Thesis
on the
Topographical Anatomy
of the
Child.

by
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Introduction

This thesis contains the results of a series of researches in connection with the topographical anatomy of the child. This subject was investigated mainly by the aid of frozen sections. It is scarcely necessary to say anything in favour of this method for the determination of the position and relations of the various organs of the body one to another. The works of Pirquoy, Cuschka, Braune, Ridding, Le Grand, Jarjassy, Simpson, Hart, Barbour &c afford abundant proofs of its value & importance.

I hope to show, from a reference to the literature of the topographical anatomy of the child, that this department of human anatomy has been comparatively speaking neglected, & especially that the investigation of the subject by means of frozen sections has been almost entirely ignored. In this thesis I have confined myself almost exclusively to the determination of the peculiarities of the child as
distinguished from the adult or foetus. I have prepared, in illustration of the anatomy of the child, drawings of about 76 frozen sections. All the sections were made by me, and they were all traced by myself, or under my immediate superintendence. Most of the drawings were finished by Mr. James Murray, after I had drawn them in outline.

There are certain parts of the body which differ in an especial manner in the child and adult, such as the spinal column, the facial portion of the skull, the ear, more particularly the external auditory meatus, the larynx, the liver and the pelvic viscera. Special attention has naturally been directed to these parts. The bones of the extremities have well marked peculiarities in the child; but these are well known and have been frequently illustrated. I have not obtained any special results from an examination of frozen sections of the limbs. The only
parts that might perhaps be better shown by means of frozen sections than by the other methods of dissecting, are the capsules of the joints in their relations to the epiphyses; but these have already been investigated by Dr A. v. Brunn (see literature).

Literature.
We now possess a large number of anatomical works which contain drawings of frozen sections of the adult and I propose here to show how far the anatomy of the child has been illustrated in a similar manner. (In the sections devoted to the different regions, references will be made to the literature bearing upon the subject under consideration, whether illustrated or not.) These works may be divided into three groups:
1st Those devoted specially to the anatomy of the child.
2nd Those entirely or mainly occupied
with the illustration of frozen sections of the body generally, or of special regions.

§ 41. General works on anatomy.

§ 42. Works devoted specially to the anatomy of the child.

Anatomie des Kindesalters von Prof. Henke.
Professor in Tübingen, mit 50 Holzschnitten.
Tübingen 1861.

This contains drawings of three sections, all of newborn children.

Fig. 42. Horizontal section of the thorax at the level of the 2nd intercostal space.

Fig. 43. Slices through the intercostal space.

Fig. 44. Sagittal section of female pelvis.

Frozen Sections of a Child by J. Dwight, M.D., with 15 drawings from nature. New York 1881.

These drawings are all from horizontal sections of one child about three years old. It is, however, the only work devoted entirely to the illustration of frozen sections of the child.

This contains drawings of frozen sections of the principal joints of the extremities in children.

2nd Works entirely or mainly occupied with the illustration of frozen sections of the body generally, or of special regions.

Pirogoff, "Anatome Topographica Sectionibus per Corpus Humanum Conjugatum / Tripartitae" illustrata, Petropoli 1859.

This is the most elaborate and exhaustive work that has been published on this subject. It contains about 185 plates, but unfortunately many of the drawings have not been made with sufficient care and distinctness to be of much value. I have gone carefully over this work, and have found that sections of children (excluding newborn infants) are very few in number. It has the following:

Sec. IIIA Tab. 16 Fig. 2 Sagittal section of pelvis of boy aged 17 years.
Figs. III. A. Tab. 17. Sagittal section of pelvis of boy aged 10 years.
Figs. III. A. Tab. 21. Sagittal section of pelvis of girl aged 10 years.
These 2 figures are so rough as to be of little value.

All the plates are those of adults except the following of newborn infants.

Pl. X. Horizontal section of thorax at level of 7th, 8th, 9th.
Pl. XI. Fig. 3 Sagittal meseial section.
Pl. XII. Fig. A Sagittal section to left of mesial plane.
Pl. XII. Fig. B -- right

Pl. IV. Fig. 2. A vertical meseial section of the pelvis of a male child aged 3 months.

Fig. 13. Sagittal section of pelvis of female newborn child.
Le Gendre. Anatomie Chirurgicale Homolographique
Paris 1856.
Pl. 17. Sagittal section of pelvis of girl aged 18 years.

Zuckerkandl. Normale und Pathologische Anatomie
der Nasenhöhle und ihrer pneumatischen An-
ähnige. Wien 1802.
Fig. 1. Sagittal section of right nasal cavity
of a newborn child.

There are no sections of children represented
in the works of Braune (1), Luschka or Kohlrausch.
(1) Braune. Topographisch Anatomischer Atlas nach
Durchschnitten angefertigten Cadaver. Leipzig 1875.
(2) Luschka. Die Ohrenorgane des Menschen in
(3) Kohlrausch. Zur Anatomie und Physiologie der

General works on Anatomy.
An examination of the ordinary text books
on anatomy will show that they contain
in illustration of the peculiarities of the
child very few drawings of frozen sections,
Of those that exist are almost entirely from newborn children. Thus there are none in Lucain, Tappey or Eggensbaur. Hinde. Handbuch der Anatomie des Menschen gives two sections,

Od. 11, page 184. Horizontal section through trunk of boy aged 15 years at level of 7-12 D.V.

Od. 11, page 189. Vertical mesial section of the pelvis of a newborn male child.

The former of these does not illustrate any peculiarity of the child, of the latter is diagrammatic.

It is clear from this general summary of the literature on this subject that even if one combined all the illustrations that have been published of frozen sections in children they would give a very imperfect view of the topographical anatomy of the child. We shall have occasion afterwards to show that, in many respects, the verbal descriptions are as defective as the illustrations on this subject.
Vertebral column.

Curves. Since the classical treatise of the brothers Weber (Mechanik der menschlichen Schwerzgeige, 1st & 2nd Weber 1836) the curvature of the adult spine has been investigated by Hornes, Meyer, Pirroff, Parow, Braune, Humphrey Ye, yet, but few accurate observations appear to have been made as to their situation & amount in the child. The general opinion seems to be that the spine of the new-born child is too flexible to admit of an accurate determination of its curves. The following quotations will serve as examples of the generally accepted views on this subject:

Durnin, 9th Ed, Vol 1, p. 18. The dorsal & sacral curves are primary... due to the shape of the bodies, the body's tendency to the upright position, only developed after birth & dependent mainly...
on the shape of the intervertebral disc.

M. Turner - Introduction to Human Anatomy
Revised Edition 1882 p. 15. "In the infant at the time of birth the sacro-
-occygeal part of the spine is concave forwards, but the rest of the spine,
except a slight forward concavity in the series of dorsal vertebrae, is almost straight.

When the infant begins to sit up in the arms of its nurse, a convexity forwards
in the region of the neck appears; subsequently as the child learns to walk
a convexity forwards in the region of
the loin."

G. M. Humphrey - The Human Skeleton 1838
p. 137. "It has been already stated
(p. 134) that the curves scarcely exist
at the time of birth, although the
preparation for them may be observed
in the configuration of the vertebral
bodies. For some time after birth
the spine is so flexible that it is
difficult to decide what is its
true shape. The formation of all
the curves, of the upper three at any
rate must commence & proceed almost cotemporaneously. If there be any difference in point of time it is that the dorsal curve has slightly the precedence the lumbar curve following closely upon it. Up to adolescence all the curves become gradually more marked. Henke (Anatomie des Kindesalters p. 95) maintains that in the newborn child the spine has usually none of its future curves, but is practically straight. As it is admitted, notwithstanding the laborious & ingenious attempts of Parrow(1) that the curves cannot be accurately ascertained by measurements on the living body, the best method at our disposal for their investigation is that of making sections of the whole trunk of the frozen cadaver. The brothers Weber & after them Horner, Humphrey &c., made sections of the spine after removing the viscera, & embedding the spine, with

(1) Studien über die physikalischen Bedingungen der aufrechten Stellung und der normalen Krümmungen der Wirbelsäule. Archiv für Arch. Bd XXXI
its ligaments & muscles, in plaster of Paris. The freezing method is now recognized as being more satisfactory, as it does not involve any removal of the soft parts, & Parow (1) has shown that the removal of the thoracic viscera causes a great increase in the flattening of the spinal column. Pirogoff, Graun, Biedinger, & Simpson & Hart have published plates of vertical mesial sections of the whole body of adults, & Biedinger figures a similar section in a newborn infant, but I have not succeeded in finding any drawings of corresponding sections in children, nor have I been able to find any reference to the results obtained by such sections. I have made the following vertical mesial sections of entire frozen subjects:

 يأتي

About 4 months—length 5½ inches see Pl. 21fig.

6
7
9

Children

Male aged 3½ m. see Plate 39.
Female 1 year + 10 m. 39.
Female 2 years + 2 m. 37.
Male 5 years 11.
Male 6 years 5.
Girl 10 years 1.

In all these specimens the body was frozen lying upon its back. The 4 postures given in the list were obtained in a fresh condition, and freezing was commenced within 24 hours after birth.

An examination of the sections obtained by this method goes to prove that in the foetus of young child the vertebral column possesses three curves—cervical, dorsal, and sacral. If that the lumbar curve does not exist up to the 6th year, it is only slightly marked at the age of 13.

Cervical curve. As the existence of a cervical curve of the spine in the foetus of young infant is generally
doubted or denied, it is advisable that I should carefully explain the grounds upon which I am disposed to consider that it possesses one.

All authorities agree that in the adult, in the ordinary erect position of the body with the face directed forwards, there is a convexity on the anterior surface of the cervical part of the spine. On account, however, of the mobility of this part of the spine not only can this convexity be increased by over-extension, but also by flexion of the head and upper cervical vertebrae it can be made to disappear from the anterior surface to present in its stead a marked concavity. This is well seen in one of Pirozoff's sections (Fig. 1 A, Tab. 15, Fig. 2) of an adult male subject. It is obvious, therefore, that in determining the existence or non-existence of a cervical curve we must attend to the position of the head.

My sections of fetuses 4, 6, 7, 9 months
old all show that with the face directed forwards, or even with the head slightly bent, there is a convexity on the anterior surface of the cervical part of the spine which is practically as distinct as in the adult. Of course this convexity can be obliterated or replaced by a concavity by bending forwards the head & upper part of the spine. If the descriptions of the curvatures of the fetal spine be intended to apply to the position which the fetus usually occupies in utero, the cervical part ought to be described as forming with the dorsal, a well marked concavity. As, however, the spine is generally stated to be straight, with the exception of the slight dorsal & the sacral curves, the erect position is evidently implied. As already mentioned, I consider that in that position there is a well marked cervical curve. Rüdinger's section (see opposite) presents a cervical curve; but there is no reference to it in the text.

Dorsal curve. This is not so well marked in fetuses & children as in
adults, it as is well known it often becomes very prominent in old age. Lumbar curve I have stated that my sections seem to show that there is no lumbar curve in children up to the age of 6 years. All my sections were made with the body in the horizontal position & the thighs extended, & it may be urged that there would probably have been a curve in the upright position. With regard to this point it may be stated that sections made with the body in a similar position in the adult show a lumbar curve (see Pirozoff 1001 1 An 167, Rüdinger, die Bacheck. 7, Braune Pl. 1912). By the 5th year the ossification of the spine is well advanced, & one might reasonably expect that if a lumbar curve existed in the erect position it would not be entirely obliterated by simply laying the body in the horizontal position. In the erect position in the living body the curves of the spine will be influenced by gravity & muscular action.
The latter cannot, of course, be demonstrated on the dead subject, and the former is certainly attended with great difficulties. It is possible that some advantage might result from freezing the body in the erect position, but Graeme is of a different opinion. If any series of representations of the body frozen in the upright were given, no advantage would be obtained. It is evident that it is impracticable to keep a body as balanced, in such equilibrium, as the muscles are capable of doing during life. The trunk always hangs over to one side to such an extent that the spine partly loses its original curvature and takes a semilexure. It is therefore not to be wondered at that the figure which Pirroff gives (a E. 5th R.) taken from a body frozen in the upright position exhibits curves having flatter arcs than it would have had if the drawings had been taken from one frozen in the horizontal position (Graeme's Topograph. Anat. translated by Bellamy, page 3).

There can be no doubt but that it
would be difficult to fix a body securely in the erect position, so as to obtain a successful medivial section, without taking some of the superincumbent weight off the spine. I think, however, it might be managed, so as to show whether or not the weight transmitted down on to the lumbar vertebrae would give rise to a lumbar curve. I intend to attempt it as soon as I have a suitable opportunity.

Relative size of the different regions of the vertebral column in the foetus, child and adult.

This subject has been investigated by Karl Langer (1), Ravenal (2) and S. Rely (3). The latter has made the most elaborate researches on this subject that have been made.

(3) Die Altersverschiedenheiten der menschlichen Wirbelsaule auch fur Anat. 1879.
published. He made careful measurements of the vertebral columns of 8 new-born children and 13 adults. One of the most interesting results he obtained was that while the cervical and lumbar regions of the spine were practically equal in length in the new-born child, in the adult the proportion between them was 2 (cervical) to 3 (lumbar). He also measured the spinal columns of children at different ages, but his cases were too few to demonstrate satisfactorily the rate of growth of the lumbar over the cervical part of the column. He gives a table of measurements of the lengths of the cervical, dorsal, and lumbar regions of the spine in 5 children aged 6 months, 1, 2, 4, 11, and 16 years. He also adds to his own cases 4 of Rennals of children aged 3 months, 1, 2, 5, and 9 years.

On an examination I noticed that in the children 5, 9, and 11 years old the proportion of the lumbar to the cervical is given as even greater than in the adult. The following are the measurements...
Absolute Höhe  Relative Höhe.

<table>
<thead>
<tr>
<th>C</th>
<th>D</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>5jähriger Knabe (R) 60, 180, 135 mm</td>
<td>20.3</td>
<td>45.6</td>
<td>34.2</td>
</tr>
<tr>
<td>9jährige Mädchen (R) 85, 195, 168</td>
<td>19.8</td>
<td>45.4</td>
<td>34.9</td>
</tr>
<tr>
<td>11jähriger Knabe  91, 219, 1535</td>
<td>19.7</td>
<td>47.2</td>
<td>33.1</td>
</tr>
</tbody>
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The result in these children appeared to me to be very peculiar, and I measured some of my sections to test them. I happened to have two specimens of male children aged 5 and 6 years, in which the cervical region was the same as in the table above, of a boy 5 years old. I also had a section of the spine of a girl aged 13.

The measurements in these three cases were as follows:

| Boy 5 years old 80, 170, 114 | 22.5 | 48.1 | 29.4 |
| Boy 6 years old 80, 175, 116 | 22.2 | 48.5 | 29.3 |
| Girl 13 years old 95, 220, 136 | 21.5 | 48.7 | 29.7 |

These figures are more in accordance with what we might expect than those given by Ravenal & Aby. I have found my measurements of spinal spines to closely agree with those of Aby.
Ossification of the Spine

Considerable discrepancies exist in anatomical works in reference to the age at which the neuro-central suture disappears, I also to the period when the odontoid process becomes united by bone with the body of the axis.

According to Ruanin the neuro-central suture exists up to the age of 3 years. Humphrey says it is obliterated between the 4th and 5th year.

J. Henke (Anatome des kindersalter) gives it as late as the 6th year.

According to my own observations it persists even longer than Henke states. I found it in my sections of children 4½, 5, 6 years old. In the latter it was well marked in the dorsal region; but partly obliterated in the lumbar region.

I made a careful examination of the spine of a girl aged 9 years. In this case I found it complete in the cervical and upper dorsal regions, but on making transverse sections of the bodies of the lower dorsal and lumbar vertebrae, it was seen to be obliterated at its extremities, a strip of cartilage still remaining in the middle.
The ossification of the cartilage forming the neo-central suture appears to be completed much later than we are generally lead to suppose.

According to Laxm, the odontoid process is ossified to the body of the axis in the 3rd year, while Humphrey states that the cartilage between them becomes ossified in front and behind at the age of puberty.

I have made vertical sections of the odontoid process & body of the axis with the following results:

Boy aged 4½ years — complete layer of cartilage between them.

5 — 5

6 — a thin layer in front was ossified (see Pl. 5)

Girl aged 9 years — partly ossified

(See Plate 1)

From these specimens it appears that ossific union commences about the 7th year, but that there is still a distinct piece of cartilage at the thirteenth year.
The nasal cavities and the air sinuses communicating with them.

The nasal cavities, like the face generally, are not only absolutely but also relatively smaller in the child than in the adult, as compared with the body generally.

The topographical anatomy of this region is, as a whole, best shown by coronal sections. There are, however, but very few drawings of sections in children either coronal, sagittal, or horizontal. Thus Zuckerkandl (1) gives a very elaborate account of the anatomy of this region, has a large number of plates of sections, in the the adult, but he only gives one section of a child (new-born) & he makes very few references to the subject in the text.

In addition to a number of sagittal sections, showing either the septum or the outer wall of the nose, I have made drawings of the following coronal sections:

(1) Normale und pathologische Anatomic der Nasenhöhle und ihrer pnuematischen Anhänger. Mit 22 lithographirten Tafeln. Wien 1882
Coronal section in an infant 2 months old.
(See Plate 1.) It shows the antrum of Highmore on each side, & the opening of the left one into the middle meatus of the nose.

Coronal section in a girl aged 6 years at the level of the 1st temporary molar.
(See Plate 2.) The opening from the antrum into the nose is seen here also.

Situs (Plate 3.) at the level of the 1st permanent molars, 1 m. m. behind preceding one.

Coronal section in a girl aged 9 years

Fig 1. At the level of the 1st bicuspied tooth.

Fig 2. At the level of the of the 1st permanent molar.

Antro-nasal of Highmore
Frontal sinuses.

Very varied statements are made as to the period when these sinuses are developed.

Drain Vol. 1, p. 70 9th Ed. "The frontal sinuses appear about the 2nd year, and continue to increase up to old age."

Humphry p. 246. "They are not developed till after puberty."

This matter has been specially investigated by Fillaux (1) and Steiner (2).

Fillaux states that he examined a large number of specimens in the Musée d’Histoire in 1858, and came to the conclusion that they do not exist before the 10th year, while they are well developed by the 15th or 20th year. He considers that they generally appear between the 11th or 12th year.

Steiner says that they begin in the 12th or 20th year by an extension from the anterior ethmoidal cells into the "pars

(1) Traité d’Anat. Pathoq. 3rd Ed. 1862 p. 259
(2) Über die Entwicklung der Stirnhöhlen und deren krankhafte Umbildung durch Ansammlung von Fettigkeiten. Arch. für Cln. Chir. XIII. 1872
nasalis of the frontal bone, & that, by the 6th or 7th year they have attained the size of a pea.

I made a series of sections of the frontal bone in the following cases:

- Girl aged 13, 4/5 m. - girl aged 2 y 12 m.
- Boy aged 4 1/2 years, two boys aged 5 y.
- Boy aged 6 years, & girl aged 6 years.

In none of these cases could I find any frontal sinuses. I could pass a probe from the middle meatus into the anterior ethmoidal cells, but I could not satisfy myself that it went into the frontal bone. There might possibly have been a slight depression on the under surface of the bone, but it certainly did not extend any appreciable distance between the two plates of the frontal bone.

In a girl aged 5 years (see Plate fig.) I found the frontal sinuses fairly well developed, & this was also the case in a girl aged 13 years.
Ear

External Auditory Meatus.
Under this head I propose to give the results obtained from a study of a series of frozen sections of the external auditory meatus in the child, to compare them with the various views held with regard to its anatomy.

An examination of the literature of this subject will show that this method of investigation has been almost entirely neglected. Even Biedinger in his splendid "Atlas des menschlichen Schilddrüsen", München 1875, does not give any sections of the meatus in children. The only illustrations of frozen sections that I have succeeded in finding are a few somatot diagrammatic sections representations of sections of the meatus in newborn infants such as that given by Tröllsch in fig 3 of his "Lehrbuch der Ohrenheilkunde mit einschluss der Anatomie des Ohres." Siebente Auflage 1881.
The following is a list of the sections I have made:
Coronal or Frontal sections

Most of my specimens of the meatus were cut in this direction. The meatus of the child is straighter than that of the adult, so that it is more easily opened by a coronal section. There is usually, however, a backward projection about its middle, especially of the anterior wall, so that the latter is convex from within outwards. I made the sections near the anterior wall 1 then, if necessary, took thin slices off until I had exposed the whole length of the meatus.

1. Section of left ear of 4 months fetus (see Pl. 19, Fig. 1)
(I made several sections of still younger fetuses, & always found the meatus closed.)

2. Section of head of 9 months fetus at level of external auditory meatus
(see Plate 19, Fig. 2.

3. Section of left ear of a child aged 12 months (see Pl. 19, Fig. 3)

4. Section of right ear of a child aged 6 months (see Pl. 20, Fig. 1)

5. Section of left ear of a child
aged 12 months (see Pl. 20 Fig 2)
6. Section of left ear of a child aged 2 years (see Pl. 20 Fig 3)
7. Section of left ear of a child aged 5 years (see Pl. 20 Fig 4).
8. Section of head of child aged 6 years made at the level of the external auditory meatuses (see Pl. 23).

Sagittal section

Section of the left external auditory of a child aged 4 months made 9 mm. external to the inner end of the floor of the meatus, seen from the outer side (see Pl. 19 Fig 4).

Horizontal section

Section of the head of a child aged 4½ years at the level of the external auditory meatuses. (see Pl. 31 Fig 1)
Length of the meatus - I have not been able to find any precise statements as to its length in the child. I indeed in almost all works on the anatomy of the ear there are no allusions to this point. The subject is, however, referred to in Braik's Anatomy, 9th Edition, Vol II, page 434, as follows:

"The auditory passage is very short and rudimentary in the infant, for the osseous part begins to grow out of the temporal bone only after birth, and thus the internal and middle ears are much nearer to the surface than in the adult."

Before considering its length in the child, we must briefly refer to some points of importance in connection with the boundaries of the meatus. In estimating the length of the meatus no difficulty is experienced in defining its inner extremity, for this is clearly marked by the membrana tympani; but as this membrane passed from above downwards and inwards, it from behind forwards..."
inwards, none of its walls extend to within the same distance from the mesial plane of the body. With regard to its external boundary this is not so well defined, as according to Gürber (1) the very various estimates of the length of the meatus are mainly to be attributed to a want of agreement as to its external boundary. Some anatomists, Meckel for example, have even included the tragus in their measurements of the walls of the meatus. The only part of the outer wall of the meatus which can naturally be distinguished from the concha of the pinna is its posterior wall, for this turns abruptly backwards, while the other walls pass outwards into the pinna without any distinct line of demarcation. The majority of authorities now agree with von Brüttau in taking as the external boundary of the meatus a sagittal plane passing through the outer end of its posterior wall. The most careful and exact measure

(1) Lehrbuch der Ohrenheilkunde, Wien 1870.
ments of the length of the meatus are those of von Frölich. He gives 24 m. as its average length in the adult, its anterior wall being 27 m., lower 26, posterior 22 & upper 21.

As the walls of the meatus in the infant are soft & yielding, it is obvious that care must be taken in measuring its length, not to stretch or compress it in any way. The length of other passages, for instance the vagina, has been greatly exaggerated by not attending to this rule. To avoid such sources of fallacy I have estimated its length from frozen sections, & below will be found a table of a series of measurements of the roof & floor of the meatus obtained by this method.
In a horizontal section of the meatuses in a male child, aged 4½ years (see Plate 31f) the anterior wall measured 11.1 m. in length, & the posterior 11.3 m. If we compare the above with the length in the adult, as given by von Koller, it will be evident that the meatus instead of being shorter is relatively longer than in the adult. Thus in the newborn child the floor is 20 m. m.; in the adult it is 26 m. m. or little more than one fourth longer. As one would naturally expect from this the meatus increases very slowly in length after birth, indeed from my cases it would appear at first to diminish. My specimens are too few to warrant any definite conclusions, but I am disposed to think that the opening up of the meatus which occurs after birth is accompanied by some slight diminution in its length.

Hence it states that the estimates of the length of the meatus vary.
from 22 m. m. to 42 m. m. These discrepancies have arisen from a want of agreement as to its external boundary (Euber), it also probably from the method of examination. My own results in children show only very slight individual variations.

The practical value and importance of an accurate knowledge of the length of the external auditory meatus needs scarcely to be insisted upon; but these measurements are also of interest in connection with the relative size in the child and adult of other parts of the ear. It is well known that the middle and internal ears are nearly as large at birth as in the adult, and the same would appear to be the case with the external ear, so far as the length of the meatus is concerned.
Lumen of external auditory meatus.

In the foetus the meatus is closed, its lower wall being in contact internally with the membrana tympani, and external to it with the superior wall. Towards the end of fetal life these become separated by an accumulation of epithelium or vernix caseosa in the meatus. This is first found at the inner end of the meatus, between the floor and the membrana tympani. The coronal section of the meatuses of a nine months foetus (Fig. 2) shows only slight separation of the walls, but in another subject at the same age the meatus was rather more opened up. In both cases respiration has not occurred. At birth the walls of the meatus are thus rather in contact or there is a small space filled with vernix caseosa, so that a child is born with its ears practically closed.

According to Kussmaul (1) the most discordant sounds made near a new-born child are: Untersuchungen über das Seelenleben der Neugeborenen Menschen, Leipzig 1859.
when awake, do not disturb it. I am not aware of any observations as to how soon after birth, or by what agencies, the meatus becomes a distinct air passage. In an infant 6 days old I found the walls of the meatus more separated than is normally the case with a newborn child, but its cavity was nearly full of detached epithelium. In a child aged 2 months (see Plate 19 fig. 3) the meatus was patent and contained air. The lumen of the meatus would appear to gradually increase in size after birth, but so slowly that it is relatively narrow in the infant, as compared with its length.

By the growth of the tympanic bone, the osseous meatus is usually formed between the ages of 12 to 15 months. From an examination of several specimens about this age, kindly lent me by Professor Turner, from others in my own possession I found that the osseous meatus measured from above downwards and back-wards, on an average, 6 to 7 mm. In the adult it is generally from 8 to 9 mm.
Walls of the external auditory meatus.

Most of the standard works on anatomy give a very imperfect description of the structure of the walls of the meatus in the child. They state that in the adult the meatus consists of an osseous and a cartilaginous portion, while in the new born infant there is no osseous meatus; but the reader is too often led to infer that at that period the meatus is entirely cartilaginous. Indeed, Sellaux in his Traité d'Anatomie topographique 3rd Ed. 1882 p. 99 says:—

"L'enfant nouveau-né le conduit auditif est donc exclusivement fibro-cartilagineux."

It was shown, however, more than 30 years ago by von F r ö l l o c k that this idea is erroneous, for, in the new-born child as in the adult, the outer part only is cartilaginous, while in the new-born infant the future osseous portion is represented by fibrous tissue into which ossification extends from the tympanic ring to form the greater part of the walls of the osseous meatus. This membrane, which
which might be called the fibrous or membranous tympanic plate, is shown in section in the floor of the meatus in several of my preparations (see PL 19 f. 1, 2, 21 PL 20 f. 5, 6, 7, 8). At birth it is thin, but it becomes thicker and firmer in a few months. As PL 19 f. 4, a sagittal section of the meatus in a child 4 months old, made 9 mm. external to the inner end of the upper end of the meatus, exhibits its relation to the anterior and inferior walls of the meatus.

Iulius Böke (i) maintains that this structure, described as membrane by v. Tröltzsch, really consists of cartilage composed of fibres with scattered cells. In the account of the minute anatomy of the external ear by J. Reussel in Sticker's Histology, there is no reference to it. I have satisfied myself by microscopic examination that it is compact fibrous tissue and not cartilage.

It is generally taught that at birth there is no osseous meatus. This scarcely conveys a correct idea of the condition.

(i) Virchows Arch. Bd XXIX 1864.
of the walls of the meatus at this period, for there is then an osseous roof and posterior wall. The roof is shown in the coronal section of the meatus of the new-born child in Pl. 19 fig. 2, and its gradual increase is seen in several other sections (see N.H. Pl. 20, fig. 5, 6, 7 x v). The sagittal section of the meatus of a child aged 4 months (see Pl. 19) was made just external to the cartilaginous portion. It shows the bony posterior and superior walls, and the anterior and inferior fibrous walls.

The formation of the tympanic portion of the osseous meatus has been investigated by Humphrey von Frölloch, Bürkner and Beckerkandl. The latter is quoted by Politzer (1) as describing the formation of the tympanic bone as commencing by the rapid growth of the anterior and posterior tubercles found on the tympanic ring of the new-born child. The lower part of the tympanic ring grows out more slowly, and the two tubercles uniting a foramen is left in the tympanic bone, which

(1) Lehrbuch der Ohrenheilkunde 1870.
sometimes remains throughout life. An essentially similar description was given by Humphry in his “Treatise on the Human Skeleton” published in 1830, and in plate XVI of the same work there are several drawings illustrating this process. After the union of the two processes of the tympanic bone, a distinct ossous external auditory meatus exists. Von Tröltsch gives a drawing of a temporal bone of a child about 3 years old, in which a gap open to the outer side is seen in the tympanic bone. The rate of ossification of the tympanic bone varies somewhat, but as a rule the tubercles of the tympanic ring unite at or soon after the end of the first year.

Inclination of the membrana tympani. Almost all authorities such as Holle, von Tröltsch, Friderich, describe the membrana tympani as being more nearly horizontal in the infant than in the adult. Sellau (1) gives the

following diagram to illustrate this peculiarity


In Politzer's Lehrbuch der Ohrenheilkunde translated by Dr. F. Caselle (1863) I find the following statement on this subject: “Until now the position of the membrane tympani of the infant has been described as nearly horizontal. Dr. J. Pollak, however, proved by numerous measurements that this assumption is erroneous, as there is no perceptible difference between the inclination of the membrane in the newborn infant and in the adult.” I have not been able to find any communication by Pollak himself on this subject, but I understand that he was formerly an assistant of Politzer in Vienna.

From an examination of my own specimen
I have satisfied myself that the membrane has practically the same inclination in children that it has in adult. In a child 2 months old it formed an angle of 55° with the horizon. I believe also that in 9 months fetuses it is similar to the adult; but that in younger fetuses it is rather more horizontal.

The idea that the membrane is horizontal or nearly so in the fetus has probably arisen from considering merely its relation to the roof & floor of the meatus. There is no doubt but that in the fetus it forms a more obtuse angle with the roof of the meatus & a more acute angle with its floor; but this is mainly if not entirely to be attributed to the obliquity of the meatus itself. In comparing the inclination of the membrane in the fetus & adult we must take the angle which it forms with the horizon, & not that with the meatus. I have not quite completed my investigations on this point.
Gustachian tube

This tube is generally considered to be shorter and more nearly horizontal in the infant than in the adult. Its pharyngeal opening is said to be smaller and not so prominent as in the adult; but the tympanic orifice not only relatively, but also absolutely larger.

A few quotations will serve as examples of the usual opinions with regard to the peculiarities of this structure in the child.


p. 245: "The tube in the infant differs much from that of the adult. It is wider, shorter, and more nearly horizontal."

Emmer - Lehrbuch der Ohrenheilkunde mit besonderer Betrachtung auf Anatomie und Physiologie. Wien 1870. page 97: "The Eustachian tube differs considerably not only in direction, but also in relative size, in the child and adult. As a whole the tube is wider in the child, especially at the isthmus of the tympanic opening. The pharyngeal opening however is smaller."
A. von Grützsch (1) page 194 "The tube in the child differs considerably from that in the adult. The child's tube is much shorter and not only relatively but also absolutely wider in its narrowest part. The cartilage does not project inwards so much as in the adult, so that there is no prominent posterior lip at the pharyngeal opening. According to Kinkel (2) the pharyngeal orifice of the tube lies below the level of the hard palate in the foetus, in the newborn child it is at the same level, at the age of 4 years 5 or 6 mm. above it, 4 in the adult 10 mm.

These peculiarities of the Eustachian tube in the child are of considerable practical importance, as the tube is less liable to be obstructed, and it can be more easily dilated than in the adult.

Although as we have just seen, the Eustachian tube is described as being short, I have not been able to find any precise statements as to its length in

(2) Hasse's anat. Studien Heft 1 S. 472. 1869.
children at different ages. According to von Tröltsch the average length of the tube in the adult is 35 m m. The results of my measurements in children are as follows:

1. Fetus (9 months) 18 m m.
2. Female child 2 years old 20 m m.
3. Female child 2 years old 23 m m.
4. Male child 4½ years old 31 m m.
5. Male child 5 years old 30 m m.

From these facts it is evident that the Eustachian tube increases in length more rapidly than the external auditory meatus. In its rate of growth it appears to correspond with the facial rather than the cranial portion of the skull.

An examination of Pl 316, a drawing of a preparation from a boy aged 4½ years in which the external auditory meatuses, tympanic cavities and Eustachian tubes were all opened, shows that at this age the Eustachian tubes have acquired to a great extent the characters of those of
the adult, I that the descriptions of the peculiarities of the Eustachian tubes in the child are only applicable to the foetus and infant. According to Benda the Eustachian tube form an angle of about 45° with the horizon in the adult. In the new born child I found it to be practically horizontal. In the child aged 4½ years (see Pl. 31) it formed an angle of about 20° with the horizon. Although the posterior border of the Eustachian tube does not project into the pharynx in the adult infant as it does in the adult, yet in the former there is a well marked recess (fossa of Rosenmüller) behind it.
Larynx.

Although various attempts have been made to settle the vexed question of the relative size of the larynx at different periods of life, they have been practically confined to measurements of the larynx after its removal from the body; while it is well known that the larynx occupies a relatively high position in the neck of the infant as compared with the adult, no attempt has hitherto been made by an examination of the organ in situ, to determine its precise position and relative size, at different ages, in relation to the vertebral column.

In the adult, with the head erect, the boundary between the larynx and trachea corresponds to about the lower border of the 6th C.V.; the tip of the epiglottis reaches up to the lower border of the 5th C.V., or probably a little higher in the male. These are the relations
of the adult larynx to the vertebral column according to the drawings of frozen sections given by Braune (1), Alldinger (2), and Cudkova (3).

Although it is frequently stated that the larynx occupies a relatively high position in the neck of the child, I have not found any statements in anatomical works as to its relations to the cervical vertebrae. There are, however, a few drawings showing its position in the newborn child. Thus Alldinger (4) has a vertical mesial section of a newborn child, in which the tip of the epiglottis is at the level of the middle of the anterior arch of the atlas, and the lower border of the cricoid opposite the upper border of

(3) Der Schädel, Pl. 4.
of the 4th C.V. Ribemont (1) gives the latter as extending to the middle of the body of the 4th C.V.; this appears to be about its usual position in the new-born child. It is evident from these facts that the larynx must undergo a considerable descent, in relation to the vertebral column, between infancy and adult life; the question arises as to how and when this occurs.

In a paper "On the Anatomical Relations of the Trachea in the Child" (Edin.Med.Soc April 1871) I figured a vertical mesial section of the neck of a child aged 2 years in which the head was thrown back as in the operation for tracheotomy; but with this exception I am not aware of any plates showing the position of the larynx in relation to the vertebral column in children (except newly born). On the next page will be found a table of the position of the larynx found in frozen sections that I have made. In all these cases the

(1) Recherches sur l'anatomie topographique du fœtus Paris 1878.
Table showing the position of the larynx in relation to the vertebral column.

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Upper end of Epiglottis</th>
<th>Lower border of Incisor</th>
<th>Position of Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetus</td>
<td></td>
<td>Basioccipital</td>
<td>U.B. 4th C.V.</td>
<td>Erect</td>
</tr>
<tr>
<td>6 m</td>
<td>M.</td>
<td>Below atlas</td>
<td>Middle 4th C.V.</td>
<td>Slightly flexed</td>
</tr>
<tr>
<td>1 m</td>
<td>F.</td>
<td>L.B. of Atlas</td>
<td>U.B. 4th C.V.</td>
<td>Erect</td>
</tr>
<tr>
<td>1 m</td>
<td>F.</td>
<td>L.B. of Atlas</td>
<td>Middle 4th C.V.</td>
<td>Erect</td>
</tr>
<tr>
<td>9 m</td>
<td>M.</td>
<td>Between body and odontoid process of axis</td>
<td>Middle 5th C.V.</td>
<td>Flexed</td>
</tr>
<tr>
<td>Child 3½ m</td>
<td>M.</td>
<td>L.B. of Atlas</td>
<td>L.B. of 4th C.V.</td>
<td>Erect</td>
</tr>
<tr>
<td>4 m</td>
<td>M.</td>
<td>L.B. of Atlas</td>
<td>U.B. 5th C.V.</td>
<td>Slightly flexed</td>
</tr>
<tr>
<td>6 m</td>
<td>F.</td>
<td>Little below atlas</td>
<td>U.B. 5th C.V.</td>
<td>Erect</td>
</tr>
<tr>
<td>8 m</td>
<td>M.</td>
<td>L.B. of Atlas</td>
<td>Time between 3rd and 4th C.V.</td>
<td>Fully extended</td>
</tr>
<tr>
<td>12 m</td>
<td>F.</td>
<td>Little below atlas</td>
<td>U.B. 5th C.V.</td>
<td>Erect</td>
</tr>
<tr>
<td>1 y 10 m</td>
<td>F.</td>
<td></td>
<td>W.B. 6th C.V.</td>
<td>Slightly flexed</td>
</tr>
<tr>
<td>2 y 2 m</td>
<td>F.</td>
<td>Little below atlas</td>
<td>W.B. 6th C.V.</td>
<td>Extended</td>
</tr>
<tr>
<td>5 y</td>
<td>M.</td>
<td>L.B. of Axis</td>
<td>U.B. 6th C.V.</td>
<td>Erect</td>
</tr>
<tr>
<td>6 y</td>
<td>M.</td>
<td>L.B. of Axis</td>
<td>L.B. 5th C.V.</td>
<td>Erect</td>
</tr>
<tr>
<td>13 y</td>
<td>F.</td>
<td>Middle 9th C.V.</td>
<td>U.B. 7th C.V.</td>
<td>Flexed</td>
</tr>
</tbody>
</table>

U.B. = upper border  
L.B. = lower border
entire trunk was frozen. If the trunk be divided at the upper part of the thorax and the head drawn afterwards frozen, the larynx will be found higher than normal, because the division of the windpipe is followed, not only by a retraction of the trachea, but also by an elevation of the larynx. It was probably from adopting this method of examination that the mistake arose of believing the larynx to end in the adult, at the level of the lower border of the 5th C. V. instead of the 6th.

It will be noticed that in this table the position of the head has been mentioned in each case. This is necessary, for the larynx moves up and down in front of the vertebral column during extension and flexion of the head. In order to determine the changes in its situation, resulting from alterations in the position of the head, I froze two children of almost exactly the same height, one
a little under, and the other a little over two years. In the one case I flexed the head so that the chin came in contact with the front of the neck, in the other the head was thrown back.

In the former (see Plate 38) an examination of the section showed that the relative position of certain structures had been considerably altered. The anterior surfaces of the bodies of the lower two cervical and upper two dorsal vertebrae formed a slight convexity; but above this there was a concavity, there the intervertebral discs were compressed. The soft palate was in relation to the roof of the pharynx, and the tip of the epiglottis was just behind the soft palate. The thyroid cartilage was behind the hyoid bone, their lower borders were at about the same level, but the upper border of the thyroid was 3 m. m. above that of the hyoid. Contrary to what one might have expected the distance, in front, between
the cricoid & the thyroid cartilages was a little longer than normal. Part of the trachea was compressed & its lumen almost obliterated, by the pressure of the chin. The lower border of the cricoid was at the level of the upper border of the 6th C.V.

In the specimen with the head extended (see Plate 37) the cervical curve of the spine was well marked. The hyoid was farther from the thyroid than is usually the case, & the cricoid was a vertebra higher than in the body with the head extended acutely flexed.

A comparison of the two specimens demonstrated that the flexion of the head was chiefly marked by the descent of the hyoid bone in front of the thyroid cartilage, & that, compared with the extensive movement of the head, the downward displacement of the larynx in relation to the vertebral column was comparatively slight, amounting only to about one vertebra & intervertebral
The lower border of the cricoid cartilage forms a well defined landmark by means of which we can easily determine the relation of the lower border of the larynx to the vertebral column. An examination of the table shows a tolerably regular and gradual descent of the cricoid in relation to the spinal column. Thus in a fetus, with the head erect, it was opposite the 4th C.V., by the end of the 1st year it was down to the upper border of the 5th C.V., by the end of the 5½ year it reached to the upper border of the 6th C.V. Had the head been erect in the girl aged 13 years I think it would have corresponded to about the middle of the 5th C.V. That these results show the descent of the larynx has no connection with the special increase in the size of the larynx which occurs in the male at puberty. The question now arises is this
downward movement of the lower border of the larynx, the result of the larynx growing more rapidly than the cervical part of the vertebral column, or is it due to a displacement downwards of the whole larynx? In order to answer this question it is necessary to ascertain the position of the upper end of the larynx at different periods of life. For this purpose I have endeavoured to determine the level of the tip of the epiglottis; the results given in the table prove that it, like the cricoid, under goes a considerable and tolerably gradual descent in relation to the vertebral column.

We may fairly take the usual position of the larynx in relation to the spinal column to be, in the newborn child, from the lower border of the atlas to the middle of the 4th C.V.; in the adult from the middle of the 3rd C.V. to the lower border of the 5th C.V. (see page 49)
In Cramm's Atlas, Pl. 1, a life-size drawing of a mesial section of a man, aged 21, the vertical extent of the larynx from the tip of the epiglottis to the lower border of the cricoid amounts to 4.2 c.m.; in the same subject the distance from the lower border of the anterior arch of the atlas to the middle of the 4th C.V. is 6.8 c.m.

In Pl. 2, a similar section in a female subject, the length of the larynx was 5.5 c.m. and the distance between the above-mentioned points on the spine was 5.2 c.m.

Rüdinger (Zweite Abth. XV) represents a vertical mesial section of an adult female. The drawing is not life-size but has been reduced by photography in it I find the vertical extent of the larynx equal to the distance from the atlas to the middle of the 4th C.V.

I have obtained practically similar results by measurements on sections of
children aged 6 months, 12 months, 5 years and 6 years.

From these measurements it is apparent that if the adult larynx were placed in front of the vertebral column, so that the tip of the epiglottis was on a level with the lower border of the atlas, the cricoid cartilage would not extend beyond the lower border of the 4th cervical.

The larynx therefore does not increase in vertical extent faster than the cervical part of the spinal column, and consequently the high position of the larynx in the neck of the child, as compared with the adult, cannot be due as often stated to its relatively small size.

It attains its low position in the adult by a downward movement of the whole larynx; I am inclined to the belief that this is almost, if not entirely, due to the growth of the facial portion of
the skull. The relatively small size of the face, as compared with the cranium, in the child has been investigated by Froiep (1). He estimates the relative size of the face to the cranium as 1 to 8 in the newborn child, 1 to 6 at 2 years, 1 to 4 at 5 years, 1 to 3 at 10 years, 1 to 2½ in the adult female and 1 to 2 in the adult male. The relative increase in the vertical extent of the face is considerable, and appears to go on gradually until adult life. In these respects it agrees with the descent of the larynx.

Trachea

The anatomical relations of the trachea in the child are of considerable surgical importance, more especially in connection with the performance of tracheostomy. As a guide to that operation vertical sectional sections of the neck are extremely useful, and it is certainly surprising that works on surgical and topographical anatomy are so destitute of drawings of such sections.

J. Chiene (1) has a drawing (Pl. XXIX) of such a section of a child aged 2 years which was made after hardening in spirit; and I have published (Edin. Med. Journal, April 1841) a plate of a frozen section of a child about the same age, in which the head was extended as in the operation for tracheostomy. These are almost the only illustrations of this kind that have been published. In the plates accompanying this thesis will be found life-sized.

(2) Lectures on Surgical Anatomy, Edinburgh, 1848.
drawings of the following vertical mesial sections of this region in children:

Male child aged 5½ months - see Pl. 39.
Female - 6 - see Pl. 41 Fig. 1
Male - 8 - see Pl.
Female - 12 - see Pl. 41 Fig. 2
Female - 13½ - see Pl. 38.
Female - 2½ - 2½ - see Pl. 37.
Male - 5 years - see Pl. 14.
Male - 6 years - see Pl. 5.
Female - 13 years - see Pl. 1.

I have already proved that the larynx undergoes a gradual descent in front of the vertebral column during childhood, so as this must be accompanied by a corresponding downward movement of the point of bifurcation commencement of the trachea, the cervical part of the trachea becomes relatively shorter. Although somewhat variable, the point of bifurcation of the trachea is lower in the adult than in the infant; but I doubt if its descent be equal to that of the larynx. My sections show that the isthmus or of the thyroid body is
generally thin & small in the child; in some of the specimens I had some little difficulty in defining it from the surrounding tissues. These sections also prove that it is not uncommon to find the innominate artery in front of the trachea above the level of the manubrium sterni (see Plates 1, 14 & 41).

Thoracic Viscera.

I have made a large number of sections of the thorax - sagittal, coronal & horizontal - especially in children about 5 & 6 years old but have failed to find any peculiarities in the position of the heart, great vessels & lungs in the child as distinguished from the adult. From the high position which the heart occupies in the embryo one might have expected to find it somewhat higher in the thorax of the child than of the adult, but if there be any difference in this respect it is very slight.
In vertical serial sections of a newborn infant of one 3½ months old I found the central tendon of the diaphragm upon which the heart rests about one vertebra higher than in the adult, but in similar sections in a boy aged 6 years and a girl aged 13 years it was at the same level as in Braune's plates of sections of the adult.

**Abdominal viscera**

**Liver**

The relatively large size of the liver in the fetus and young child is well known. Not only is the liver as a whole very large, but the left lobe is much larger as compared with the right than in the adult. Henle states that the vertical extent of the liver diminishes from right to left more rapidly in the adult than in the newborn child. Pirogyf and Rüdinger both give plates of sections showing the size and position of the liver in the newborn child. In my plates will be found horizontal, sagittal, and coronal sections of the
liver in children aged 4½, 5, 6, and 13 years old.

In account of the variations in the size of the adult liver even under healthy conditions, and the influence of neighbouring organs upon its position, it is difficult to make any precise statements in attempting a comparison between its position in the adult and in the child.

The sections in children from 4½ to 6 years seem to show that the liver is still relatively larger than in the adult. The diaphragm does not appear to be placed at a higher level in relation to the ribs and vertebra than in the adult; but the liver extends lower down, and its left lobe seems to reach farther to the left side than in the adult. The amount of extension of the liver to the left of the midline plane is best shown by means of coronal sections such as those in Plates 32, 33, and 34. In this subject the stomach was moderately distended (see Plates 32 and 33). If these sections be
compared with similar section of the adult

given by Mirzoff 1 (see Fig. 11 B. fig. 3, fig. 2,
Fig. 4, fig. 1 2, fig. 5, fig. 1 2, fig. 6, fig. 1 2)

with Plate 1, & Plate 17, Fig. 2 73, of
Luschka's Caudalgone it will be seen

that while in my specimen (a child 4½
years old) the left lobe of the liver
extended beyond the level of the heart
close up to the left wall of the
abdomen, in the adult it does not
reach as far as the left border of the
heart. Luschka represents it as terminating
2½ inches to the left of the median
plane.

In making any series of comparisons with
regard to the position of the left lobe of
the liver, it is necessary to take
into consideration
the condition of the stomach whether
empty or distended. The stomach during
distension not only pushes the left
lobe of the liver upwards forwards,
but also towards the right side.

I was able to satisfy myself of this
by a comparison of horizontal sections
(cit.)
in cases with the stomach empty, moderately & fully distended. As a rule horizontal sections are not adapted for showing the position of the left border of the liver, unless they be made very thin. The lateral displacements of the liver can however easily be seen in such sections by an examination of the position of the falciform or suspensory ligaments.

In a series of horizontal sections of the trunk of a child aged 12 months, in whom the stomach was fully distended, I found the suspensory or falciform ligament in the position indicated in the tracing on the opposite page. The dotted line represents the juncture of the right & left lobes of the liver.

In a horizontal section of a boy aged 5 years (see Pl 17 Fig), in whom the stomach was empty, the suspensory ligament was thrown into folds, & its attachment to the liver was opposite its connection with the anterior abdominal wall. The lengths of the
suspensory & left lateral ligaments of the liver are such as allow of a consider-
able movement of the liver. The term suspensory ligament is, as pointed out by
lushka, a misleading one. It rather performs the function of a mooring apparatus.
In almost all my sections of children in whom the stomach was empty or mod-
erately distended, the left lobe of the liver touched the spleen. I do not
think it does this normally in adults, unless the stomach be quite empty.
I found the liver to correspond closely in shape with the description given
by Stix (Arch. fur Anat. 1878).

The stomach, spleen, kidneys & supra-
renal capsules had very similar positions
to that which they are found to have
in the adult.

Color. In Plates 18, 130 & 36 will be
seen drawings of transverse sections of the
abdomen about the level of the umbilicus,
showing the relations of the ascending
descending colon in children aged 5, 6 + 4½ years. In two of these (see Plates 30 & 36), the situation + relation to peritoneum of the ascending + descending colon correspond to what is considered to be the typical arrangement in the adult. In both these cases lumbar colotomy might have been performed without much danger of wounding the peritoneum. In the other specimen (see Plate 18) in which the section is made a little higher than in the other 2, the descending colon lies in front of the inner part of the kidney instead of towards the outer side, + it is covered by peritoneum in front + on the outside. After hardening in spirit, I made another transverse section lower down + found that immediately below the kidney the descending colon possessed a distinct mesentery + became convoluted.
Pelvic viscera.

Male Pelvis. It is well known that the pelvis of a new-born child is relatively small, so that at that period the bladder is an abdominal organ rather than a pelvic one. As the pelvic cavity increases in size, the bladder gradually descends into it, and the rectum becomes more curved. These changes in the position of the pelvic viscera have important surgical bearings, yet they have not been investigated with the care and thoroughness that they deserve. Thus, notwithstanding the numerous and valuable works that have been published of late years on topographical and surgical anatomy, no satisfactory plates have been published of sections of the male pelvis between infancy and adult life, nor have I been able to find descriptions of such sections.

Pünderger (1) in a drawing of a vertical mesial section of the body of a new-born child gives an excellent representation of the position of the bladder.

(1) Op. cit. 18 Ablth. Tafel XI.
at that age, V. Renle (1) also figures a similar section of a male pelvis. Jarjavy (3) represents a muncal section of the pelvis of an infant 3 months old. The sections of the male pelvis that of children above this age that have been published are of but little value. Houston (3) has a section of the pelvis of a child aged 2 years; but the method of preparation which consisted in the removal of the pelvis, the distension of the bladder & rectum with spirit & making a section after hardening in this fluid, renders it of little use in determining the normal position of the bladder. Perzoff (4) has a frozen sagittal section of a boy aged 10 years; but the drawing is very rough, & the bladder, urethra & anus do not appear to have been opened. He gives a somewhat better view of a section of the pelvis of a
(1) Handbuch der Anatomie des Menschen. Fig. 131.
(3) Views of the Pelvis etc. Dublin 1829.
(4) Anatome Topographica
had aged 17 years, but even here the position of the anus is not shown. There can be no doubt but that sections of the proper cadaver are the best means at our disposal for the accurate determination of the position and relations of parts one to another. So far as the bladder is concerned, there are no reasons to suppose that it alters its position, in any essential respects, after death. For a complete and satisfactory demonstration of the changes which occur in the position of the pelvic viscera between infancy and adult life it would be necessary to have a series of frozen sections of children at different ages, if it would be necessary to study more carefully than has hitherto been done the changes in the position of the bladder resulting from variations in the amount of its contents.

In consequence of my inability to obtain suitable material my series of sections is very incomplete; but
those I have made demonstrate some points of interest.

In my plates there are drawings of the following vertical mesial sections of the male pubis:

Child aged 3½ months (see Pl. 39)

6 months (see Pl. 42 b)

½ years (see Pl. 36)

5 years (see Pl. 25)

6 years (see Pl. 5)

The first two represent the infantile type, and it is the four last sections that I intend especially to refer to. These four boys from whom these sections were made were all about the same height, viz., 39 inches, so that they readily admit of comparison with one another. In two of them the bladder was empty and contracted, in the other two I injected some water before freezing. The specimens with bladder empty and contracted.

The shape and position of the bladder in these two cases were almost identical.

In the specimen represented in Plate 11 the bladder contained a few drops of frozen
urine it was firmly contracted. It will be seen to be situated behind the upper half of the pubic symphysis. A straight line from the upper edge of the symphysis to the tip of the coccyx passed just below the orifice of the urethra. A line from the same point in front, backwards to the juncture of the 3rd and 4th piece of the sacrum, nearly corresponded to the upper surface of the bladder. The vesical orifice of the urethra was about 5 mm. below the level of the upper border of the pubic symphysis. The prostatic part of the urethra was 13 mm. in length, the membranous 5 mm., and the vesical orifice of the urethra was 20 mm. above the level of the lowest part of the bulbous portion of the urethra. The cavity of the bladder was triangular in section, one angle was directed forwards, another backwards, and the third corresponding to the opening into the urethra downwards. The rectum was empty. The peritoneum lined the anterior abdominal wall down to the upper border of the pubic symphysis, and at this
point it turned backwards covering the upper surface of the bladder. At the juncture of the superior & posterior surfaces it formed a free fold & then descended between the bladder & rectum to within 4 c.m. of the anus.

In the other specimen (see Plate 18) the bladder was more contracted & its upper surface more convex. The principal difference between the two was in the relations of the peritoneum. In front it descended slightly behind the pubic symphysis before passing on to the bladder, but it did not reach so low behind the bladder. The distance from the very shallow rectovesical pouch to the anus was 5.2 c.m. There was a free fold of the peritoneum at the back of the bladder as in the other specimen. I have always found one or more folds of this kind in cases where the bladder was empty & contracted, but I have not seen any reference to them. They will gradually be obliterated as the bladder becomes distended with urine.
A comparison of these specimens with similar ones in the infant indicates a distinct descent of the bladder. This is best seen by examining the relation of the bladder to the anterior abdominal wall. During infancy (see Pl. 39 & Pl. 42 Fig.) the bladder, even though it be empty, lies in direct contact with the anterior abdominal wall above the level of the pubic symphysis, the peritoneum being reflected from the anterior abdominal wall on to the bladder some little distance above the level of the pubic symphysis. As I have already shown in my two sections of boys 5 years old the bladder does not come in contact with the anterior abdominal wall, the peritoneum lines the latter down to the symphysis pubis.

It is difficult to make a satisfactory comparison between the position of the bladder in these two cases, for that which it occupies under similar conditions in the adult, because almost all the sections in the adult are from specimens in which
the bladder was more or less distended with urine. This is the case in those given by Graeme, Riedinger, Henle, Tappey, Rothrausch, Le Sandre & others.

Jean-Jacques (i), Plate VI, gives a medial section of a male pelvis with the bladder empty & contracted in which it is lower than in my specimens. From this, or one or two plates in Pirogoff's Atlas, it seems probable that in the adult with the bladder empty & contracted, the peritoneum descends about half way down the back of the pubic symphyses before it is reflected on to the bladder. Specimens with bladder distended.

These are from boys 4 1/2 years (Pl 36 Fig 2) & 6 years (Pl 5) old. Having ascertained by percussion that the bladder did not project above the pubic symphyses it was probably nearly empty. I injected some water into the bladder. In the former case about 3 oz in the latter 2. If these specimens be compared with the sections in which the bladder

was empty & contracted it will be found that during the distension of the bladder this viscus not only rises up into the abdomen, but also pushes its way down towards the perineum & in so doing shortens the length of the prostatic & membranous portions of the urethra. This is quite apparent in both, but is more marked in the boy 6 years old. In this case the prostatic portion of the urethra was 7 mm. in length & the vesical orifice of the urethra was 10 mm. above the level of the back lowest part of the bulbous portion of the urethra, while in the specimen with the bladder contracted & empty they were 13 mm. & 20 mm. respectively.

Sarson (1) has shown that by distending the rectum with water the bladder can be pushed up towards the abdomen. This is accompanied by a stretching of the prostatic & membranous portions of the urethra.

(1) Edinburgh Medical Journal, Oct, 1898
In one case in which he placed an empty india-rubber bag into the rectum and then injected into the bag about 300 grammes of water the prostatic portion of the urethra was nearly double the normal length.

Little attention, however, appears to have been paid to the effect of distension of the bladder upon the position of its base and upon the length of the prostatic and membranous portions of the urethra. The only reference to this subject that I have noticed in anatomical works is in Rüdinger's "Supplement zur Topographisch-Chirurgischen Anatomie des Menschen" 1879. In Plate 3 he figures a median section of a male body in which the bladder was greatly distended. In the explanation of this plate he directs attention to the low position of the base of the bladder. The plate also shows very distinctly a marked shortening of the prostatic and membranous portions of the urethra.

As one of the principal difficulties...
in the performance of perineal tettotomy in children is attributed to the high position of the bladder at that age it is obvious that this subject is worthy of more attention than it has hitherto received.

As the position of the bladder in relation to the pelvis and perineum is influenced by the degree of its distension and by the state of the rectum, it also appears to present individual variations under what seem to be practically similar conditions, it is clear that it would require a large number of sections before a satisfactory comparison could be made between its situation at different periods of life. If, however, we compare sections of the distended bladder in the foetus at full term and in the adult with those I have made of children 4½ years and 6 years old there will be no difficulty in recognising the fact that in the latter its position is very much nearer the adult than the infantile type.
In the case of the boy aged 6 years the bladder is fully as low in the pelvis as it is under similar conditions in the adult.

We have already mentioned (see page 60) that no satisfactory drawings of sections of the male pelvis between infancy and adult life have been published, and it appears to me that the infantile position of the bladder is generally supposed to persist much longer than it really does. Dr. H. Thompson (1) writes: 'The bladder in children is an abdominal organ rather than a pelvic one'. We have seen that this is not the case with children 1½, 5 and 6 years old, and such a statement is probably only applicable for the 1st year or so after birth. Spencer (2) expresses himself more cautiously as follows: 'In performing the lateral operation on young children it is important to bear in mind that the bladder lies high'.

(1) Lancet 8 March 1862 p. 246
(2) Lectures on Surgery, 2nd Ed. Vol II p. 1630
Female Pelvis

In considering the various regions of the body we have almost invariably had to show that published drawings of sections illustrating their topographical anatomy have been practically confined to the periods of infancy & adult life. We have to repeat this statement in connection with the female pelvis. Thus in J. C. Hart's "Atlas of Female Pelvic Anatomy" which is the most recent complete work on this subject, there are no representations of sections of the female pelvis in children, & I am not aware of any having been published.

I have drawings of vertical serial sections of the pelvis of the following children:—Child aged 2 months (see Pl. 42 fig. 2)

6      (see Pl. 42 fig. 3)

1 y. & 18 m. (see Pl. 38)

2 y. & 2 m. (see Pl. 42 fig. 4)

6 years. (see Pl. 30)

13      (see Pl. 1)
I do not think that they throw much new light upon the anatomy of this region, but there are some points of interest to which I wish to refer.

Uterus. It is unnecessary to discuss here the vexed question of the normal position of this organ, still these sections prove that its position is as variable in the child as it is found to be in the adult. In all my specimens the body was found lying upon its back. In the child aged 17 + 10 m. (see Pl. 30) the uterus was retroverted, in all the others the fundus is directed more or less forwards. The influence of a distended bladder or rectum, or both, upon its position is easily understood, but in the case of retroversion the bladder was empty. In Pl. 42 fig. 3 we have an excellent example of an uterus fixed up between a distended bladder + rectum.

In the girl aged six years (see Pl. fig.) there was some serous fluid both in front + behind the uterus. The section of the girl aged 13 years
showed what is generally considered to be an excessive amount of anteverision although in this case the bladder was not empty.

The peculiarities of the uterus before puberty are well illustrated by the sections in girls aged 6-13 years. In both of them the small size of the body is very apparent.

In the girl aged 6 years the uterus was 2.5 cm. in length, in the one aged 13 years 3 cm. Although in the latter the uterus was scarcely half the normal length of the adult, the vagina was nearly as long. Its anterior wall was 2 inches & its posterior 2½ inches.

According to Hart in the adult anterior wall = 2 to 2½ inches, posterior = 3 in.

**Ovaries** The position of the left ovary in the girl aged 13 years is very distinctly seen in Plate 4. After the section had been embedded in plastic of Paris hardened in spirit I carefully turned aside the coils of small intestine
lying above the bladder & uterus, so as to expose the ovary. I am satisfied that I did this without displacing the ovary. It was situated below the true bone of the pelvis, its direction closely corresponded to that described by Drs. I examined the right ovary in a similar manner & found that its position & relations to the fallopian tube were the same as the left one except that the ovary was more nearly vertical. Bladder. Dr. J. B. Hart has drawn attention to the fact that the empty bladder may be found on sagittal merial section to be relaxed & have with the urethra a Y shape, or it may be contracted & the urethra & bladder cavity form a continuous slit. He was formerly disposed to think that the posterior limb of the Y was pathologic (see "Shape of Empty Female Bladder," Edin Med Jour, March 1881) but he now considers the Y shape to be the normal one for the empty & relaxed bladder although the posterior limb may be exaggerated by intersacral cellulitis.
In all my sections in which the bladder was empty it had the Y shape. In the young fetus there is no posterior limb to the empty bladder but I found a small one in a fetus at about the full time. The posterior limb is quite distinct in the section of a child 2 months old (see Pl. 32 Fig. 2) and it is extremely well marked in the girl 6 years old (see Pl. 30 Fig. 2). I believe the posterior limb is developed as the bladder descends into the pelvis.

It may be that the bladder represented in Pl. 30 Fig. 2 after contracting to expel its contents became relaxed and acquired the shape it now has; but one can easily imagine that in this case the urine was expelled either before or after death simply by the abdominal pressure.

I have no specimens of contracted bladders in female children but in the small child I found the bladder with two limbs even when well contracted.
List of Drawings of Sections.

Girl aged 13 years, height 57 inches.

Plate 1. Vertical mesial section of body.
   2. Sagittal section 2 inches to the right of the mesial plane.
   3. Sagittal section 1 1/4 inches to the left of the mesial plane.
   4. Vertical mesial section of the pelvis, with coils of small intestines removed from pelvis to show the ovary.

Boy aged 6 years, height 39 inches.

Plate 5. Vertical mesial section - left side.
   6. Sagittal section one inch to the left of the mesial plane.
   7. Sagittal section two 1/2 inches to the left of the mesial plane.
   8. Sagittal section two inches to the right of the mesial plane.
   9. Sagittal section one inch to the right of the mesial plane.
   10. Sagittal section two inches to the right of the mesial plane.
Boy aged 5 years, height 39 inches.

Plate 11. Vertical meral section of body.

12 Sagittal section one inch to the right of the meral plane.

13 Sagittal section one three-quarter inches to the left of the meral plane.

Boy aged 5 years.

Plate 14. Vertical meral section of head, neck.

15 Fig. 1. Horizontal section at the level of the 5th D.V.

Fig. 2. Horizontal section at the level of the 7th D.V.

16 Fig. 1. Horizontal section at the level of the disc between 5th and 7th D.V.

Fig. 2. Horizontal section at the level of the 10th D.V.

17 Fig. 1. Horizontal section at the level of the disc between 11th and 12th D.V.

Fig. 2. Horizontal section at the level of the disc between 14th and 15th D.V.

18 Fig. 1. Horizontal section at the level of the 1st L.V.

Fig. 2. Vertical meral section of pelvis.
Sections of External Auditory Meatus.

Plate 19. Fig. 1. Coronal section of right external auditory meatus of a 9 months fetus, seen from the front.

Fig. 2. Coronal section of head of a 9 months fetus, at the level of the external auditory meatuses.

Fig. 3. Coronal section of left external auditory meatus of a child 2 months old, seen from the front.

Fig. 4. Sagittal section of the left ear and meatus of a child 4 months, made 9 mm. external to the inner end of the floor of the meatus, seen from the outside.

Plate 20. Fig. 1. Section of right ear of a child aged 6 months.

Fig. 2. Section of left ear of child aged 12 months.

Fig. 3. Section of left ear of a child aged 2 years.

Fig. 4. Section of left ear of a child 5 years old.

Figures 1 to 4 are drawings of coronal sections of ext. and. meatus.
Sections of Fortuses.

Plate 21. Fig. 1. Vertical mesial section of fetus 5½ inches in length.
   Fig. 2. Vertical mesial section of fetus 1½ inches in length.
   Fig. 3. Vertical mesial section of fetus 13½ inches in length.
   Fig. 4. Vertical mesial section of fetus 20 inches in length.

These 21 plates are bound together
to form Vol. I.

Vol. II.

Girl aged 6 years, height 36½ inches.
Plate 22. Fig. Coronal section of head at level of 1st milk molar.
   Fig. 2. Coronal section of head at level of 1st permanent molar.
Plate 23. Coronal section of head at level of external auditory meatus.
Plate 24. Horizontal section at the level of the cricoid cartilage.
   Fig. 2. Horizontal section at the level of the clavicles.
Plate 25 - Fig. 1. Horizontal section at the level of the 3rd D.V.
   Fig. 2. Horizontal section at the level of the 4th D.V.

Plate 26 - Fig. 1. Horizontal section at the level of the
   Fig. 2. Horizontal section at the level of the

Plate 27 - Fig. 1. Horizontal section at the level of the disc between 1/8 and 2/8 D.V.
   Fig. 2. Horizontal section at the level of the body of the 7th D.V.

Plate 28 - Fig. 1. Horizontal section at the level of the disc between 10 3/8 and 11 3/8 D.V.
   Fig. 2. Horizontal section at the level of the body of the 12th D.V.

Plate 29 - Fig. 1. Horizontal section at the level of the disc between 13 3/8 and 14 3/8 D.V.
   Fig. 2. Horizontal section at the level of the disc between the 5th and 6th D.V.

Plate 30 - Fig. 1. Horizontal section at the level of the 4th D.V.
   Fig. 2. Vertical mesial section of pelvis

All the horizontal sections in this subject are represented as seen from above.
Boy aged 4½ years, height 38 inches

**Plate 31** Fig 1 Section at the level of the ears

This section is not all in one plane.
A horizontal cut was first made so as to open the epi- and endo-]

Oblique slices were then taken off
the anterior part in order to
divide the whole length of the
Eustachian tubes.

**Fig 2** Horizontal section at the
level of the tonsils

**Plate 32.** Coronal section of thorax +
upper part of abdomen.

**Plate 33.** Coronal section of thorax +
upper part of abdomen 15 mm behind
preceeding section

**Plate 34.** Coronal section of thorax +
upper part of abdomen 15 mm behind
preceeding section

**Plate 35.** Coronal section of thorax +
upper part of abdomen 15 mm behind
preceeding section

All these coronal or frontal sections
are represented as seen from the front.
Plate 36. Fig. 1. Horizontal section at
level of umbilicus (disc between 243534)
Fig. 2. Vertical mesial section
of pelvis.

Plate 37. Vertical mesial section of
girl aged 2 years 1/2 months made
with the head extended.

Plate 38. Vertical mesial section of
girl aged 1 year 6 months made
with the head flexed.

Plate 39. Vertical mesial section of
male child aged 3/2 months.

Plate 40. Coronal sections of nasal
cavities of girl aged 9 years.
Fig. 1. At level of 1st bicuspids.
Fig. 2. --- 1st permanent molar.

Plate 41. Fig. 1. Vertical mesial section of
head & neck of female child
aged 6 months.
Fig. 2. Vertical mesial section of
head & neck of female child
aged 12 months.

Plate 42. Fig. 1. Vertical mesial section of
pelvis of male child aged 6 months.
Plate 42 (continued) Fig 2. Vertical mesial section of female child aged 2 months.
Fig 3. Vertical mesial section of female child aged 6 months.
Fig 4. Vertical mesial section of female child aged 2 years 4 months.