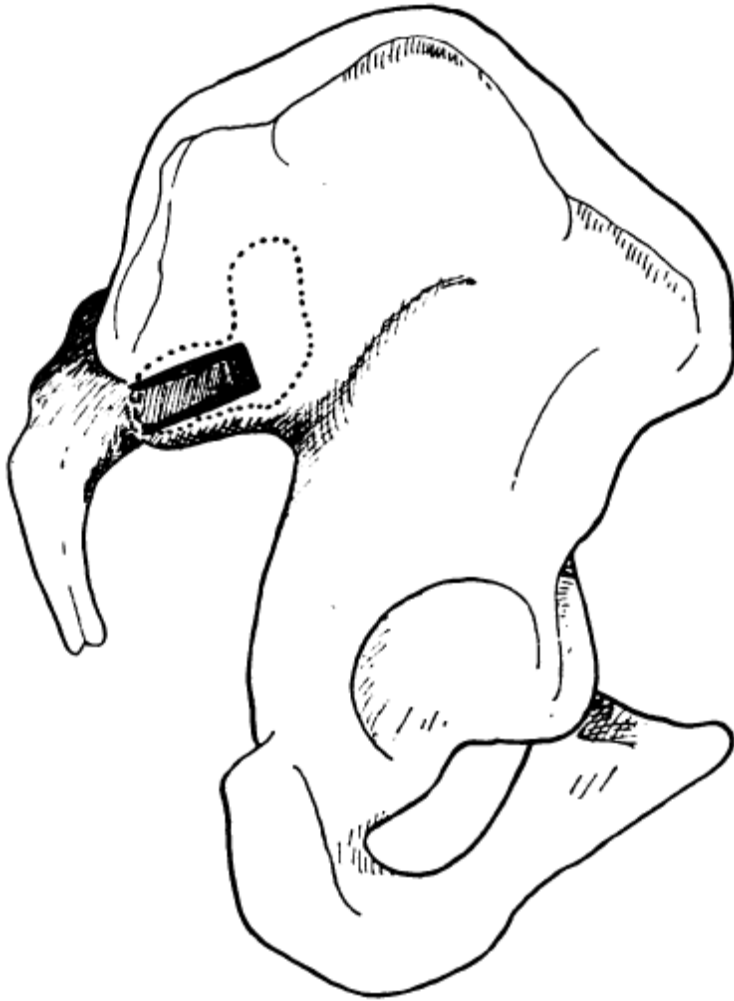


FIG. 4.—Dotted line represents sacroiliac joint projected on the lateral surface of the ilium. Window removed as described for cases of osteomyelitis: from posterior border of the sacroiliac joint between posterior superior and posterior inferior spines. It runs anteriorly parallel with the sacro-sciatic notch.

countered by the straight limb of the incision, and sometimes cause considerable bleeding. They have to be sacrificed in order to get a satisfactory reflection.

3. The flap thus outlined is reflected sub-periosteally, exposing the posterior portion of the lateral surface of the ilium. (Fig. 2.)

4. If the sacroiliac joint is projected on the lateral surface of the ilium, it will be found that the inferior border corresponds with the sacro-sciatic notch, and the anterior border with the median gluteal line. (Fig. 3.) The superior border is not of importance, because the two above landmarks determine the location of the joint sufficiently. A window is now cut through the ilium within the projected area of the joint. (Fig. 3 and 4.) A window, rectangular in shape, has been used in the majority of cases. (Fig. 3 and 4.) The thickness of the ilium just above the sacro-sciatic notch is considerable, sometimes as much



FIG. 5. (a)—Cross section of sacroiliac joint and of the posterior sacroiliac ligament.



FIG. 5 (b).—Window removed from ilium down to joint surface.



FIG. 5 (c).—Cartilage removed from joint surface of the sacrum as well as underlying cortex, exposing cancellous bone.



FIG. 5 (d).—Window replaced. It bridges the joint and cancellous bone is in contact with cancellous bone.

as an inch, but if care is taken, the entire block of bone from the outer to the inner table of the ilium may be removed in one piece. The operator is rewarded for his labor when, upon removal of the window, the cartilaginous joint surface of the sacrum comes into view. (Fig. 5B.) The cartilage of the sacrum as well as its cortex is next removed, bringing about a good exposure of cancellous bone. The above procedure results in a rectangular channel bordered on all sides by cancellous bone, extending from the ilium through the sacroiliac joint into the sacrum. (Fig. 5C.)

5. After removing the cartilage and cortex from the block of bone removed from the ilium, this is replaced in its original site and counter-sunk, so that its cancellous surface will be in contact with the cancellous bone of the sacrum. (Fig. 5D.)

6. The flap is now returned to its place and periosteum and soft parts sutured in layers.

The position of the window should be varied according to the case encountered. In purulent infections of the joint, the window is cut in a direction parallel to the sacro-sciatic notch; this will give efficient drainage of the joint. (Fig. 4.) In cases of tuberculosis, it is better to cut the window at an angle as a better dowel is thus obtained. (Fig. 3.) This, of course, also holds true in cases of sacroiliac relaxation.

In cases of tuberculosis, the above description and diagrams do not hold absolutely true, as the curette has to be used extensively to reach the parts of the joint not actually exposed. Seven cases of tuberculosis of the sacroiliac joint have had arthrodesis of the above type during the past three years, with uniformly gratifying results. Cases of relaxation of the sacroiliac joint which have had the above type of arthrodesis performed, have also been uniformly successful. They are, however, only six in number, three of them too recent to judge.

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- ¹ Boston Medical and Surgical Journal, Aug. 13, 1908, page 207.
- ² Am. Journ. Orth. Surgery, August, 1917.