With graduation thesis.
F. Jureček
III.


IV.

(The Late Sir James H. Simpson's Standard Atlas)
VII.

Obst: Mus.; Edin. University.

VIII.

In the writer's profession.

XI

XII


585. XVII D. Msc. Royal Col. of Surgeons, Edin.

XXIII. D. Mus. Royal Col. of Surgeons, Edinburgh.
XVII. Mus. of Royal College of Surgeons, Edinburgh.
   (not marked - next to III B.)

XVIII. K. 4. 2. Mus. of Liverpool School of Medicine.
Mus. of Liverpool School of Medicine.

Mus. of Liverpool School of Medicine.

(True Molluscs of Oium, bone, soft and greasy)

(Hamilton's Prod. Observations, Plate VIII)

XXIX.

Anat. Mus., Edin. University

XXX.

Anat. Mus., Edin. University

(Hamilton’s Pract. Observation. Plate X VII.)
(Male pelvis)

Cast. 229 g. Nat. Mus., Royal Col. of Surgeons, Edinburgh.
XXXIII.


XXXIV.
230 g. Flot. Mus., Royal College of Surgeons, Edinburgh.

(Petroleum specimen No. 583. XXXIII C.)
Contribution

to the Mechanism and Dynamics of Parturition,

a graduation thesis

by Francis Imbach M.B., M.R.C.S.

"late house-surgeon to the Lying-in Hospital, Liverpool"

"Accurate and minute measurement seems to the
non-scientific imagination a lab. lofty and
beneficial. But nearly all
the grandest discoveries of science have been but the
rewards of accurate measurement and patient long
continued labour in the minute sifting of
numerical results."

Address to the British Association at its
meeting in Edinburgh, by its president
Sir W. Thomson.
Introduction.

Mechanism according to its scientific definition, is concerned with the construction of a machine and the movement of its parts. Dynamics is concerned with the forces which cause the movements.

This thesis is in three parts, two on the mechanism and one on the dynamics of birth.

The first part is a study of the mechanism of the birth of the head of the child.

The second part is an investigation into the area of the brim of the pelvis and the chief cranial planes that engage in the brim.

The third part is an investigation into the power of labour.

No cases are cited in the first part, though it was chiefly composed while the writer was house-surgeon in the Liverpool Hospital, and was, as far as possible, verified by observation of numerous cases.

To permit, to measure the area of the brim of normal and abnormal pelvis, the subject of the second part, the writer was chiefly indebted to Professor Turner, Curator of the Anatomical Museum, Edinburgh; Professor Simpson, Curator of the Geological Museum of the University of Edinburgh; and Mr. Bell Pettigrew, Curator of the Museum of the Royal College of Surgeons, Edinburgh.

With regard to the third part the writer is painfully aware of the insufficient number of cases he hopes, however, to be able shortly to pursue this subject further.
The developed female pelvis is a somewhat complex tunnel which may conveniently be considered as composed of two portions, one a nearly straight cylinder of oblique inferior section, the remainder greatly curved - the curve being variously described as circular, parabolic, and irregular.

The symphysis pubis, the anterior wall of the upper portion, measures 1.5 inches. The posterior wall is thus described by Kuenneke: “if we draw at the posterior wall of the pelvis from the prominent outlying a parallel to the direction of the driving power, it is found to coincide with the anterior surface of the two upper bones of the sacrum, passes diagonally through the third vertebra, and then runs behind the sacrum. Its length is about 2.5 inches in a well-formed pelvis. The axis of this portion (reflecting the small angle of about 10° which the walls form both each other) is half their mean length, or 2 inches.

The subpubic ligament is taken by Dr. Hodge as the centre of curvature of the remaining lower portion of the developed pelvis. This is certainly to some extent erroneous as the curvature is not uniform throughout it is partly nowhere circular, but he has shown that the error is less than that contained in Calories’ description. The posterior wall measures about 7 inches (3" sacrum + coccyx, 4" perineum). And the axis measures half this, or 3.5" inches. The amount of longitudinal distension of the perineum in any labour determines the length of the ace.
This distension may be from 1 inch (where the perineum has been extensively lacerated) to 3 inches, hence a possible variation of 2 inches in the length of the axis. The amount of circular distension determines chiefly the position of this portion of the axis. The antero-posterior diameter may be from (say) 3.5 to 3.8 inches; hence a possible variation of 7 inches in the distance of the axis from the subpubic ligament. Assuming the antero-posterior diameter of this portion of the pelvis to be 4.5 inches (the axis circular) the angle subtended at the subpubic ligament is almost exactly 90°.

The whole average length of the anteriors bone, therefore, is 1.5 inches, that of the posterior wall 9.5: that of the axis 5.5.; and the whole curvature about 160°. Dr. Mathews-Dunlop says: "the length of the axis "may be greatly diminished by rupture of the perineum", Still more if the sphincter ani is torn through. It forms a curve whose amount of bending varies from about 60° to 150°.

**Definitions**

The terms point, axis, etc. are used, as will be seen by the context, without implying that in the mean time that the position of any point or axis spoken of has been determined with any exactitude.

It is customary to name fetal planes (or imaginary sections through the head) after only one of their diameters, eg. the suboccipito-bregmatic plane. In some cases the biparietal is the second character necessary for the definition. The head may then be said to be at the brain
When the head has advanced to the entrance of the pelvis with the greatest area which it presents to it. (This definition is adapted from Naegeli’s description of the passage of the head, P. 19, Rigby’s translation). Professor Leishman defines the head to be at the brim “when the long diameter occupies its plane.” Dr. Hodge says that the child’s head may be regarded as having passed through a plane where its prominences are opposed to any part of the circumference of its plane. It has not entered a plane where the prominences are still above it, wherefore much of the head may project through the plane. Excepting may be taken to mean definitions as much as the two prominences may never be in one pelvic plane. However, it may be stated generally that the head is in that part of the pelvis in which is the greatest fetal plane engaging its bony.

On the movement of the head during labour.

That portion of the mechanism of birth to which the term has until recently been restricted consists in the movement of the head (and other parts) in and through the pelvis. All such movement may be resolved into one or more of these.

1. Progress, or movement in the direction of the axis of pelvic aperture.
The whole process of the head during its parturition is, in ordinary, about equal to the length of the pelvic axis together with the length of the foetal vertical diameter:

\[ 3.5^9 + 3.75 = 9.25 \text{ inches}. \]

2. Deviation, or movement in the engaging pelvic planes.

It is evident that the possible deviation will be greater in cases of large pelvis or small head than in those of small pelvis or large head. The following results are from well-known average measurements:

- **Brin**
  - A head engaged transversely in brim, not flexed.
    - Transverse of brim left occipitomental diameter gives possible transverse deviation:
      \[ 3.5 - 4.5 = 1 \text{ inch} \]
    - Conjugate of brim left biparietal diameter gives possible antero-posterior deviation:
      \[ 4.5 - 3.5 = 1 \text{ inch} \]
    - Or, in many cases:
      \[ 4.25 - 3.75 = .5 \text{ inch} \]
  - In flexed.
    - Transverse of brim left suboccipitobregmatic diameter gives possible transverse deviation:
      \[ 5.5 - 3.75 = 1.75 \text{ inch} \]
    - The possible antero-posterior deviations in the same as before.

- **Cavitt**
  - Head not flexed.
    - Diameter of cavity left occipitomental gives possible deviation introduction of that foetal diameter:
      \[ 5 - 4.5 = .5 \text{ inch} \]
    - In the direction of the biparietal diameter:
      \[ 5 - 3.5 = 1.5 \text{ inch} \]
  - In flexed.
6. Flared.
Possible deviation in all directions about
3°-37½° = 1.75 inch.
The curvature of the lower portion of the pelvis probably
diminshes to some extent the amount here stated, and
the bladder, rectum, and soft parts, clothing the cavity
will have a similar effect.

There is no deviation possible at the outlet.

These statements, however, concern possible
rather than actually observed amounts. Dr.
Simpson, Dr. Barnes, Spiegelberg, and others
have carefully observed the transverse deviation
at the brim, with reference to the different
cranial diameters which may pass or be made to
pass the contracted conjugate. In the cavity
of the pelvis there is generally posterior deviation,
the head being pushed into the great anterio-posterior
cavity.

3. Rotating constitutes the third movement.
All possible revolving of the head may therefore
be resolved into equivalent revolving about any
three mutually rectangular axes, passing as near
as may be through the centre of the neck, together
with some small amount of progressive deviation.
There are, however, three reasons for not practically
attempting such analysis.

1. For evident reasons the selection of mutually
rectangular axes is limited to one of two sets:

- Fratello-biparietal, Parieto-mental,
  Occipito-fratetal, Sub-occipito-biparietal.
- Parieto-occipital, Parieto-occipital.

But the position of these diameters has not been
determined with such exactitude as to fulfill
the conditions required for numerical analysis.

2. Their position is altered by the cranial strains in labour to an unknown extent.

3. The variations (normal and abnormal) in the course of the head through the pelvis have not even yet been described so as to allow any accurate analysis. Though so much has been written on the mechanism of labour, divergent opinions are still held by different authors. With the exception of Dr. Lister's observations on the head at the outlet, no ordinary digital examination has been reported. But to determine the course of the head in labour with any exactitude we require an instrument, self-recording continuously or at short intervals, giving the simultaneous position of three distant cranial points not in the same straight line. Until some such method has been adopted it does not appear probable that much more will be made out in this department.

Numerical analysis, then, being for the present impossible, some remarks may be made upon the mechanism of labour as ordinarily described.
Naegela obliquity.

"At the entrance of the pelvis the head does not take a perpendicular, but a perfectly oblique direction, so that the part which lies lowest is neither the vertex nor the sagittal suture, but the right parietal bone. The higher the head is, the more oblique is its direction." (9) There is evidence (10) that this is erroneous description of natural labors. When it occurs with the head not flexed, the occipito-parietal diameter is the axis of revolving. Where it occurs with persistent flexion of the head, the axis lies somewhere between that diameter and the brachelo-bregmatic diameter, its exact position being determined by the amount of flexion.

Flexion.

"The higher the head is the nearer its long diameter corresponds to the lateral diameter of the pelvis. As the head presentation occurs the entrance of the pelvis, the posterior fontanelle commonly descends more in proportion than the center in one does. This revolving on its lateral axis takes place especially when the head, as it advances, experiences rather more than the usual degree of opposition to." (11) Were however, the Naegela obliquity is persistent is not about the frontal lateral axis, but about one between that and the brachelo-bregmatic diameter and coincident with the conjugate.

Spiegelberg has thus described...
the passage of the brain contracted in the conjugate diameter. If simply flat palms the head with the anterior half of the vertex — the anterior fontanelle lies a little nearer the examining fingers than the posterior; the normal suture runs near and parallel to the conjugate diameter; the bitemporal suture of the head lies in the conjugate itself; the biparietal to that side of the conjugate to which the back of the head is directed. The sagittal suture runs in a transverse direction very near to the posterior wall, an exaggeration of Neugebauer's obliquity; the anterior fontanelle is found in the neighbourhood of the promontory on the side to which the forehead is directed. This is what de Roever describes thus:

"In this position the head presses the brain in the following manner:

1. The bitemporal parietal bone, which is situated above the promontory, is flattened and depressed against the latten by the power of labour, and is thereby forced more and more down. The sagittal suture comes nearer the true transverse diameter; that is, to the anterior margin of the brain.

2. The whole head descends, but not in the axis of the brim; the bitemporal diameter does not descend in the conjugate and the biparietal on this side of it, but the head is pressed in an oblique direction towards that side where the forehead lies, so that the biparietal diameter, while it only approaches the anterior parieto-frontal diameter, enters a parallel plane below the brim. That the movement downwards is truly described is shown by the course of the depression caused by the promontory on the posterior parietal bone, running as it does from the parietal
Postrotation towards the inferior anterior angle. During this movement the head becomes a little more flexed; the anterior fontanelle rises higher up, the occiput comes down, and can easily be felt.

"The mechanism, therefore, is composed of two rotations of the head, one on the occipito-frontal axis [the sagittal suture leaves the posterior border of the brain], the other upon the transverse axis [the occiput comes down]."

Though it is impossible that the bitemporal diameter be in the conjugate with exaggerated Nagel's obliquity, and though some other statements are equally loose, as a whole the description is precise and may be accepted as true. But the analysis of the mechanism is imperfect. For, first, there is evidently progressive and lateral deviations in addition to revolving, and, secondly, as the two revolutions do not succeed each other but, often at least, (the writer believes) occur simultaneously, the axis of this compound revolving ought to have been stated. This is easily found (roughly) to be an axis passing when the occiput is at the left, through the left frontal eminence and a point midway between the two posterior angles of the right parietal bone, and when to the right, through similar points on opposite sides.

Synclitism. During the course of birth the same cranial plane, say the subarcatus, becomes, does or does not remain fixed with uncinate engaging pelvic planes according as it does.
or does not revolve about one (pelvic) transverse axis to an amount equal at any instant to the angle the brim or engaging plane makes with each other. In other words, for continued parallelism there must be revolving about a (pelvic) transverse axis relative to the brim, but more relative to successive engaging planes. Revolving about an axis perpendicular to the engaging plane would not as such interfere with this parallelism. Revolving about a (pelvic) anterior-posterior axis would still, as such, admit of anterior-posterior parallelism. The term *sincipitism* has been introduced by Kuenzels to express a different parallelism supposed by him to occur, but the existence of which has been disputed. According to Kuenzel's view, the presenting point is always in the m easial line, always in the sagittal section, and must be so." (13)

Diagram 1 represents continued coincidence of the engaging cranial + pelvic planes. CD, C'D', and C"D' are successive positions of one cranial plane.
A'B', A'B'' and A'B'''' successive positions of the cranial
diameter at right angles to it. The dotted line, continuous
A'B', represents successive positions of the point B. If the
course of the head is as here represented it is evident
that (regarding transverse deviation) the original
presenting point persists as long as it is in the straight
portion of the pelvis; but when it passes into the curved
portion the presenting point continually changes,
until the engaged cranial plane enters the
curved portion, after which there is a new
persistent presenting point.

Diagram 2, represents the
original presenting point persistent in the curved
portion of the pelvis which is apparently what
(regarding transverse deviation) Kneeland's views
amount to. As in the preceding diagram, CD, C'D' and
C''D'' are successive positions of one cranial plane,
A'B', A'B' and A'B'' successive positions of the perpendicular
diameter. Evidently if this represents the true course
of the head it is impossible for the same cranial
plane to engage in successive pelvic planes.

The observations of Naegle, as outlined
of the head, as explained by Dr. Duncan, Leishman,
but, appear to be in accordance or at least not
inconsistent with the former representation, as the
following quotation shows: "In the first half of the
head's course through the ligamentous pelvis, a point
in or near the sagittal suture is the presenting
point. ... As it advances, passes the first bone
of the sacrum, the sagittal suture approaches near
the sacrum, or rather to its lower portions, and
becomes more distant from the symphysis pubis... The
vertebra impinges on the posterior wall of the pelvis...
... While advancing at this point of its proper axis
presenting point part, therefore, is changed. It soon
becomes the upper and right posterior part of the right parietal bone, instead of as before, a point in the mesial line of the head." (14)

To call this mode of advance oblique, as Dr. Duncan does, is misleading; it should rather be termed the direct mode.

Evidently the head cannot in both modes at once, though it may in one or between the two.

Yet Dr. Norga expressly affirms that in his judgment the cervix-hepatic plane "preserves parallel to all the planes of the pelvis and vagina, from the superior strait or brim, until the delivery at the vulva. The axis of this cervix-hepatic plane is the occipito-mental diameter of the head, whose diameter, therefore, is coincident with the axis of the brim, until the top of the head reaches the floor of the pelvis, and then with the axis of each of the successive oblique planes of the lower part of the pelvis and of the distended vaginal canal to its extreme orifices." The exact meaning of the second quoted sentence is rendered certain by the following paragraph (16)

"I cannot help, therefore, agreeing with Kneeland, that this portion of the child's head or vertex, presents, towards the end of the canal from the beginning little end of descent, and of course, differs from Dr. Duncan and most others, in transferring this portion from the line of the sagittal section to the anterior parietal bone."

But this is descriptive of an imperfect case. If the cervix-hepatic plane is parallel to an oblique pelvic plane, the occipito-mental [occipito-mental?] diameter must be tangent at
or near its centre to the pelvic axis. But a
tangent five inches long cannot be taken as
"coincident" with the circumference of a circle
with a diameter only equal to the anterioposterior
diameter of the pelvis. Its extremity would be
about an inch behind the presenting point,
that distance further from the subpubic
ligament.

**Rotation.**

Sometimes during the course of labour
usually when the head presses against the
floor of the pelvis, rotation of the head occurs.

"The posterior fontanelle at last gradually moves
itself by slight degrees, repeated at equal intervals,
in a direction from left to right (frequently
more or less from above downwards) and the
occipital bone advances from the side of the
pelvis under the arch of the pubis. It is
not, however, the centre of the occiput that
advances under the pubic arch, but the
head approaches the as externum with the
posterior and superior part of the right
parametral bone, and remains in this position
until it has passed through the outlet of the
pelvis...." (7)

Lateral obliquity at the outlet is recognized
by almost all authors, and its amount has
been determined with some accuracy by Dr.
Leishman (8) "The direction of the capital's suture
have found the at this time from the left
ascending rami of the pubis of the right
sacro-sciatic ligament, somewhat nearer its
caudal than its ischiadic extremity." It is
easily accounted for. The presenting point (or
part) according to Nasgele is persistent, that is, today, the axis of rotation passes through it. But, adopting the view that this is the new persistent presenting point formerly described, it is evident that the axis is not perpendicular to the cranial plane engaged in the pelvis. Hence, that plane does not revolve in the pelvic plane, but assumes an oblique position.

In some instances, however, there is little or no obliquity at the outlet and the sagittal suture (in accordance with the descriptions of the older authors) corresponds with the antero-posterior diameter of the outlet. In such cases, at least in some of them, the presenting point is not persistent. A line passing through the left infra-malar articulation and through the right parietal bone at a point one-third of the distance of its protrusion from the sagittal suture midway between the two fontanelles will be found to very nearly represent the axis of rotation when the head is well flexed and in the first position. A line passing through the root of the left pterygoid process and through a point in the right parietal bone two-thirds of the distance of its protrusion from the sagittal suture midway between the two fontanelles very nearly represents the axis of rotation when the head is in the fourth position. The axes for the second and third positions, of course, pass through corresponding points on opposite sides.

Revolving about one or other of these axes (together with some preflexion) is a complete
description of the phenomena of rotation in these cases. The approximate ascertainment of the axes is, of course, only possible with the dried skull and pelvis. Such study, however, is sufficient to show that the coincidence of the sagittal suture with the antero-posterior diameter of the outlet is to be regarded as an abnormality rather than as the proper completion of rotation.
On the area of the plane of the brim in the normal female pelvis and in various abnormal female pelvis.

The size and shape of the plane of the pelvic brim are distinct subjects of inquiry, though the extent of its area has some inverse relation to the irregularity of its distributions. Hitherto the attention of obstetricians has been entirely confined to its distribution and, more especially, to projecting parts in, above and below the plane. Imnumerous diameters have been measured, and outline diagrams made, of the brim of all sorts of pelvis; and the normal and abnormal distributions of the plane of the brim have thereby been accurately mapped out for comparison. But, as far as the writer is aware, no estimate of the extent of area has been attempted in any case. Yet if an engineer were considering the problem of a relatively large body having to be pushed through a cylinder by a force often only sufficient to overcome the resistance when exerted during a considerable portion of a limited time, and in some cases (of itself) quite insufficient, and if, moreover, that force were, in part at least, hydrostatic, varying therefore, to that extent with the area, — no degree of regularity or irregularity in the form of the cylinder would render it less important for him to investigate the area of its lumina.

The following observations are based on an examination of thirty-five female pelvis and one (extremely rickety) male pelvis.
It is necessary to define at the outset what is meant by the "plane of the brim." Even in a normal pelvis the circumference of the brim is not exactly in a plane, the so-called plane being in reality a curved surface. The curvature, however, is so small that it may be disregarded. But in (for example) a marked case of malpresentation the brim is often greatly contorted and its surface no longer exactly plane but greatly curved. When the "area of the brim" is given in such cases this curved surface is not meant but a plane surface — the first plane surface in the loosen of the pelvis that is completely surrounded by a ring of bone. And the circumference, therefore, is not that of the anatomical brim, but of the ring of bone.

The brim of the average normal female pelvis has a definite circumference and area.

In abnormal pelves

1. The circumference remaining the same as in the normal pelvis, the area may be increased or diminished.
2. The circumference being greater or less than the normal, the area may be proportionately increased or diminished;
3. Or, the area may remain of normal extent or be disproportionately altered.

These abnormalities result from

1. Overgrowth, undergrowth, or shrinking of the pelvic brim or a part of it.
2. Strains, (a) in the plane of the brim, and (b) perpendicular to it. The following are the chief varieties of strains.

A nearer approach to the circular form with equal circumference the area is increased.

Change from the (roughly approximative)
Circular form to the (roughly approximating) elliptical form, the major axis being transverse. The "simply flat" pelvis is an example. With equal circumference the area is diminished.

Sinosus curvature of the circumference of the brim in its own plane. Three great incursions one posteriorly, two antero-laterally, occur in malacotic pelvis. Two great incurvations, one posteriorly, one anterically, occur in a form of rectal pelvis—the feint of eight form. One great incurvation posteriorly in another form of rectal pelvis—the reniform pelvis. With equal circumference the area is greatly diminished.

Diagram 3 is a projection of the outline of one half of the brim on the antero-posterior plane passing through the conjugate. P's is the conjugate diameter, and P's the projected outline of the brim in a normal pelvis. P's and P's corresponding parts in malacotic pelvis.

This deformation does not alter the circumference of the anatomical brim. But it diminishes the circumference of the first plane occupying the pelvis basin, and gives it a more elliptical form by diminishing the antero-posterior diameter while the transverse diameter remains unaltered. Hence the area is more than proportionately diminished.

In order to measure the circumference and area thin drawing paper was cut to such shape and size that the piece accurately fitted into and fully occupied the plane of the brim as above defined. A thread was then traced round the edge of the paper, and its length measured. The paper was then weighed, and (the weight of a square inch having...
been previously determined, the area was easily calculated. Slight error in cutting out the pattern of the brain was inevitable. The calculations presently mentioned do not make the error cumulative; hence the results may be termed rough rather than erroneous.

The results are given in Table I. The first column gives the reference number of the pelvis. The second column gives a general description of the pelvis. The third, fourth, and fifth columns give respectively the conjugate, transverse, and oblique diameters. Here it may be deemed that the conjugate diameter is not the same as the antero-posterior diameter of the plane of the brain; for the promontory is generally above that plane. The eighth and seventh columns give respectively the circumference and area. The eighth column gives the area which a normally shaped pelvis with the same circumference as the deformed one would have. This is obtained by

\[ a - \left( \frac{c'}{c} \right)^2 = \pi \]

where \( a \) is the area and \( c \) the circumference of the brain of the normal pelvis, and \( c' \) the circumference of the brain of the other. The mean area and circumference of pelvis 11 and 2 gave the values of \( a \) and \( c \). The loss from deformity is thus readily estimated.

Accompanying this thesis is a sketch book containing exact outline copies of the patterns of all the pelvis examined.
<table>
<thead>
<tr>
<th>No.</th>
<th>Description of Fetus</th>
<th>Conjugate diameter in mm</th>
<th>Transverse diameter in mm</th>
<th>Oblong diameter in mm</th>
<th>Circumference in inches</th>
<th>Area in square inches</th>
<th>Area of ellipse of same Circumference</th>
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<td>Ricketsy</td>
<td>3.75</td>
<td>4.875</td>
<td>4.5</td>
<td>13.75</td>
<td>13.13</td>
<td>14.26</td>
</tr>
<tr>
<td>XVII</td>
<td>Ricketsy</td>
<td>3.75</td>
<td>4.25</td>
<td>4.5</td>
<td>13.75</td>
<td>13.13</td>
<td>14.26</td>
</tr>
<tr>
<td>XVIII</td>
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<td>2.0</td>
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<td>4.75</td>
<td>14.12</td>
<td>11.87</td>
<td>15.04</td>
</tr>
<tr>
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<td></td>
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<td>4.75</td>
<td>4.5</td>
<td>15.0</td>
<td>11.37</td>
<td>13.24</td>
</tr>
<tr>
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<td></td>
<td>2.875</td>
<td>4.75</td>
<td>4.25-4.00</td>
<td>13.25</td>
<td>11.28</td>
<td>14.78</td>
</tr>
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<td></td>
<td>3.75</td>
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<td>4.5</td>
<td>14.0</td>
<td>11.28</td>
<td>16.97</td>
</tr>
<tr>
<td>XXII</td>
<td>Malacoeltos</td>
<td>3.125</td>
<td>4.625</td>
<td>4.3-4.5</td>
<td>15.0</td>
<td>11.0</td>
<td>16.97</td>
</tr>
<tr>
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<td></td>
<td>3.75</td>
<td>4.875</td>
<td>3.8-4.5</td>
<td>15.0</td>
<td>11.0</td>
<td>16.97</td>
</tr>
<tr>
<td>XXIV</td>
<td></td>
<td>3.75</td>
<td>4.3</td>
<td>3.8-3.6</td>
<td>15.125</td>
<td>10.47</td>
<td>17.25</td>
</tr>
<tr>
<td>XXV</td>
<td></td>
<td>3.6</td>
<td>4.0</td>
<td>4.25-4.00</td>
<td>16.0</td>
<td>10.27</td>
<td>19.31</td>
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<td>3.375</td>
<td>3.75</td>
<td>3.9-3.4</td>
<td>13.375</td>
<td>9.81</td>
<td>13.48</td>
</tr>
<tr>
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<td>3.5</td>
<td>3.0</td>
<td>3.875</td>
<td>12.125</td>
<td>9.73</td>
<td>11.05</td>
</tr>
<tr>
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<td>3.375</td>
<td>4.5</td>
<td>3.75-3.5</td>
<td>14.0</td>
<td>9.05</td>
<td>14.17</td>
</tr>
<tr>
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<td></td>
<td>3.75</td>
<td>3.0</td>
<td>3.875-3.5</td>
<td>12.375</td>
<td>8.4</td>
<td>11.55</td>
</tr>
<tr>
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<td></td>
<td>2.0</td>
<td>3.0</td>
<td>2.8</td>
<td>12.875</td>
<td>5.31</td>
<td>12.35</td>
</tr>
<tr>
<td>XXXI</td>
<td>Malacoeltos</td>
<td>1.5</td>
<td>4.125</td>
<td>3.875-4.00</td>
<td>13.125</td>
<td>8.0</td>
<td>13.48</td>
</tr>
<tr>
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<td>3.25</td>
<td>3.6</td>
<td>13.25</td>
<td>7.41</td>
<td>18.24</td>
</tr>
<tr>
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<td>2.875</td>
<td>3.875</td>
<td>3.5-3.0</td>
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<td>6.54</td>
<td>13.94</td>
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<tr>
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<td>3.6</td>
<td>2.8</td>
<td>12.875</td>
<td>5.31</td>
<td>12.35</td>
</tr>
<tr>
<td>XXXV</td>
<td></td>
<td>3.0</td>
<td>3.5</td>
<td>3.35-3.25</td>
<td>13.825</td>
<td>5.67</td>
<td>14.0</td>
</tr>
<tr>
<td>XXXVI</td>
<td></td>
<td>2.0</td>
<td>3.5</td>
<td>3.0</td>
<td>14.125</td>
<td>3.05</td>
<td>15.05</td>
</tr>
</tbody>
</table>
Examination of this table brings out important results.

Pelvis IV and V are taken as most nearly approaching the standard form and diameter.

<table>
<thead>
<tr>
<th>No. of pelvis</th>
<th>Circumference in inches</th>
<th>Actual area in sq. inches</th>
<th>Area of circle with same circumference</th>
<th>Difference in area</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV</td>
<td>16</td>
<td>19.24</td>
<td>20.38</td>
<td>1.14</td>
</tr>
<tr>
<td>V</td>
<td>15.25</td>
<td>17.69</td>
<td>18.52</td>
<td>.83</td>
</tr>
</tbody>
</table>

From this table it is evident that the imperfect normal form of the brim of the pelvis involves a top of about one inch in the area of its plane.

Pelvis I and II are unusually large, with brims more nearly circular than normal.

<table>
<thead>
<tr>
<th>No. of pelvis</th>
<th>Circumference in inches</th>
<th>Actual area in sq. inches</th>
<th>Area extended from area with same circumference</th>
<th>Difference in area</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>16.4375</td>
<td>21.01</td>
<td>20.37</td>
<td>.64</td>
</tr>
<tr>
<td>II</td>
<td>16.125</td>
<td>20.03</td>
<td>19.6</td>
<td>.43</td>
</tr>
</tbody>
</table>

From which two examples it is evident that in some pelvis, the outline of the brim is such as to increase the area of its plane by about half an inch beyond the normal.

Pelvises VIII, XV and XVII are approximately equal to the just minor. But the brim of XV is more nearly circular than the normal, and XVII has a slight obliquity.
Table IV.

<table>
<thead>
<tr>
<th>No. of pelvis</th>
<th>Circumference</th>
<th>Actual Area</th>
<th>Area of standard form, little moon circumference</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII</td>
<td>14.375</td>
<td>13.48</td>
<td>13.53</td>
<td>-0.05</td>
</tr>
<tr>
<td>XV</td>
<td>13.25</td>
<td>13.53</td>
<td>12.99</td>
<td>(-)0.54</td>
</tr>
<tr>
<td>XVII</td>
<td>13.375</td>
<td>13.14</td>
<td>13.48</td>
<td>(+)0.34</td>
</tr>
</tbody>
</table>

No. III is a "simply flat" pelvis, and XV, XVI, and XVII "generally contracted flat" pelvises.

Table V.

<table>
<thead>
<tr>
<th>No. of pelvis</th>
<th>Circumference</th>
<th>Actual Area</th>
<th>Area of standard form, little moon circumference</th>
<th>Difference</th>
<th>Anti-post. diam. etc. planes</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>16.25</td>
<td>19.46</td>
<td>19.03</td>
<td>+0.47</td>
<td>3.56</td>
</tr>
<tr>
<td>X</td>
<td>14.25</td>
<td>14.82</td>
<td>15.32</td>
<td>+0.57</td>
<td>3.56</td>
</tr>
<tr>
<td>XVI</td>
<td>14.50</td>
<td>13.46</td>
<td>15.86</td>
<td>+2.46</td>
<td>3.425</td>
</tr>
</tbody>
</table>

Such pelvic deformity is so frequent, and consequently so important, that it may prove useful to put these few data in another way. It may be asked — if four women had pelvics of a given size, and the brims of these pelvices became (from any cause) so distorted that in form they exactly resembled the brims of III, X, XVI, and XVII, respectively, — what would be the areas of their planes?

Let the common circumference be 16 inches. in order that the areas may be compared with that area of the brim of the normal pelvis IV, the problem is readily solved by the formula:

\[ a \left( \frac{16}{2} \right)^2 = x \]

Where \( a \) is the area, and 16 the circumference, of the brim.
The deformed pelvis. The following table gives the result together with the calculated antero-posterior diameters.

<table>
<thead>
<tr>
<th>No.</th>
<th>Circumference</th>
<th>True Area</th>
<th>Anterior-posterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV.</td>
<td>16</td>
<td>19.24</td>
<td>22.25</td>
</tr>
<tr>
<td>(III)</td>
<td>18.86</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>(IX)</td>
<td>18.71</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>(XV)</td>
<td>17.61</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>(XVII)</td>
<td>17.88</td>
<td>3.9</td>
<td></td>
</tr>
</tbody>
</table>

The greatest loss, therefore, would be 1.63 sq. in. in pelvis (XVI).

Pelvises VI, VII and XXV are vically. Their right and left values are approximately symmetrical, and their conjugate diameters is contracted.

<table>
<thead>
<tr>
<th>No.</th>
<th>Circumference</th>
<th>True Area</th>
<th>Area Obtained</th>
<th>Difference</th>
<th>Not post. of plane</th>
</tr>
</thead>
<tbody>
<tr>
<td>XI</td>
<td>14.875</td>
<td>14.82</td>
<td>16.66</td>
<td>1.84</td>
<td>3.24</td>
</tr>
<tr>
<td>XII</td>
<td>15.0</td>
<td>13.03</td>
<td>16.97</td>
<td>3.04</td>
<td>3.25</td>
</tr>
<tr>
<td>XXV</td>
<td>13.25</td>
<td>11.87</td>
<td>13.24</td>
<td>1.8</td>
<td>2.575</td>
</tr>
</tbody>
</table>

Calculating, by the preceding formula, the areas of similar pelvises with 16 inches as the common circumference of brim, we get the following result.
### Table VIII.

<table>
<thead>
<tr>
<th>No. of Pelvis</th>
<th>Circumference</th>
<th>Area</th>
<th>Anteroposterior diameter of plane</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV</td>
<td>16</td>
<td>19.24</td>
<td>4.25</td>
</tr>
<tr>
<td>(XI)</td>
<td></td>
<td>17.04</td>
<td>3.5</td>
</tr>
<tr>
<td>(XII)</td>
<td></td>
<td>13.88</td>
<td>3.47</td>
</tr>
<tr>
<td>(XX)</td>
<td></td>
<td>16.48</td>
<td>3.47</td>
</tr>
</tbody>
</table>

The greatest loss, therefore, would be 3·36 in pelvis (XII). Comparing Tables VII + VIII it is evident that, circumference and anteroposterior diameter being equal, a simply flat pelvis has a greater area of brim than a uniform rectangular pelvis. The mean area of (III) and (XVI) is 18.23 sq. in.; that of (XI)(XII)(XX) 16·46 sq. in. and the difference, 1.77 sq. in.

Pelvis VII is triangular and XXII coroliform. Both have a circumference of 15 inches, the effect of circumvallation of the sacrum is at once seen by placing them together for contrast.

### Table IX.

<table>
<thead>
<tr>
<th>No. of Pelvis</th>
<th>Circumference</th>
<th>Area</th>
<th>Anteroposterior diameter of plane</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII</td>
<td>15</td>
<td>15.48</td>
<td>4.5</td>
</tr>
<tr>
<td>XXI</td>
<td>15</td>
<td>11.28</td>
<td>3.1</td>
</tr>
</tbody>
</table>

The effect of rickets and malacostasis is shown in the parallel series in Table IX. The pelvis of Table V + VII are included under the head of "rickety pelvis." The second column in each series gives the actual area. The third gives the loss relative to an assumed standard area, the mean of the areas of pelvis IV & V, of 18.47 square inches. The fourth gives the loss from deformations of its circumference from the normal. This column, accordingly, represents the loss from strain in the plane of the brim.

The writer has not been able to discover any
Simple laws for the rate of diminution of area in either form
The numerous irregularities of form make this difficult or
impossible.

**Table X.**

<table>
<thead>
<tr>
<th>No.</th>
<th>Actual Area</th>
<th>Log on Average Area</th>
<th>Log from Oceanic Pelvis</th>
<th>No.</th>
<th>Actual Area</th>
<th>Log on Average Area</th>
<th>Log from Oceanic Pelvis</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>19.46 (-)1.1</td>
<td>10.4</td>
<td>XXXI</td>
<td>11.28</td>
<td>7.2</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>17.52</td>
<td>3.0</td>
<td>XXXII</td>
<td>11.02</td>
<td>7.4</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>15.48</td>
<td>2.0</td>
<td>XXXIII</td>
<td>10.47</td>
<td>8.0</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>15.26</td>
<td>1.8</td>
<td>XXXIV</td>
<td>10.27</td>
<td>8.2</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>VII</td>
<td>14.82</td>
<td>1.5</td>
<td>XXXV</td>
<td>9.81</td>
<td>8.6</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>VIII</td>
<td>14.82</td>
<td>1.8</td>
<td>XXXVI</td>
<td>9.57</td>
<td>9.1</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>IX</td>
<td>13.93</td>
<td>3.0</td>
<td>XXXVII</td>
<td>8.48</td>
<td>10.0</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>13.71</td>
<td>2.9</td>
<td>XXXVIII</td>
<td>8.40</td>
<td>10.0</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
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<td>13.46</td>
<td>2.4</td>
<td>XXXIX</td>
<td>7.41</td>
<td>11.0</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
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<td>13.14</td>
<td>1.9</td>
<td>XXXX</td>
<td>6.54</td>
<td>11.9</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>XIII</td>
<td>11.72</td>
<td>1.9</td>
<td>XXXXI</td>
<td>5.86</td>
<td>13.18</td>
<td>7.2</td>
<td></td>
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<tr>
<td>XIV</td>
<td>11.28</td>
<td>2.5</td>
<td>XXXXII</td>
<td>5.66</td>
<td>12.8</td>
<td>8.3</td>
<td></td>
</tr>
<tr>
<td>XV</td>
<td>11.28</td>
<td>5.2</td>
<td>XXXXIII</td>
<td>3.06</td>
<td>15.4</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>XVI</td>
<td>8.0</td>
<td>10.4</td>
<td></td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finally, the great diminution of area in XXV is evident in the pelvis of Robert, and the small diminution (from the more uniform curvature of the normal or secondary affected side) in XXXI, a pelvis with the Magellae obliquity.
On the area of certain cranial planes in the foetus.

The principal areas of the body are perfected through the pelvis, their diminution and redistribution under pressure, are worthy of minute investigation. Determination of the areas presented by the pelvis in spontaneous evolution, head-locking, hydrocephalus, etc., and after such operations as cephalostomy, paramidotomy, would certainly assist the advance of the science of operative midwifery. Partly, however, for the sake of simplicity, and partly from want of material, the writer has only attempted to determine the area of three chief planes of the head.

Six living children, born at full term, were subjected to measurement. A piece of head wire of sufficient thickness to retain any unformed form was moulded accurately over the head, and the pattern thus obtained was traced out on silk, paper, cut out and weighed. It may be mentioned that in every case the head presented in labour.

Table XI gives the results.

<table>
<thead>
<tr>
<th>Plane</th>
<th>1. Par. 10 inch of head</th>
<th>2. Par. 17 cm of head</th>
<th>3. Par. 24 cm of head</th>
<th>4. Par. 31 cm of head</th>
<th>5. Par. 37.5 cm of head</th>
<th>6. Par. 44.5 cm of head</th>
<th>Weight of Plane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biparietal diameter</td>
<td>3.75</td>
<td>3.64</td>
<td>3.5</td>
<td>3.575</td>
<td>3.625</td>
<td>3.75</td>
<td></td>
</tr>
<tr>
<td>Suboccipital-bregmatic</td>
<td>4.0</td>
<td>4.0</td>
<td>3.875</td>
<td>4.25</td>
<td>4.0</td>
<td>3.75</td>
<td></td>
</tr>
<tr>
<td>Occipital-fontal</td>
<td>4.0</td>
<td>4.5</td>
<td>4.75</td>
<td>4.75</td>
<td>4.375</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>Parietal-mental</td>
<td>5.25</td>
<td>5.5</td>
<td>5.12</td>
<td>5.0</td>
<td>5.375</td>
<td>5.625</td>
<td></td>
</tr>
<tr>
<td>Suboccipital-bregmatic-plane</td>
<td>14.67</td>
<td>11.4</td>
<td>12.145</td>
<td>11.5</td>
<td>11.45</td>
<td>11.28</td>
<td>12.01</td>
</tr>
<tr>
<td>Occipital-fontal</td>
<td>16.65</td>
<td>14.6</td>
<td>13.88</td>
<td>13.9</td>
<td>13.18</td>
<td>...</td>
<td>14.44</td>
</tr>
<tr>
<td>Parietal-mental</td>
<td>17.87</td>
<td>16.8</td>
<td>16.16</td>
<td>15.9</td>
<td>15.61</td>
<td>15.04</td>
<td>15.07</td>
</tr>
</tbody>
</table>

* The child of a Liquorist.
Hence, the head being of normal size and the vertex presenting, the cranial plane engaged in the pelvis measures twelve square inches when the head is greatly flexed, and fourteen and a half when not at all or only slightly flexed. When the brow presents, the cranial plane measures sixteen square inches.

For a comparison of these areas with the area of the brim of a pelvis it is necessary to abstract from the latter the area of the soft parts clothing the brim (peritoneum and sub-peritoneal cellular fat), of the rectum, and of the uterus or vagina where they pass through the plane. An exact estimate is impossible. The following, however, is a rough approximation.

Taking the peritoneal and sub-peritoneal tissues as one eighth of an inch thick and the circumference of the brim as sixteen inches long, then the area of the cross section of these parts equals 2 square inches.

Taking the uterine passages as of the same thickness and its circumference as fourteen inches, then the area of cross section equals 1.75 square inches.

The area of cross section of the rectum is about .5 square inch.

Hence the whole area to be deducted from that of the brim is 4.25 square inches. In order, however, to be within the mark we may allow that pressure may diminish this by 1.25 sq. in. The area, therefore, to be deducted equals 3 square inches.

From consideration of areas only it is evident, then, that a head of normal size with the vertex presenting would pass through pelvis I to VI inclusive, and might pass, if well flexed, through pelvis VII to IX. But before it could pass through any of the other pelvis it would be necessary to reduce its dimensions by cephalostomy or other operative procedure.

In the above statement it is assumed
that the whole of the area of the plane of the
breech in pelvis VII and IX might be occupied by
the cranial plane engaged in it. A distinction,
however, must certainly be drawn between the
actual area and the available area, available
either for occupation by a child that may be
alive or by a child that must be dead. The
area available to a dead child is probably in
nearly all cases coextensive with the actual area.
But that available to a living child must often
be much less extensive. Into this subject, however,
the writer does not propose to enter further.

The area of cross-section of the forearm of
an infant is about an inch and a quarter, and
that of the arm and leg about an inch and a half.
Hence if the two arms descend with the head the
foetal plane engaged in the pelvis is increased by
from two and a half to three inches.

It is evident that a part of the pelvic area
that is not available to the head may yet be available
to an arm, a leg, or the umbilical cord.
Contributions to the dynamics of pregnancy and labour.

Direct measurement of the pains of labour was first definitely proposed and a method suggested by Dr. Duncan in 1867. Since then Gebhard has published an elaborate series of investigations on this subject. It is not hereupon proposed to give an abstract of his researches, not to treat the subject generally, but only to state shortly the result of some observations made chiefly during the years 1872 and 1873, before the writer had opportunity of perusing Gebhard's papers.

1. On the intra-uterine pressure during pregnancy.

Two cases have here to be narrated. In neither was chloroform given.

It is interesting to compare the following formula from Gebhard with the first case, which, in part at least, bears it out. (20)

"After the uterine pressure of the interval between the pains has been extensively increased by the former sudden increase of its contents, after a time the pressure falls back to about its former height, without the uterine contents having been diminished to its former amount."

Again, Dr. Wren Müller has recently shown that the vascular system of the placenta possesses a power of accommodation. He found that on the abstraction of a certain limited amount of blood from a mammal there was only temporary diminution of the blood-pressure, in a short time it returned to its normal height, although the circulating fluid remained decreased in amount. Conversely on
injecting fluid into the vein, the increase of
pressure consequent on the increased amount
of blood in the refills was only temporary, the
pressure soon resuming its normal height;
although the circulating fluid remained
increased in amount.

Case 1. E.P. aged 19, admitted into hospital
18 Aug. 1873. Had been confined of her first
child on 10 Aug. 1872 in hospital, caesarean
section being resorted to, giving contraction of the
uterus. The foetus was "exactly three inches" in length.
Last menstruation 5 July 1873. She was found to
be at about the end of the seventh month of
pregnancy, and induction of labour was
advised and consented to. In order to induce
labour the finger in charge determined that
a large quantity of water should be injected
into the uterus. The water, therefore, asked
and obtained permission to connect a
mercurial gauge with the apparatus for
injection, and note the results. I see stated
at end of description as follows:

19th inst. Great care was taken that the
apparatus was completely filled with water.
The woman lay on her left side, and the
mercury in that gauge was eight inches
below the level of the horizontally placed
catheter, which was passed outside the membrane
three or four inches into the uterus. The cervix was
closed by the surgeon's finger. Assuming that
the point of the catheter was in a straight
line with the point of external bolla of the
following noted pressures (from which lies.
mercury have been deducted in order to allow for
the weight of water from the catheter to the patient.) If
the mean intra-uterine pressure, the woman
lying on her side.
From 4.10 to 4.20 p.m. 40 g warm water
were slowly injected through the catheter into the
uterus. During each injection with the syringe
the pressure was about 12 inches mercury (about
6 lb). After each injection the tap 6 was
turned. The pressure given is that noted after a
short interval of time.

At first only a drachm or so of water was
injected; pressure about 0.4 in. (30 g.) After the
first syringe full had been injected, the pressure
was 0.9 in. (73 g.c.). During the injection of
the remainder of the 40 g. the pressure was
gradually raised until after the whole was injected
it had reached 1.4 in. (119 g.c.). The finger of
the operator was now withdrawn from the cervix, and
that of the operator (then the assistant) was inserted in its
place. Only a small quantity of water escaped, and
some more was then added to replace it. The manubrium
was now raised 6 or 7 inches above the level of the
water. Pressure after a short interval 1 in. (8 g.) On
this, the patient occasionally coughed. Each cough
raised the pressure lineally 4 in. mercury (2 lb.) At
5.10 p.m. one attempt raised the pressure to 6.5 in. After this
the water gradually escaped from the uterus. The
membranes were found. The entire. The feet
presented.

7th inst. 10 a.m. Membrane entire, but nearly
fully dilated. Unassisted. The surgeon in attendance
accordingly turned and delivered a living child of
about the seventh month of pregnancy. The woman did well
so far as obstetrical was concerned, but died of
septicemia in a somewhat unhealthy hospital.
From this case it appears that the intra-uterine pressure during pregnancy is only about 3 ounces on the square inch, that immediately after the injection of a quart of water this pressure is increased to 11 ounces but gradually subsides to 8 ounces.

Case 2. W. R. aged 35. Has had five children and three miscarriages. After the birth of the third child patient had numerous fits lasting about an hour. They occurred three or four times a day for six weeks, after which they subsided. A sea voyage restored her to apparent health. The seventh pregnancy ended in miscarriage at the fifth month. She states that she had flooding after it, and completely lost her eyesight for a period of twelve days — after which it suddenly returned.

From the 20th to 24th Sept. 1874 the patient was threatened with miscarriage at about the fourth month of pregnancy, during which the writer attended her. The symptoms, however, went off and the pregnancy continued. She was again seen on 29th Dec. She was perfectly blind, being unable to distinguish between light and darkness, and stated that her eyesight had become more or more imperfect since the 16th inst. She had also constant severe headache, vomiting nearly all her food, and her mind was very much depressed. The urine was normal in quantity and without albumen or casts. As regards the urine almost daily examination during several weeks gave similar results. The specific gravity varied from 1015 to 1020.

5th Jan. 1875. Since first report patient has proved been getting worse in spite of careful dieting and her condition now appears serious. 1 pm to 3 pm. Convulsions, not violent but long continued. Chloroform given during the convulsions, and chloral in the evening.
7 a.m. Threatened convulsion; no loss of consciousness, but twitching of arms and legs. Shortly after this she thought three distinct labour pains.
2.45 p.m. Os found found sufficiently dilated to admit the finger.
3 p.m. As there was no further appearance of labour being about to set in, and as the patient was at about the eighth month of pregnancy, the writer determined to induce the labour.

The apparatus used was similar to that used at St. Helen's, only that for the mercurial gauge was substituted a Boarder's gauge to be described hereafter. The whole apparatus was carefully emptied of air and filled with water. The patient being in the ordinary obstetric position the gauge was brought to a level with the as, the catheter (about 8 in.) inserted about three inches into the uterus and the cervix plugged with the finger. About two ounces of water were injected, some of which escaped. The pressure of the syringe was 2 lbs.

During the gradual escape of the water from this injection, there were three times repeated with intervals of about five minutes. After each injection the pressure sank to 0.6 lbs (= about 9.1 g) at which it remained for several minutes. This result was very pleasing and marked. The catheter was then removed. The further history of the case will be hereafter narrated.

In this case, then, the intra-uterine pressure was apparently greater than in the first case. The conditions of the uterus were very similar in each.
and has attempted to distinguish the "pseudo-intra-uterine" pressure (or intra-uterine pressure from the combined effect of the tension of the abdominal and uterine muscles) from the "water-pillar" pressure. The method he adopted was to put the women under chloroform, insert a cærocatheter bag through the os internum and inject it with water. The bag was connected by a tube with a kymograph and mercurial dynamometer. This method appears to necessitate too much interference with the uterine to yield results of much value. The following, however, is the translation of the general results from observation in the first case: (32) "In a uterus pregnant for the eighth time after the insertion of a balloon filled to measure alongside the womb in the thirty-eight weeks of pregnancy the pseudo-intra-uterine pressure before the beginning of the birth amounted to exactly the same as in the birth during the interval between the pains, that is, in the back position, 20 mm. of mercury. As if these 20 mm. 15 are caused by the water-pillar pressure of the uterus, so amounted the intra-uterine pressure caused by the tension of the uterine and the belly muscles. Then the uterus is inactive and the woman lying on her back to 5 mm. mercurial pressure the inactive muscular tissue of the expanded cervix amounted in comparison to a pressure of only 2 mm."

He was not quite so fortunate in the observation of this second case, when a woman near the full term. He thus states the general results: (33) "In a uterus pregnant for the fourth time the intra-uterine pressure before the birth amounted at its highest probably to
3.5 mm. mercury. The increase of the uterine contents by the greatly filled balloon raises the intra-uterine pressure 3 mm., a result which one must attribute to the stretching of the muscles fibres by the increased distension. But the increase of pressure subsides again through accommodation. The muscular tone of the cervix caused by very moderate stretching an increase of from 0.5 to 1.5 mm. by great stretching from this to 8.5 mm. The first birth pain [which caused the expulsion of the bag and confirmed further observation] found here also no changing influence on the height of the intra-uterine pressure between the pains."

The mean intra-uterine pressure, therefore, during the latter months of pregnancy, according to Schatz is, when the woman lies on her back, 7.5 + 3.8 = 12.3 mm., or half an inch of mercury.

2. The force required to dilate the cervix uteri

The very existence of rigid cervix can never be predicated until we have determined the normal resistance of the cervix to dilatation and have ascertained by direct measurement that in certain cases that resistance is increased. The two subjoined cases are wholly inadequate to determine the required force. They are sufficient, however, to show the direction in which the writer was, desirous of working, had he been able to get suitable cases.

Case 1. A woman with a distinct history of syphilis, ch. 39. 11 children of which 9 were born dead. Requested by a midwife to see her on 7th May 1874, found that the membranes had ruptured on the 4th March, that since then pains had been weak and infrequently
notwithstanding frequent administrations of ergot.
11 a.m. Cervix soft but undilated, lower segment of
tons hard as if firmly contracted. A foot appeared
to present, but the os was too high in the pelvis to
allow of this being ascertained with certainty.
2 p.m. A 2 to 2 Barus’ bag inserted into the cervix
uteri and connected with the Broun’s gauge
(hide inflat). Water was then injected (by a force of
10 lbs on the square inch) until the pressure
within the bag remained at 2½ to 3 lbs when the
spongia was disconnected. The greater part of
the os uteri was completely dilated, and the bag
was extended. Chloroform was given and the foot
seized and brought down until the child’s pelvis
was engaged in the cervix. More ergot was then
given, but as it failed to bring on uterine contractions,
the delivery was artificially completed at 3.30 p.m.
The child was still born, but the mother made a
good recovery.

Case 2. This is the second case described
under the heading “intra-uterine prosthesis during
pregnancy.” Separation of the membranes proving
insufficient to bring on labour, and it being desired
to conclude the labour as soon as possible, chloroform
was administered at 6.40 p.m., and 2 to 2 Barus’ bag
inserted into the cervix and distended. From
6.40 to 7 p.m. the pressure of the bag (as shown by the
Broun’s gauge) was from 2½ to 3 lbs on the sq. inch.
At the end of this time the cervix was found to
have been dilated to the size of a crown piece. At
7 p.m. the largest sized bag was inserted and
distended until its pressure equalled 2 lbs on the
sq. inch. At 7.25 p.m. this prosthesis had so
dilated the os that the bag was extended. At 7.30 p.m.
the membranes were ruptured, and the foot seized and brought down. Expot and hand were then given. At 9.15 p.m. a few sharp pains occurred, the child was then artificially delivered. The uterus contracted well, and the patient made a good recovery though the convulsions recurred with great severity for several weeks after the confinement. The child was stillborn.

Unfortunately in both cases the premature within the bag after their removal from the vagina was neglected.

3. The effective prepared during the second stage of labour.

A clinical instrument for precise measurement of the power of labour at all stages, capable of being applied without pain or injuring the mother or child, is greatly to be desired. Until it has been discovered and extensively applied we can have no exact knowledge of such subjects as rigidity of the os uteri and of the perineum, "poorly," and "obstructed" labour, the effect of chloroform, ergot, etc. And until data so obtained have been duly sifted and compared, no scientific rules for treatment are possible.

It is not too much to say that such an instrument would rival in importance the stethoscope and thermometer.

Schatz has, indeed, measured the intra-uterine pressure per square mil through the whole course
of labour in twenty-five cases, and has apparently obtained, by the aid of a kymograph and
mesurinal dynamometer, very exact results.
he connected these by means of tubes with a coothing
balloon or bag into which and along part of the
tube a flexible catheter was slipped in order to
maintain the portency. After such preparation (and
certain precautions had been taken which need not
here be narrated) the balloon was introduced into the
uterus. "This is best done under chloroform
anesthesia, and is possible as soon as the os
exterrnun is patent to the finger. For the intro-
duction of the balloon one must always insert the
whole hand into the vagina, and usually one
will use two or three fingers to push it past the
os intemnum, which, when the external os is
related to the eje of a thaler, is often 5 centimeters
or more above the pelvic inlet. The balloon is
introduced according to the position of the head,
always on the abdominal aspect of the child,
— for example, in the first position, in the
right half of the uterus; and, of course, one avoids,
if possible, tearing the membranes. When the whole
balloon (somewhat folded within itself) is slipped past
the internal os, it is firmly held there (usually
near the child's face) with the fingers, and an
amount of water previously found to be sufficient
is injected with a large enough glass syringe.

But by this method one cannot estimate
the effective pressure against the cervix after
rupture of the membranes, or against the trun or
perineum. For we have as yet no means of estimating
the area over which the known pressure per square
inch is exerted with effect, and no means of
estimating the top of power from the clasping of the
child by the body of the uterus, and by the cervix.
(after the head has passed), and from fictitious resistance in the remainder of the pelvic passage. Moreover, the method necessitates administration of chloroform, is perhaps a little dangerous, and is certainly inapplicable out of a German hospital. Therefore, though Schatz has laid the experimental foundation of the dynamics of labour, he certainly has not invented an instrument fitted for clinical use.

In 1872 and 1873 the writer (being then house-surgeon at the Royal Infirmary, Liverpool) spent much time in attempting to an instrument that should be portable, easy of application and not painful or injurious, and capable of measuring both extant and the effective pressure of the pains at any stage of labour. Though Schatz's first paper was published in 1871, the writer had no knowledge of his method until after the observations were concluded. As will be observed, the two methods adopted differ entirely in their principle.

Evidently the method described above for the measurement of the prepuce within the uterus during pregnancy is also applicable for during labour until the os uteri becomes dilated. No observation, however, were made in this way.

The following is the principle or method of measurement that was adopted.

During a pain, the whole prepuce upon the head, the os being fully dilated and the head in the cavity of the pelvis, was allowed to be directed against a caoutchouc bag partially distended with water. This bag was connected by a flexible tube to a manometer, and the
Height to which the pressure within the bag was noted. After the labour was over, additional leaden weights were placed upon the bag until the manometer indicated the pressure previously noted. The weight which raised the pressure to this height was considered the effective pressure of that pain. In the observation no measurements of the duration of the pressure of a pain were made. The Bag. In the first few cases a globular caoutchouc bag, two inches in diameter, was used. It was inserted within the vagina, and counterpressure made with a porcelain ring preparatory to the labour. The bag was placed upon the ring preparatory before the weights were put on it. The observation where this bag was used is recorded below. The others were tentative and not worth recording as only one or two pains were measured. The objection to this method was that the progress of the head was stopped by the bag, hence continuous observation was impossible, or at least unjustifiable.

A Barnes' bag (no. 2) was next tried. As soon as the head came down upon the perineum, the bag with from 1½ to 2 oz. water was slipped between them. In this way the progress of labour was not at all interrupted during observation; for the whole pressure was transmitted to the perineum. Sometimes the bag remained in situ during the pains without assistance, but occasionally it had to be prevented from slipping out of the vagina by placing within it fingers. If ordinary and is taken, the perineum undergoes no risk of laceration from the pressure of the bag. For at any moment the head may, if desired, be held back by the hand of the attendant and the bag emptied and removed. After labour the bag (with the same oxygen...
contents) was placed on a flat table, and then weighted. Cases 2 to 9 (inclusive) reported below were observed with this bag.

A flat caoutchouc bag, two and a half inches long by two wide, not fiddle-shaped was next tried in Cases 10 and 11.

Finally a flat caoutchouc bag, three inches long by two and a half wide, not fiddle-shaped, distilled with one ounce and a half of water was selected as the best suited for that purpose. Cases 12 and 13 were observed with this bag.

\[\text{Manometer} \]

In all but the thirteenth reported case the open mercury gauge depicted in sketch was employed. It must be clearly understood that in the reports the pressures stated do not represent pressure per square inch, but the whole pressure upon the perineum (except in Cases 1 and 10 where the perineum was not being distended during observation).

A mercury gauge is satisfactory in all but two respects— it is somewhat alarming in appearance, and it is not portable. According to an extremely sensitive but very exact Riversen's gauge was constructed for the writer by a well-known Liverpool maker. It measures three and three-quarters inches across and is one and three-eighths deep. It weighs only fourteen to a half ounces. This beautiful instrument together with the bag found by observation to be the most serviceable is submitted with this thesis as a clinical tonoodynamometer, portable, painless and uninjurious in application, and of great exactitude. Continuous observations can be made, if desired, with it from the time the head comes down upon the
perrineum to the completion of the labour without interfering with its progress. For the whole of the effective uterine and abdominal pressure is transmitted to the perrineum and distributed equally over it.

In order to save the trouble of placing the weights on the bag after each labour, the following observations were made. The bag contained exactly 1.5 oz. water.

<table>
<thead>
<tr>
<th>Brand's gaze</th>
<th>Weight on bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 lb per sq. in</td>
<td>4 lbs</td>
</tr>
<tr>
<td>1.4</td>
<td>7</td>
</tr>
<tr>
<td>2.2</td>
<td>11</td>
</tr>
<tr>
<td>3.0</td>
<td>14</td>
</tr>
<tr>
<td>3.9</td>
<td>18</td>
</tr>
<tr>
<td>4.2</td>
<td>21</td>
</tr>
<tr>
<td>4.8</td>
<td>23</td>
</tr>
<tr>
<td>5.2</td>
<td>28</td>
</tr>
<tr>
<td>5.6</td>
<td>32</td>
</tr>
<tr>
<td>6.2</td>
<td>35</td>
</tr>
<tr>
<td>6.6</td>
<td>39</td>
</tr>
<tr>
<td>7.2</td>
<td>42</td>
</tr>
<tr>
<td>7.6</td>
<td>46</td>
</tr>
<tr>
<td>8.0</td>
<td>49</td>
</tr>
</tbody>
</table>

From these data a scale sufficiently exact for practical purposes may easily be calculated.

Table XII

<table>
<thead>
<tr>
<th>Brand's Gaze</th>
<th>Weight in lbs</th>
<th>Brand's Gaze</th>
<th>Weight in lbs</th>
<th>Brand's Gaze</th>
<th>Weight in lbs</th>
<th>Brand's Gaze</th>
<th>Weight in lbs</th>
<th>Brand's Gaze</th>
<th>Weight in lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>3.5</td>
<td>14</td>
<td>5.5</td>
<td>26.5</td>
<td>7</td>
<td>41.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>7.5</td>
<td>3.5</td>
<td>16.5</td>
<td>5.5</td>
<td>30.5</td>
<td>7.5</td>
<td>45.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>4.5</td>
<td>19</td>
<td>6</td>
<td>34</td>
<td>8</td>
<td>49.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>19</td>
<td>4.5</td>
<td>21.8</td>
<td>6.5</td>
<td>37.9</td>
<td>8.5</td>
<td>53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No prepare has been observed higher than this during labour.

The following figures are the calculations:

0.5 = 52.8 = 0.5260.35 = 10 = 64.36
The following reports of 13 cases in which the effects of labour was measured are given almost exactly as they were taken—only that the more ordinary data are collected in a table for the sake of convenience.

Table Xlll.

| No. | Man of case | Age | No. & char. of prom. | Date of prom. | Prom. was | Labour began | Labour ended | Duration | Condition of child.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mrs. 22</td>
<td>0</td>
<td>17 March</td>
<td>Head</td>
<td>10 a.m.</td>
<td>8 a.m.</td>
<td>10'</td>
<td></td>
<td>Healthy.</td>
</tr>
<tr>
<td>2.</td>
<td>G. 24</td>
<td>0</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>M. 24</td>
<td>2 nat.</td>
<td>16 July</td>
<td>Head</td>
<td>1 p.m.</td>
<td>8 a.m.</td>
<td>7'45'</td>
<td>16'</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>A. 24</td>
<td>1 '</td>
<td>16 May</td>
<td>Head</td>
<td>1 p.m.</td>
<td>8 a.m.</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>V. 20</td>
<td>0</td>
<td>18 June</td>
<td>Head</td>
<td>3'45'</td>
<td>8'30'</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>P. 27</td>
<td>0</td>
<td>26 July</td>
<td>Head</td>
<td>10'30'</td>
<td>9'30'</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>K. 19</td>
<td>0</td>
<td>15 July</td>
<td>Head</td>
<td>10 a.m.</td>
<td>8 a.m.</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>L. 21</td>
<td>0</td>
<td>23 July</td>
<td>Head</td>
<td>1 p.m.</td>
<td>8 a.m.</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>R. 29</td>
<td>0</td>
<td>1 Aug.</td>
<td>Head</td>
<td>7 a.m.</td>
<td>8'30'</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>T. 23</td>
<td>0</td>
<td>10 July</td>
<td>Head</td>
<td>7 a.m.</td>
<td>8 a.m.</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>S. 24</td>
<td>2 nat.</td>
<td>10 May</td>
<td>Head</td>
<td>11'30'</td>
<td>8'30'</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>B. 36</td>
<td>0</td>
<td>23 May</td>
<td>Head</td>
<td>12'30'</td>
<td>8'30'</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>J. 39</td>
<td>0</td>
<td>2 May</td>
<td>Head</td>
<td>12'30'</td>
<td>8'30'</td>
<td>16'</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Liquor amnii early discharged throughout the labour.
** Uterine labour. After the child was born the uterus was observed to have an unusual amount of obliquity to the right. A firm rounded tumour was felt attached to its left side, about the size of a hen's egg. After removal of the placenta the whole hand was pressed into the uterus without any pain being caused. By combined external and internal examination the apparent tumour was found like the left corner of the uterus. The right corner, in which the placenta had been, was somewhat larger than the left. An external anterior prominence of the fundus and an external prominence on ridge marked the segmentation of the uterus. The internal ridge was more sharply marked than the external furrow, but was not sufficient to completely divide the uterine cavity.
Case 1. 

M.G. Natural labour with pains of apparently average strength. 

The head having approached the perineum about 6 p.m., a round earthenware bag two inches in diameter was filled with water and inserted within the vagina, and its tube was connected with the mercury gauge formerly mentioned. The tube passed through a porcelain ring to which counter-pressure was made. Numerous pains were measured and found to vary from 18 to 27 lbs. The catheter requiring the bag, the bag was withdrawn for that purpose. Before draining off the urine the catheter was connected by a tube with the gauge. Two or three pains gave a pressure varying from 2 to 2.5 lbs on the square inch. The force of the last expulsive pains was not measured.

Case 2. 

Natural labour with frequent pains of apparently average strength. No chloroform or ether. 

Observations between 6:30 and 7:30 p.m. Barnes' bag no. 2 was inserted within the vagina so as to lie between the perineum and the child's head, moderately distended and connected with the gauge. Numerous observations made. Pains gradually rose from 19 to 37 lbs. The force of the last expulsive pains was not measured.

Case 3. 

Same bag similarly situated and distended with 2 lbs water. Labour natural, pains apparently of average strength, little or no ether, chloroform or ergot. 

Observations between 12:30 and 1:45 a.m. During absence of pains the pressure on the perineum remained about 7.5 lbs. During the first half hour the pressure rose regularly during the pains to about 15 lbs, and after that, irregularly, to about 30 lbs until ten minutes before the complete delivery. Then came two or three pains during which the pressure rose to nearly 40 lbs. The last of these caused the bag to slip out. The head was born during the next pain.
Case 4. A. Natural labour, apparently average pains.

No chloroform apparatus was used. Observations between 8:15 and 9:25 p.m. The head came down to the perineum at 8 p.m. At first the pressure during several pains was only to 14 lbs. Brandy 3 fl. and egret 3 fl. accordingly were given. At 9 p.m. the pressure during the pains was again measured and found to equal 38.75 lbs. On this instance the pressure rose to 38.75 lbs. About this time during each pain the pressure rose to a certain height at which it remained for a few seconds, rose again to a greater height at which it again remained for a few seconds, then reached its maximum, maintained that height for a few seconds and suddenly fell. For example, one pain lasted fifteen seconds. The pressure quickly rose to 8 lbs at which it remained for five seconds, then rose to 14.5 lbs at which it remained for the next five seconds after which it reached a maximum of 38.75 lbs. This was maintained for another five seconds, then suddenly the pressure sank. The bag was withdrawn at 9:25" and 9:40" the child was born by pains that seemed no stronger than those measured.

Case 5. V. Natural labour, pains were frequent and appeared stronger than the average. No chloroform or ergot. Observations between 12:30 and 2:30 a.m. Continuous observation was made that in every pain was measured during two hours but only the average result during each successive twenty minutes was noted down. The pressure of the pains rose gradually and with great regularity from 22.5 to 38 lbs. The following table then gives the amount of pressure of the majority of the pains during each successive twenty minutes.
Time
12' 30" a.m. - - - - 22.5 Lbs.
12' 30" " - - - - 29 "
1' 10" " - - - - 30.5 "
1' 30" " - - - - 40.5 "
1' 30" " - - - - 48
2' 10" - - - - Pain at first became less frequent &
left strong, then
became irregular &
renew, the pressure rising to
5.3 Lbs.

The birth was now evidently about to be concluded,
the bag was withdrawn, and the head was born into
the next pains.

Case 6. B. Labour lingering throughout. At 9.30 a.m.
the cervix uteri being well dilated, the Membranes
were ruptured. Patient was kept under chloroform
from this time to 1.30. Anaesthetic observations
between 2' 30" and 5' 45". From 2' 30" to 1' the pain
were infrequent, and appeared weak. Measurement,
however, showed them to press on the perineum with a
force equal to from 15 to 29 Lbs. At 4 a.m came a few
pains varying from 29 to 36.5 Lbs. At 4.30" the
bag (Beneke no.2 as in other cases) was removed for
ten minutes. From 3' 15" to 3' 45" the pains were more
frequent and appeared stronger, - by measurement
they were found to amount to about 38 Lbs, but sometimes
the pressure diminished to 29 Lbs, and occasionally rose
to 36.5 Lbs. The bag was now removed, and the head
born ten minutes after during pains apparently no
stronger than those which had been measured between
5' 15" and 5' 45".

Case 7 K. lingering labour. Chloroform from
midnight till 2 a.m. 9' 45" Membranes ruptured. Chloroform
then given and continued until 4' 15" a.m. Observations...
between 3'45" and 8', the head came down on
the perineum almost immediately after the membra-
erum ruptured. Pains were infrequent, and appeared not
strong, making little impression on the perineum.
During the interval of the pains, the pressure on the
perineum was 8 lb at first 3 lb, towards the
end of the observation it had risen to about 6 lb.
3'45. Pains of pains equal to from 7 to 12 lbs. A pain
whose pressure was equal to 7 lb appeared no
stronger and gave rise to no more outcry than a pain whose
pressure was equal to 33 lbs. 3'30' Brandly 3.
3'40" to 6'40" continuous manometric observations.
Pains varied greatly in strength, having sometimes a
pressure of only 1 lb, sometimes 23 lbs, sometimes
31.5 lbs, and occasionally 33 lbs. They were as
irregular in their recurrence as in their strength. The
woman appeared somewhat exhausted. From 7'20" to
7'50" the pains became apparently stronger, and
had a considerable effect upon the perineum. Most
of the pains measured from 33 to 36 lbs, but occasionally
they were 12 lbs. For example, a pain occurred whose
pressure was 23 lbs. This was followed by one with a
pressure of 31.5 lbs. And next came a long sustained
pain with a pressure of 33 lbs which greatly distended
the perineum. Five minutes after this the head was
borne during a pain that was apparently little
stronger than that last recorded. It was not, however,
measured, the bag having been removed a few minutes
previously.

Case 8. L. Lingering labour. 5'40" p.m. head down
upon perineum. No sensible caput succedaneum.
Manometric observations from this time to the end of the
birth of the head at 9'20" p.m.— 5'40" p.m. From the
order and posture, the pains, which recurred every ten minutes or oftener, would have been considerable of at least average strength, but though the head was fairly down upon the perineum they caused no distression of that part, and their pressure was found equal only to from 4 to 6 lbs—a cough or voluntary bearing down gave as much. Manual pressure from above during the absence of a pain equalled 12.5 lbs. This observation was repeated several times with a similar result. 12.5 lbs, therefore, may be taken as the amount by which labour can be assisted by pressure upon the abdomen, the woman being on her left side and the assistant at her back.

6' p.m. Brandy 3 1/2. The pressure of the pains remained as before. 6' 20'' Left leg out. Leg m. xx

Pressure of pains as before — 7'. Brandy 3 1/2, ether; slight

min. xx. From 7' to 7' 30'' pressure of pains = 12.5, 15.5 and occasionally 22 lbs. At this time the pains became rather more frequent, and a pressure of 7.5 lbs was, for a while, maintained in the interval between them, but this soon subsided. 7' 30'' to 8' pressure of pains from 20 to 27 lbs. About the beginning of this half hour, the pressure of the pains being pretty constantly 20 lbs, the caput succedaneum quickly formed. 8' 30'' Relief of pains 25 lbs, different pains varying very little in strength. Considerable impregnation was made upon the perineum. 8' 45'' pressure of pains frequently reached 27 and 28 lbs; greater impregnation upon the perineum. The pains were more frequent. They often occurred in series of two: thus a pain of 15.5 lbs was followed by one of 20 lbs, and then they became a pause; a pain of 18 lbs was quickly followed by one 27 lbs, and then there was a pause; or in series of three:—thus three pains quickly followed each other whose pressures were respectively 15, 20 and 25 lbs in one instance, and in another
18, 22 and 27 lbs. — a pause following in each instance — 9'15" Pains now succeeded each other more and more quickly. For ten minutes their frequency only amounted to 25 lbs., but that pressure was maintained for a considerable time. Then two or three pains followed of 31 lbs. pressure. These were succeeded by one of 33 lbs. pressure, and then by several of only 25 lbs. After this time, 9'30", the perineum was completely distended, and the head about to be born. It being that in this case the perineum was not likely to be lacerated the bag was left in situ during the birth of the head. The pressure of the pains that expelled the head was exactly 38 lbs. The perineum was carefully examined and found to remain entire.

Case 9. B. Natural Labour. No chloroform. The membranes having ruptured at 7'35" the head came immediately down upon the perineum. Manometric observations from 8' to 8'30." During this half hour pains occurred every two or three minutes. 8'. Pains of pains, 11 lbs., occasionally 16 lbs., 8'10". Pains of pains 22 lbs. The perineum was now partially skeletonized during each pain, and caput succedaneum began to form. 8'20" Pains of pains, 27 lbs., occasionally 32 lbs. These pains whose pressure equaled 27 lbs. greatly skeletonized the perineum. Only twice or thrice was the pressure equal to 32 lbs. 8'30" Head about to be born. The perineum being considered safe the bag was allowed to remain in situ. The pain during which the head was born had a pressure upon the perineum of only 22 lbs. The perineum was not injured.

Case 10. B. Face to face. Labour terminated by forceps. No chloroform until the forceps were about
to be applied. Manometric observations between 5'15" and 9'50" p.m. The membranes had ruptured on the previous evening, but there had been no sensible labour pains until 7 a.m. 5'15" Head had entered the pelvis, but not come down upon the perineum. The Barnes' bag, moderately distended, was inserted past the perineum along the wall of the vagina until it reached the part against which the head pressed. The bag had a great tendency to slip out of the vagina during each pain and required to be retained in position by the hand. The lower portion of the vagina and the hand therefore afforded in this case the counter-prepuce for the perineum.

5'30" Pressure of pains 14 lb., occasionally 22 lb.
5'40" .
5'42" A rough analysis of a pain was attempted. During this pain, the pressure rose rapidly to 15 lb., sudden to 14, rose to 18, sudden to 14, rose to 22, sudden to 14, rose to 29.5, sudden to 14, rose to 29.5, sudden to 14, rose to 32, and finally fell with rapidity at the end of the pain. This pain may be expressed by the following formula, the number below the line representing the constant pressure, the numbers above the line the fluctuating pressures.

18. 18. 22. 29.5. 29.5. 32
14

The fluctuation was probably almost entirely due to variation in the abdominal pressure. Internal observations of a similar nature were made, but after Schatz's exact determination of the fluctuations by the use of the kymograph, they are not worthy of further notice.

To 6 p.m. the pressure of the pains was about 27 lb., but occasionally 39. After this two or three pains occurred with a pressure of 39 lb. The bag was accordingly removed in
the expectation that the power would be sufficient to
finish the labour, but no progress was made.
6'40" Bag reapplied, pressure on pains only 14 lbs.
7' As the presence of the bag in the vagina appeared to
excite the pains, and to hasten rather than retard the
labour, it was maintained in position, and
during the next thirty minutes, the pressure of pain,
was measured. The result was as follows.

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Pressure (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7' 1'2&quot;</td>
<td>14</td>
</tr>
<tr>
<td>7' 1'5&quot;</td>
<td>22</td>
</tr>
<tr>
<td>7' 1'7&quot;</td>
<td>22</td>
</tr>
<tr>
<td>7' 1'10&quot;</td>
<td>22</td>
</tr>
<tr>
<td>7' 1'14&quot;</td>
<td>27</td>
</tr>
<tr>
<td>7' 2'0&quot;</td>
<td>27</td>
</tr>
<tr>
<td>7' 2'3&quot;</td>
<td>27</td>
</tr>
<tr>
<td>7' 2'3&quot;</td>
<td>14</td>
</tr>
<tr>
<td>7' 2'9&quot;</td>
<td>18</td>
</tr>
<tr>
<td>7' 3'2&quot;</td>
<td>22</td>
</tr>
</tbody>
</table>

Again, at 7'40" the pressure of pain was 24 lbs.
and at 7'41" 14 lbs.
From 9'25" to 9'35" the pressure of the pains varied from
22 to 27 lbs. At 9'44" the pressure of pain was 27,
and at 9'50" that of another 29 lbs.
At 11" it became evident that the combined
abdominal and external pressure was insufficient
to complete the labour, chloroform was given, and
the forceps applied. Considerable traction was
required before the head could be delivered.

Case II. S. Natural labour; no chloroform.
The os. uteri being fully dilated, the membranes
were ruptured at 11'45", and the head came
down immediately upon the perineum. Pains
occurred every minute or oftener. 11'45" Prepared on perineum during pains only 11 lbs. The next two or three pains followed in rapid succession, their pressure amounting to 17 lbs. Others followed with a pressure of 19 lbs, then two of 23 lbs pressure, by the last of which the head was born. The bag was allowed to remain in situ. The perineum was not injured.

Case 12. B. Natural labour; no chloroform.
9'30" a.m. Mewmans had ruptured in the previous evening. Of fully dilated, head on perineum, caput succedaneum beginning to form, Manometric observations from this time till termination of labour at 1 p.m.

There was a constant pressure of 2 lbs upon the perineum between the pains. The following gives the pressure of successive pains from 9'30" to 10'14".

9'30" a.m. A pain with pressure equal to 15 lbs.
9'38" " " " 10
9'36" " " " 10
10" " " " 8
10'4" " " " 8
10'7" " " " 8
10'10" " " " 9'5
10'11" " " " 8 (every shot)
10'14" " " " 6

For some time the pains continued feeble.
11" Pains with pressure varying from 13 to 18 lbs.
11'3" A pain with pressure equal to 13
11'9" " " " 13
During the next fourteen minutes the pains followed in rapid succession, the pressure rising in nearly every instance to 13 lbs. At 11'23" the pressure during the pain rose to
15 lbs., and at 11'25" to 18 lbs. These pains had a considerable effect upon the perineum. 11'30" to 12" pains during pains 18 lbs., during interval 4 lbs. 11'45" to 12" pains during pains varies from 8 to 15 lbs. 12'20" to 12'45" pain very frequent with 21 lbs. prepare. Head expelled by a pain with 25 lbs. prepare. Bag remained in situ; no harm done to perineum.

Case 13. Natural labour; no chloroform. Membranes artificially ruptured at 8'30" 1/2m. as the cervix was fully dilated. Manometric observations from this time to the birth of the head at 8'45". The head came down immediately upon the perineum, and the pains were frequent and of apparently average strength. The first four or five pains had a pressure of 14 lbs., then followed two or three of 19 lbs., and kept one of 34 lbs. by which the head was born. The bag was left in situ, and no harm done to the perineum.

No very precise conclusions need be drawn from these reports. They were observed rather for the purpose of discovering the best instrument for, and the chief points worthy of, observation than for the purpose of formulating any of the dynamical laws of labour. The series is preliminary, unmethodical, tentative, short. Still, however, a few of the more obvious points may be noticed.

The following note was appended to the original report of case T. K. The remainder of the series supported the conclusions then arrived at:— In this labour, as in the others, the power of the pains on the perineum increased slowly and gradually, being least when the head first came down upon
it and greatest about the time of expulsion. At any period the pains had what may be termed a standard strength for that period — a weaker pain being usually followed by a stronger, and finally a stronger still, until the standard strength was reached. Occasionally there would be even a stronger pain than this, one belonging, as it were, to the next period. Such a pain would be repeated at shorter and shorter intervals until, at length, say in half an hour, they became the standard pains.

It must, however, be observed that these variations are only variations in the effective pressure upon the perineum, not necessarily variations in the uterine or abdominal effort.

The pressure on the perineum between the pains varied from 2 to 7 lbs.

Caput succedaneum formed slowly when the pressure of the pains was about 13 lbs, quickly when it was 20 lbs.

In five cases the strength of the pain that expelled the child was measured. The maximum pressure was 38 lbs, the minimum 9.2 lbs, the mean 28.4 lbs. The following are the cases:

- Case 8 — 38 lbs, primipara
- 9 — 22 lbs, multipara
- 16 — 23 lbs, primipara
- 12 — 24 lbs, primipara
- 13 — 31 lbs, multipara

Generally the pain that expelled the child was a few pounds greater than the pain immediately preceding, but sometimes it was less. In no case in which the bag was left in situ was any injury done to the perineum. In some cases the bag was born with the head in. Then, it remained in situ. In the latter cases,
it was emptied and removed before the
shoulders were born.
References.

(1) Handb. by T. Matthews Duncan - Mechanism of Normal & Morbid Parturition pp. 197-8
(3) Mechanism of Normal & Morbid Parturition p. 54
(4) System of Midwifery p. 318.
(7) Obstetric Operations. B. X. X. IV.
(10) Duncan and Chadwick - Litchman: Mechanism of Parturition Ch. 3, 4, &c.
(11) Hagesle, oud. pp. 16 &c.
(13) Duncan - ibid p. 195.
(14) Duncan - ibid pp. 188, 189.
(17) Hagesle, oud. pp. 21-23.
(18) Litchman - Fresh actress of Parturition p. 824.
(19) "If there is any definite change in the dimensions of form of the body there is the force which causes such change."
(21) Dr. W. von Müller - "Die Abhängigkeit des auf
allen Drüsen von der Blutmenge." Leipzig 1873.
(22) Archiv für Gymnastik - Schatz. H. 115.
(23) Archiv für Gymnastik
(24) Archiv für Gymnastik