THE ACTIONS
OF
MIDWIFERY FORCEPS.

A STUDY IN MECHANICS.

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That when the blades of any of the ordinary forms of Midwifery-forceps, at their greatest width in the show operation, width, are less than 3% inches apart, it is not possible, by pressure of the forceps-handle, to compress the head; --

If this fact is appreciated then all else I am contending for must follow. -- 

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INTRODUCTION.

Some ten years ago I advanced certain theories regarding the actions of Midwifery forceps. These were then considered as not quite in accordance with the explanation generally accepted by those who are the recognised teachers of this subject and they did not quite receive the acceptance I think they ought to have had.

Since that time I have had this subject, more or less, ever present in my mind and from time to time have had opportunity of putting my theories to the test. Now, after so long a time, I feel more than ever convinced that what I then propounded is substantially correct; and also that its acceptance will mark a decided advance in Midwifery practice. Therefore I choose this as the subject of the THESIS which I present for my M.D. degree.

As to the standard of what is at present taught I take the text-books of GALEBIN, (of London), sixth edition, published 1904; and that of Professor J.C. Webster, who was (in 1892) Assistant to Professor Simpson of our university, and who now is Professor of Midwifery at the University of Chicago, U.S.A. America. These two, I think, it will be allowed, fairly represent the present teaching on this subject.

Save in those cases where I agree, I will not quote from the works of the late Dr. PLAYFAIR, (of London), which I did, ten years ago, when I wrote my former papers
on this subject. My reason for this is that, at the time these papers were written, I forwarded a copy of each to Dr. Playfair. These he was good enough to read and afterwards he wrote me as follows:

"33. Grosvenor Street.
April 28th, 1898.

"Dear Sir,

"I have to thank you for sending me your interesting 'STUDIES IN OBSTETRICS.' I am not quite prepared to accept all your conclusions, but there is much in them that is interesting and suggestive. I am sorry not to have seen them before I had completed the forthcoming new edition of my Midwifery.

"I am,

"truly yours,

(signed) "W.S. PLAYFAIR."

Dr. Playfair has now passed away. The last edition of his work is dated 1904. But I think that, from his letter, I am entitled to assume that, had he lived long enough to have issued another edition, the views I have advanced might possibly have received some recognition from him."
I will preface what I have now to place before you on this subject by saying that in this paper I will not raise any question as to which, (provided what I present for your consideration is understood) there can be any difference of opinion; but will limit myself to advancing propositions which are so self-evident that they must command the assent of everyone who will take the trouble to understand them: indeed so axiomatic, that to be understood will be to be accepted.

Further:--the space at my disposal is so limited that I cannot do more than give a brief statement of the elements of my subject. You will quite understand that if I to attempt a full exposition of the actions of Midwifery forceps, my THESIS would far exceed in length what is usually allowed for such papers. I will therefore avoid all matter in the present teaching on this subject which I think is correct, limiting myself to those points regarding which I think I can offer something new, or at anyrate something different from what is at present taught.

Also I wish it to be understood that, unless expressly stated, what I now advance in this paper is meant to have reference only to normal cases, or at most to those cases where, the only abnormality is a certain amount of delay;--cases of deformed pelves, absolute uterine inertia, or other abnormality is not at all included within the scope of this paper.
The present teaching regarding the action of Midwifery forceps is that it acts chiefly as a TRACTOR of the fetal head. It is also said to act as a COMPRESSOR, and to have certain other actions which are too trifling to require further notice.

GALABIN in his 'MANUAL of MIDWIFERY' pages 667-659, has a section entitled 'Mechanical Action of Forceps.' in which he has the following:

"IT is frequently stated that the action of forceps is three-fold, namely that of a tractor, a lever, and a compressor. The essential action however, is that of a tractor only. To carry out this action it is essential that the instrument should be constructed so as to be capable of maintaining a firm hold of the head without slipping. The two blades of the forceps also form a double lever like a pair of scissors, the fulcrum being at the lock. The action of the double lever is to compress the head. This compression of the head however is not one of the objects aimed at in the use of forceps, but is, on the contrary, generally injurious and should only be carried so far as is necessary to secure a firm hold. For the blades of the forceps being generally applied at the sides of the pelvis, or nearly so, the compression of the head in the transverse diameter of the pelvis tends to bulge it out in the conjugate diameter of the pelvis where there is generally least..."
"room for it. It is only therefore in the comparatively rare cases of transverse contraction of the pelvis that the action of forceps as a Compressor is directly advantageous. Besides the double leverage causing compression, another kind of leverage may be exercised, not when simple traction is used by the forceps, but only when an oscillatory or pendulum movement is made with the handles, the head being grasped tightly enough to form an immovable mass with the two blades. In this case the lever is formed, not by one blade of the forceps, but by the whole mass of the head with the two blades. It will be seen hereafter that the oscillatory movement in traction is not generally desirable, though recommended by many authorities."

I have given this paragraph in full so as to make clear what this author teaches on this subject. I need not however extend the quotation further.

Professor Webster on page 695. of his 'Textbook of Obstetrics,' has the following:

"The chief essential use of the forceps is as a Tractor, the instrument replacing or supplementing the natural expulsive powers. In the older books, various other functions are mentioned, e.g. compression, rotation, leverage, and dynamic action."

"Whenever the forceps is applied to the head, compression undoubtedly is produced. With the Axis-traction forceps this is slight, with the short or long forceps this is greater, because the hands in exerting traction are used to keep the handles together and can scarcely fail to compress the head unduly. The most marked
"compression occurs when the head is compressed antero-'
''posteriorly, or obliquely. Injury may be done to the s
"skull or intercranial structures, yet frequently marked 
"antero-posterior telescoping of the bones may be produced 
"without injury. It has generally been held that antero-
"posterior compression causes transverse compensatory 
"bulging. Murray has shown that bulging takes place in 
"a vertical direction and that therefore a long-held 
"objection to the use of Forceps in flat pelves is 
"removed. It is important to note that the more the 
"head is compressed the more the moulding and adaptation 
"to the birth-canal is prevented. The purposeful applica-
"tion of compression by the forceps is inadvisable; 
"ordinarily the blades should mark the head slightly 
"if at all."

I need not quote further from this author as he 
go on to deal with actions of Midwifery forceps which 
do not come within the scope of this paper.

With regard to the action of the Fixation-screw 
I may perhaps be allowed to sum up the present teaching 
regarding this as follows,—

'That when the forceps is in position over the 
fetal head and within the maternal pelvis, the 
tightening up of the screw tends to increase the 
pressure on the head, while the loosening of the 
screw tends to take off this pressure.

I presume that I will command the assent of all those 
who are considered as teachers of this subject if I 
briefly state the present ideas on this subject as follows,—

That Midwifery forceps acts in the following ways—
1. By TRACTION on the fetal head,—this being by far its most important function.
2. By direct compression on the fetal head, so as to decrease the diameter of that portion of the head which happens to lie transversely within the maternal pelvis.
3. That all other actions ascribed to Midwifery forceps are comparatively unimportant.
4. That tightening the fixation-screw when the forceps is in position tends to increase the pressure on the head; while loosening the screw tends to take off this pressure.
Before proceeding further I will bring to your notice certain actions of Midwifery forceps which are either unexplained by the present teaching regarding the action of this instrument, or are directly contrary to what we might expect if the present teaching is correct. The examples I refer to are the following:

A. The effect of tightening and loosening the fixation-screw while the forceps is in position within the maternal pelvis.

B. The rapid delivery which often follows the placing in position of forceps on the fetal head, and this without any increase in uterine action, or traction by the Accoucheur on the forceps handles.

C. The apparent uncertainty as to what is the correct position for the fixation-screw.

A. The effect of tightening and loosening the fixation-screw while the forceps is in position within the maternal pelvis.

The present teaching is that, when Midwifery forceps is placed as in the LOW OPERATION, i.e. with the widest portion of the blades lying within the maternal pelvis, the effect of tightening the fixation-screw is to increase the pressure on the fetal head; while the effect of releasing the screw is to take off that pressure.

In order to show that this is just the very opposite of what really occurs I will ask you to place a pair of Midwifery forceps with the screw loosened, in position
within the birth-canal of the dummy-mother and to draw the instrument sufficiently forward so that it will represent the position the instrument occupies in the low operation of Midwifery forceps.

Next, let the operator place his closed fist within the cavity of the forceps-blades, in the position which would be occupied by the fetal head. Now let an Assistant tighten up the fixation-screw, and note the result. I think the operator will have a very distinct consciousness of the pressure being taken off from his hand.

Now let the Assistant loosen the screw; and the operator will feel that the pressure on his hand is being increased. The Assistant may repeat this several times in order to satisfy the operator of what really takes place. It will be found that every time the screw is tightened the pressure on the hand is diminished, while when the screw is loosened the pressure is increased.

It will be evident that in this experiment the hand of the operator occupies the position that, in parturition, is occupied by the fetal head; and that whether the cavity of the forceps-blades is occupied by the hand of the operator or by the fetal head, the result is the same, viz., tightening the screw relieves the pressure, while loosening the screw increases the pressure.

Here we have an action of Midwifery forceps which is the very opposite of what, according to the present teaching of the actions of this instrument, we are led to expect. If we continue to understand the forceps as acting always as a lever of the first class, this action is
simply inexplicable. Later on in this paper I hope to show that in the low-operation, Midwifery forceps acts, (not as a lever of the first class but) as a lever of the third class; and understanding the action in this way everything is perfectly plain.

B. The rapid delivery which often follows the placing in position of forceps on the fetal head, and this without any increase in uterine action, or traction by the Accoucheur on the forceps-handles.

My attention was first specially drawn to this by the Professor of Midwifery of one of our Medical Schools, to whom I had been explaining my ideas regarding the actions of forceps. What I refer to is the following:

In many cases of delayed labour, where there is nothing at fault save deficient expulsive action, it often happens that after the forceps are placed in position over the advancing head, there is almost immediate progress; and this without any traction whatever being applied to the handles of the instrument, or any increase in the force of the uterine contractions.

The question arises:—What is the explanation of this? The Professor who drew my attention to it was unable to explain it. To him it was a mystery and he acknowledged this. There was no increased uterine action, so that it could not be that the introduction of the instrument had any dynamic action in inducing the uterus to contract and so to expel the advancing head. My friend therefore could not account for this action.
I ask any of those who have been educated with the present theory of forceps-action if he can explain this? As it seems to me there is no explanation to be given according to present theories. Yet that the action does occur is undeniable. I am sure that every observant Obstetrician must have observed it again and again. What then is the explanation?

As I understand it, the explanation is what I have termed the WEDGE-ACTION of forceps. At present I do not do more than mention this. Later on in this THESIS I hope to explain fully what I mean; but for the present I only draw attention to the fact.

C. The apparent uncertainty as to which is the correct position for the Fixation-screw to be placed.

If Midwifery forceps is a double lever of the first class, with the fulcrum at the lock, as Calabin teaches, then it must be evident that those who place the fixation-screw at the near-end of the forceps-handles are correct. Stawell and some others so place this screw, while the great majority of the forceps made have the screw placed at the crossing of the handles, as is the case with the forceps of Professor A.R. Simpson, Milne Murray, and others. Indeed, all the forceps which have their origin from the Edinburgh School have their screws so placed. I will discuss this question later; meanwhile I content myself by drawing attention to the fact that this radical divergence exists.

I think I have said enough to show that there is
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I think I have said enough to show that there is
more in forceps-action than has yet been realised, and also that I have made out a good case for a reconsid\er-\ation of our ideas of forceps-action.
FACTORS INVOLVED in HUMAN PARTURITION.

It may help us to understand the question of forceps-action if we briefly consider what are the chief factors involved in Human parturition. In normal cases these are,-

A. The MATERNAL TISSUES. These, before labour comes on, form a covering which surrounds the fetus and protects it on all sides. Previous to their dilatation they resist the onward progress of the fetus, but as labour progresses they undergo a physiological modification, as the result of which they relax and so allow of the onward progress of the child.

B. CONTRACTIONS, Uterine etc. In the first stage of labour these act to a great extent through the Amniotic fluid and the membranes. Later, when the waters have broken, they act through the fetal head and body. The effect of these contractions is to dilate the passages and so to open up a way for the expulsion of the child.

The special point which I wish now to bring out is, that it is a mistake to consider the fetus, during the active stages of labour, as lying passively within the maternal uterine cavity, and requiring to be drawn out by forceps, in much the same way as a nail is drawn out of a piece of wood by a pair of pincers. Really the uterine contractions are exerting a tremendous force which is acting through the ovum towards the opening up of the maternal passages so as to complete the expulsion of the child. It is probable that this uterine expulsive
force is much greater than what is, in ordinary cases, exerted by the Accoucheur in traction on the forceps-handles. I shall return to this point later, but now wish to emphasise the fact that there is present a very considerable force which makes the fetal membranes and head an important factor in the process of dilatation of the parturient canal.

There is another point in this connection which, although not of so much importance, is worth mentioning. This is,—the comparative danger to the child of injury to its head, and the comparative harmlessness to the mother of injury to, or laceration of, the tissues of her parturient canal. It has been taught that, in parturition, the duty of the Accoucheur is to save the mother at the risk of injury to the child. This is undoubtedly true in extreme cases,—where the choice lies (say) between the loss of the mother or of the child.

But in ordinary cases the risk is not nearly so great,—it often amounts to no more than either a laceration of the maternal parts or an injury to the fetal head. In such cases I venture to think that the Accoucheur should risk doing considerable injury to the maternal tissues so that he may protect the fetal head. The maternal tissues, as is well-known, are capable of very extensive dilatation and laceration without permanent injury being done,—indeed we know that there are wounds in the human body which heal so readily as the injuries or tears in the parturient canal which occur during the process of parturition.
In the case of the child, on the other hand, we know how vital are the head and other parts which are most in evidence during parturition, and how lasting may be the ill effects of even a slight injury done to the child during birth.

I would therefore press this as the more correct view;—that in normal cases of parturition the thought present in the mind of the Accoucheur should be, (not action on the fetal head by traction or compression,) but action on the maternal tissues by dilatation, and that his rule should be;—to produce an unblemished child even at considerable risk to the mother.
DESCRIPTION OF MIDWIFERY FORCEPS.

I accept the ordinary description given of Midwifery forceps as to size and shape. As these are stated by Galabin I think that they are practically correct. I now quote from his TEXT-BOOK, page 659.

"The cranial curve should be equivalent to the arc of a circle nine inches in diameter. The tips of the blades should be about an inch apart, when the handles are closed. The outside measurement across the blades at their widest part should not be greater than three and three-eights inches." Other details do not concern us here.

I do not now discuss the French type of Midwifery forceps; these differ from the English type in the formation of their lock, and probably are justly entitled to the name of forceps.

But with the English type of Forceps it is different. This is not a forceps in the sense of the word, and this is my present point.

In one of our best Encyclopedias the definition given of the word 'forceps' is as follows:

"A two-bladed instrument of jointed metal with which objects are taken hold of."

Examples of forceps given are the following:

Dentist's forceps. In these the object to be seized is grasped at the one end, the force which seizes is at the other end, and the pin which fastens the two blades together and gives the fixed point, is placed toward the centre.
Dissecting forceps is a different variety of forceps. The object is seized at the one extremity, the fixed point is at the other extremity, and the force that seizes is applied between the two.

The special features which are essential to every true forceps, as this term was originally understood, are the following:—

(a). The fixed point must be an integral part of the instrument, the force employed in each variety of forceps having an invariable relation to this. The function of the instrument is always to seize an object.

(b). This seizure is always effected by means of the inner surface of the instrument only; the outer surface never coming into action at all.

But the English type of Midwifery forceps differs from these requirements in the following respects:—

(a) Its fixed point is not an integral part of the instrument, but only sometimes comes into use. Besides it is questionable where the fixed point really is, at one time this seems to be at the near end; at another time at the crossing of the blades.

(b). I will show later that this instrument only to a very small extent fulfils the function of seizing at all. Also

(c). That the outer surface of the blades have a very distinct action.

Thus I have shown that Midwifery forceps is not a forceps at all in the original sense of the word. But like many other terms in our language, the name of '
'Forceps' has come to have an extended meaning; and now we have quite a number of instruments to which the name of 'Forceps' is applied which are not forceps in the original meaning of the word. I will refer to only one of these, and I choose this special one because it has exactly the same actions as the Midwifery Forceps. The instrument to which I refer is the 'CROSS-ACTION-TRACHEAL-DILATING FORCEPS' of Luer. I give a diagram of this instrument at page 27. of this Thesis, and now only draw attention to the fact that this forceps is an instrument which has no grasping action at all. Another instrument which has this kind of action is the Bulldog Artery Forceps, which when the handles are forced...
LEVER ACTION in relation to MIDWIFERY FORCEPS.

The present teaching regarding the action of Midwifery forceps is based on the assumption that it always acts in exactly the same way; i.e. that in all positions it always acts as a double lever of the first kind.

It is the case that this instrument acts in this way so long as its blades at their widest are more than 3½ inches apart. But I hope to demonstrate to you that when the blades at their widest distance apart are less than 3½ inches apart that the forceps cannot possibly act in this way, but that it acts as a double lever of the third class.

To demonstrate this I will deal, in the first place, with lever action in its simplest and most abstract form.

I need hardly remind you that in the ordinary textbooks on MECHANICS a lever is defined as a rigid rod or frame, which is essentially composed of three elements: one of which, known as the FULCRUM, is fixed in position; and another, the weight to be raised, or RESISTANCE to be overcome, is situated at some point so that it can be acted on by the third element, vizt. the force or POWER which is applied at another point.

Levers are generally regarded as of three classes; described as FIRST, SECOND, and THIRD; these classes depending on the relative positions of the three elements of which they are composed.

In levers of the FIRST CLASS the FULCRUM is situated between the other two elements, thus.

![Diagram I](image)
In levers of the **SECOND CLASS** the **RESISTANCE** is situated between the other two elements; thus,

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Diagram 2

Lever of Second Class.
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In levers of the **THIRD CLASS** the **POWER** is situated between the other two elements; thus,

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Diagram 3

Lever of Third Class.
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Now let me apply this to **Forcipe-action**,

In levers of the **first class** the **Fulcrum** is placed between the **Weight** and the **resistance** to be overcome, thus,

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Diagram 4

Lever of First Class.
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Such levers may be either **single** or **double**, depending on the nature of the **fulcrum**.

**Examples of single levers of the first class** are to be found in **ordinary balances**, the **crowbar**, the **pump-handle**, and other similar **contrivances**.

**Examples of double levers of the First kind** are to
be found in such articles as Scissors, Pincers, etc.

Calabin in his Manual of Midwifery, page 658, says, "The two blades of the forceps also form a double lever "like a pair of scissors, the fulcrum being at the lock." I accept therefore the illustration of ordinary scissors to bring out what I desire to establish.

I now give a diagram of an ordinary pair of Scissors.

\[ \text{Diagram 6} \]

In this, the fulcrum is the nut which joins the two blades; the power is the force exerted at the handles; and the resistance is the cloth or other material which is placed between the two blades to be cut.

Now I will ask you to apply this to the case of Midwifery forceps and to consider the circumstances in which this instrument can act as a lever of the first class. I take the ordinary long forceps, or the ordinary Axis-traction forceps divested of their traction-rods, to show what I mean. The following is a diagram showing forceps opened out as was in the case of the scissors in the last diagram.
Here the fulcrum is at the crossing of the blades, the power is applied at the handles; and the resistance is that which happens to be between the two blades;—all exactly as Galabin has described.

In this case the handles can easily be separated and again approximated as often as is desired. Undoubtedly in this position forceps do act as a double lever of the first class, exactly as did the scissors.

But I would ask you to notice that this action is possible only so long as the blades are so opened out that at their widest part they are more than 3% inches apart,—this Galabin tells us is the measurement across the blades at their widest distance apart when the handles are in apposition throughout their entire length.

I now show the relative position assumed by the two blades when thus their handles are in complete apposition.

**Note that the distance apart of the two blades at their widest is exactly 3 3/8 inches.**
I now give a diagram of a pair of Scissors the blades of which are completely closed.

[Diagram of Scissors with Blades Closed]

It must be evident that when the two blades of the scissors have reached this relative position that all further action is impossible.

So in the case of Midwifery forceps; all scissors-like action must come to an end when the two handles become approximated throughout their entire length; thus

[Diagram of Forceps with Blades Approximated Throughout Entire Length]

Note. The transverse diameter between the blades at their greatest width is 3 3/8 inches exactly.

But in this respect there is a material difference between the scissors and the Midwifery forceps, and this is due to the fact that in the scissors there is a nut at the crossing of the blades which prevents any further movement. But in the case of Midwifery forceps of the English pattern there is no such fixed fulcrum and so the forceps have a further possible movement.
I now ask you to observe what takes place when the blades of Midwifery forceps are still further approximated than was shown in the last diagram. I now give a diagram in which I show the instrument with the points of the two blades almost touching each other:

\[\text{Diag. 10} \quad \text{Showing forceps, with the blades approximated so that their greatest width is less than } \frac{3}{8} \text{ inches.}\]

*Note:* The handles are touching at their near ends, and open out at their crossing.

You will observe that the two handles are still touching each other; but that they do this at their near ends, and that, at the crossing of the blades they have become separated; which is the reverse of what was the case in the Scissor-action.

In this position the forceps has ceased to have the same action as had the scissors. The point of contact, i.e., the fulcrum, has now removed itself from the crossing of the blades to the near-end of the handles. In other words, the instrument has now ceased to have the actions of a double lever of the First-class.

But the question arises:—If the forceps has ceased to be a double lever of the First-class, what then has it become?

The answer to this question entirely depends on how we place the other two elements of the lever action:—the power, and the resistance to be overcome. I will show later on, when I come to speak of the Wedge action of forceps, that there are cases in which forceps may...
may be regarded as acting as levers of the second class.

But now I deal with those cases where the power is applied at the crossing of the blades, as is undoubtedly the case where the power is applied by means of the fixation-screw being tightened up, as in the following diagram:—

Diag. 11. Showing ordinary type of traction forceps.

\[ \text{R} = \text{Resistance between the blades.} \\
\text{F} = \text{Power applied by means of the screw} \\
\text{f} = \text{Fulcrum at the near end of the handle.} \]

Here undoubtedly the power is applied by means of the screw, at the point \( p \); the resistance to be overcome is that which happens to be between the blades, \( r \); and the fulcrum can only be at the unoccupied position, viz., at the extreme end of the handles, \( f \).

A reference to the classification of levers given on page 20. of this paper will show that now we have to deal with Forceps acting as a double lever of the third class.

In levers of the third class we have the POWER placed between the other two elements of lever-action. viz., the fulcrum and the resistance. I now give the usual diagram given in text-books showing this:—

Diag. 12

\[ \text{Lever \# Third class} \]

\[ \text{F} = \text{Fulcrum} \]

\[ \text{N} = \text{Resistance} \]
Examples of single levers of the third class are to be found in the action of many of the muscles of the human body; e.g. that of the Biceps acting on the forearm. The following diagram illustrates this:

**Drag 13**

*Showing action of Biceps muscle of forearm.*

Note: The power is applied between the fulcrum and the muscle here; the fulcrum is at the elbow-joint; the power is applied by the muscle at the bicipital tuberosity; and the resistance is the hand with its contents.

An example of a double lever of the third class is to be found in ordinary Sugar-tongs. I give a diagram showing this: the arrows *p.p.* indicating where the power is applied:

**Drag 14: Ordinary Sugar-tongs**

Here the fulcrum is at the rounded extremity; the resistance to be overcome, i.e. the piece of sugar, is grasped between the spoon-shaped ends; and the power is applied at a point somewhere along the shafts. It will be evident that pressure applied at the points *p.p.* will lead to approximation of the free ends.
of the tongs, as is the case when a piece of sugar is grasped.

But in order to learn how this principle works in the case of Midwifery forceps we will have to push the free ends of the sugar-tongs beyond their place of meeting in the middle line so that they cross each other as is the case with forceps. I show this done in the case of the sugar-tongs.

It will now be evident that if pressure be applied to the points indicated by the arrows P, P, the free ends of the tongs will be pushed further apart; while pressure at the points indicated by the arrows m, m will result in the closer approximation of the free ends. I may here say that exactly this action is found to take place in Luer's cross-action Tracheal dilating forceps of which I give a diagram.

From these examples we may say that if the arms of
a double lever of the third class are crossed at a point between the power and the extremity which acts on the resistance, (as in the case of these sugar-tongs) acted on at the points p p ,) the power so applied tends to push these extremities further apart; while if the power is applied between the point of crossing and the effective ends, (as in the case of the sugar-tongs acted on at the points m m ) the pressure tends to approximate these ends.

Now this is exactly the kind of action which Midwifery Forceps exerts when the widest diameter between the blades is less than 3½ inches. When the handles of the old Simpson's forceps are firmly grasped so as to be approximated throughout their entire length the action is that of the arrows p p in diagram No. 15; while if the pressure on the instrument handles is relaxed, then any pressure that may be exerted by the maternal tissues on the external surface of the blades is allowed to be transmitted to whatever may lie within the cavity of the blades, which is exactly the action shown by the arrows m m in diagram No. 15.

That this is so, let me now demonstrate by means of a very simple experiment which anyone can easily perform. In order to reproduce, as far as necessary, the conditions which exist when the Midwifery forceps are acting within the maternal pelvis, I ask you to place two books, each of about three inches in thickness, so that they lie back to back, about 4 inches apart at their one extremity, and 2 inches apart at their other extremity; the passage
between to represent the pelvic portion of the maternal canal;— the wider extremity representing the pelvic brim, the narrower extremity, the external outlet.

Now I ask you to place between the two books as arranged, an old Simpson's Forceps with the handles in apposition throughout their entire length, and so that the outer surfaces of the blades are in contact with the books;— as in the following diagram.

Now let an Assistant press together the two books in the direction of the arrows. Now note the result.
It will be observed that as the blades become approx-imated, the handles open out at the point of crossing of the blades.

Now let the Assistant leave off his pressure on the books, and let him grasp the handles firmly so as to approximate them throughout their entire length and it will be found that the blades are forcibly thrown apart opened out and the two books are forcibly thrown apart, as is shown in diagram [7].

Anyone who will take the trouble to perform this simple experiment will have no difficulty in understanding what I am now endeavouring to establish, viz., that with Midwifery forceps, when the blades at their widest distance apart are less than 3½ inches apart the actions it has is that of a double lever of the third class.

From what I have said I think it will be evident that the English type of Midwifery forceps may act either as a double lever of the first class, or as a double lever of the third class; the difference of action depending on the width between the blades at their widest parts.

A. If this width exceeds 3½ inches the action is that of a double lever of the first class.

B. If this width is less than 3½ inches, then the instrument acts as a double lever of the third class.

The consideration of the action of forceps as a lever of the second class I leave over until I deal with the WEDGE-ACTION of forceps.
The ACTION of MIDWIFERY FORCEPS in PARTURITION.

Those who have followed what I have written in my last section will recognize that, while the forceps is within the maternal parturient passage there are three possible relations which the blades may have to each other.

A. Where the handles remain in contact at their blade-ends, and the outside measurement across the blades at their widest part is greater than 3\(\frac{3}{4}\) inches.

I give a diagram of this.

Diag. 19. Showing forceps opened out as scissors are:

- Showing blades at their midmost distances are more than 3\(\frac{3}{4}\) inches.

In such cases the forceps is a double lever of the first class, and has a scissor-like action.

B. Where the handles remain in contact throughout their entire length, and the outside measurement across the blades at their widest part is exactly 3\(\frac{3}{4}\) inches.

Diag. 20. Scissors with handles approximated throughout entire length.

- Blades exactly 3\(\frac{3}{4}\) inches across at greatest width.

In such cases no action whatever is possible, any more than there could be with closed scissors.
C. Where the handles remain in contact at their near ends, and the outside measurement across the blades at their widest part is less than 3\% inches.

I give a diagram of this;-

\[ \text{Diagram 21: Forceps with Handles Touching at Near-end at The Crossing} \]

Blades less than 3\% inches apart at their greatest width.

In such cases the forceps acts as a double lever of the third class, as I have already shown.

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So that with regard to the outside measurement across the blades at their widest part, we have three possible relations of the blades the one to the other.

1. Where this diameter is greater than 3\% inches.
2. \(\ldots\) \(\ldots\), exactly \(\ldots\), \(\ldots\)
3. \(\ldots\), \(\ldots\), less \(\ldots\), \(\ldots\)

The second of these conditions, (in which no lever action is possible) need not detain us. So now we have to consider what are the positions in the normal parturient canal in which the first and the third condition are possible.

With regard to the first of these---where the outside measurement across the blades is greater than 3\% inches, I think that there can be no doubt that the position in which this occurs is in the high operation, i.e. where the forceps-blades are above the maternal pelvic brim.

Here the abdomen is large and roomy and the uterus is
expansible to a very considerable extent, so that the
forceps-blades may open out as much as is necessary.

But, with the normal pelvis and fetal head, such an
action is impossible in the low operation. We know that
the maternal pelvis is filled up with soft tissues. So
that the parturient passage is a mere slit which has to
be dilated in order that the head may descend; the amount
of dilatation being decided by the diameters of the
fetal head, and it is the transverse diameter of the
head which has decided that the outside measurement
across the forceps-blades shall be 3½ inches.

So that in the low operation the transverse diameter
of the maternal parturient passage is expected to dilate
up to 3½ inches and no more. It will be evident therefore
that in the low operation the forceps-blades cannot open
out to a greater extent than 3½ inches at their widest
parts; but that whatever lever action there is within
the maternal pelvis must be limited to the forceps-blades
becoming more approximated than the 3½ inches referred to.

It will therefore be evident that the sphere in which
the forceps-blades may open out to a greater diameter
than 3½ inches at their widest is in the HIGH OPERATION,
while the sphere in which they open out to a less extent
than 3½ inches at their widest is in the LOW OPERATION.

From what I have already demonstrated in my former
section it will be recognised that this is equivalent
to saying that in the HIGH OPERATION forceps acts as a double
lever of the FIRST CLASS, while in the LOW OPERATION
they act as a lever of the THIRD CLASS.
MIDWIFERY FORCEPS as COMPRESSORS of the FETAL HEAD.

In my second section, (pages 3 and 4,) I quoted from the text-books of Calabin and of Webster showing what these authorities teach regarding the actions of Midwifery Forceps in so far as this instrument acts as a Compressor of the fetal head. I need not therefore now repeat these quotations in full; but will only draw attention to what Calabin says as to this compression taking place while the forceps is acting within the maternal pelvis. On page 658. of his text-book he has the following:

"The blades of the forceps being generally applied "at the sides of the pelvis, or nearly so, the compres- "sion of the head in the transverse diameter of the "pelvis tends to bulge it out in the conjugate diameter "of the Pelvis where there is generally least room for "it. It is only therefore in the comparatively rare "cases of transverse contraction of the pelvis that the "action of the forceps as a compressor is directly "advantageous."

I need not quote this author further, but think there can be no doubt that he understands this action of compression as taking place in what is generally known as 'the Low Operation.'

I may perhaps be allowed to state, in a word, what is the present teaching regarding the action of Midwifery forceps as Compressor, by saying that it is taught that: "This instrument acts uniformly throughout"
'entire range of action, in both the high and the low operations, as a Compressor of the fetal head, in much the same way as does a pair of scissors when it cuts a piece of cloth.'

This I hope to demonstrate to you is not strictly accurate.

In the Low operation there may be and undoubtedly often is an amount of pressure exerted by the soft tissues lining the inner aspect of the maternal pelvis which (unless resisted by the dilating action of the forceps-blades when the handles are approximated throughout their entire length, as is shewn on page 30, of this thesis,) may be transmitted to the fetal head.

But in the LOW OPERATION it is simply impossible by any pressure which the Accoucheur may bring to bear on the forceps-handles to bring about Compression of the fetal head; and that the sphere in which the forceps can act as a Compressor of the head is in, and only in, the HIGH OPERATION, i.e. while the blades are acting above the brim of the maternal pelvis.

In order to establish this I will deal in the first place with the action of Midwifery forceps in the low operation.

In my previous section, (page 33,) I demonstrated that in the LOW OPERATION Midwifery forceps acts as a double lever of the Third class. To bring out what this means I take the extreme case of a small head in a normal-sized pelvis. Then the two blades of the forceps
would assume, the one to the other a relative position much as in the following diagram.

It will be observed that here the near-ends of the forceps-blades are in apposition, and at their blade-end they have become separated.

Now I think that it will be evident that pressure applied to the near-ends of the handles, i.e. at the points indicated by the arrows \( p \), cannot possibly compress the head; indeed such pressure would be absolutely ineffective, because these ends are already as near to each other as they can be, and therefore any pressure cannot bring them nearer.

Again, if pressure be applied at any other point along the Forceps-blades, say at the point indicated by the arrows \( m \), it will be evident that this cannot possibly result in compressing the head. On the contrary it will tend to force the blades still further apart than they now are, as has been shown on page 29 and 30.

From this it will be evident that it is simply impossible for the Accoucheur, by bringing or keeping the handles together to exert Compression on the fetal head.

Indeed it is the very opposite of compression of the head which occurs when pressure is applied to the handles. For I have shown in my last section, (p.30),
that in the LOW OPERATION forceps acts as a double lever of the third class, and that therefore any pressure applied to the handles so as to bring them together results in a greater separation of the blades at their widest part.

Therefore when the forceps is acting in the LOW operation it is impossible, by any pressure which the Accoucheur may bring to bear on the handles, to cause Compression of the fetal head. But that

In the LOW OPERATION with ordinary short or long forceps the bringing together of the handles, instead of compressing the head, tends to relieve the head from compression by counteracting the pressure of the maternal pelvic soft tissues.

I need not now delay by considering the case of forceps in which the handles are approximated throughout their entire length, as in the following diagram:—

I have already shown that when in this position the forceps cannot possibly have any lever action whatever, and that consequently they cannot act as compressors of the head; any more than scissors can have any action when their blades are closed.

Therefore I claim to have demonstrated that it is impossible for the Accoucheur, by means of pressure applied to the forceps-handles to compress the fetal head in any other than the HIGH OPERATION.
I will now deal with Midwifery forceps in their action in the HIGH OPERATION, and repeat my diagram showing the relation of the one blade to the other when they are high up, above the maternal pelvic brim.

I have already shown, (page 32-33) that this separation of the blades is possible only when the instrument blades are so high up, within the maternal parturient canal, as to be above the pelvic brim, and that then the forceps acts as a double lever of the first class, in much the same way as do scissors.

It will be at once evident that with forceps in this position it is possible that the instrument acts as a Compressor of the fetal head, and in my experience it often does act in this way.

I think then that I may claim to have demonstrated
A...That it is inaccurate to say that Midwifery forceps can act as a Compressor of the fetal head in all situations throughout the maternal parturient canal
B...That Compression of the fetal head as the result of the Accoucheur keeping the handles together can occur only in the HIGH OPERATION.
C...That in the LOW OPERATION the bringing of the handles together leads to the counteracting of the pressure of the maternal soft tissues, so relieving the head from Compression.
I will not at this stage discuss the action of Axis-traction forceps. This I will deal with later when I come to consider the actions of the fixation-screw.
MIDWIFERY FORCEPS as a DILATOR of the MATERNAL CANAL.

In my reading I have not yet come across a hint of the existence of a dilating action of forceps. Yet I venture to think that, not only does this action exist, but that a very considerable portion of the force exerted by the Accoucheur in traction of the forceps-handles is expended in dilating the maternal parturient canal. I will deal with this more particularly in my next section when I come to discuss the action of this instrument as a Tractor.

In this section I propose to give a very practical illustration in proof of what I now contend for, and will show you that a very considerable force is required to draw the empty forceps out of the parturient canal. I will ask you to perform the following experiment;—

(a) Place an ordinary Axis-traction forceps in position within the birth-canal of the Dummy Mother;—

(b) Tighten up the fixation-screw; and then

(c) Attempt to draw the forceps out of the birth-passage.

I think that if anyone will take the trouble to perform this slight experiment he will be conscious of two things;—

1. that a very considerable force is required to pull the forceps out of the passage, and

2. that as the forceps advanced, the vulvar opening enlarged considerably.

But if we consider it we will recognise that, as in this experiment the forceps-blades were quite empty, it cannot be the fetal head that is the cause of the...
resistance. It must be that the force which has been exerted in traction has been entirely expended in dilating the parturient canal.

The only possible objection to the validity of this experiment is that there is a considerable amount of friction is thus drawing the forceps-blades through the dummy birth-passage, which is not present in the living mother. But the walls of the dummy passage and also the forceps-blades may be amply lubricated, and in this way the excessive friction may be overcome; but even then it will be found that, as I have said, a very considerable force is necessary to draw the forceps-blades out of the dummy birth-canal.

What I have to say in this connection will come more appropriately in my next section, i.e. when I deal with 'Forceps as a Tractor.'

The point I wish now to emphasise is that the A. the EXTERNAL SURFACES of the forceps-blades have an action as well as their internal surfaces; and
B. that these external surfaces act chiefly on the maternal tissues; and
C. that this action is in the way of dilating the maternal tissues so as to open up a way for the descending head.

My own experience would lead me to say that this dilating action is the most important of all the beneficial actions which Midwifery Forceps exert. Every Obstetrician must be aware how great is the expulsive force which is exerted by the uterus and abdominal
muscles. It seems to me to be self-evident that
A. provided the head is sufficiently moulded so that
   it is down to the normal diameters and the maternal
   passages dilated up to the same measurements, the
   'vis a tergo' will be more than sufficient to expel
   the child; Also
B. that if the passages are dilated by the Accoucheur
   a lesser amount of moulding of the descending head
   will suffice to bring about the birth of the child, and
   so the labour will be over the sooner.
MIDWIFERY FORCEPS as a TRACTOR.

The present teaching on this point is that the chief action of Midwifery forceps is that of a TRACTOR. Professor Webster, in his text-book, page 695, says:—

"the chief essential use of forceps is as a tractor, the instrument replacing or supplementing the natural expulsive powers."

Gallatin, in his text-book, page 657, says:—

"It is frequently stated that the action of forceps is threefold, namely that of a tractor, a lever, and a compressor. The essential action however is that of a tractor only."

To put this plainly it means that the chief action of Midwifery forceps is to draw the fetal head out of the maternal parturient canal in much the same way as a nail is drawn out of a board by a pair of pincers, or a tooth out of its socket by a pair of Dentist's forceps.

A little consideration however will show that there is a very material difference between the nail or tooth, and the child.

In the case of the nail or tooth:—
1. These are held firmly in position, and embedded in the tissues in which they are situated.
2. There is no expulsive action whatever on the part of the tissues by which they are surrounded.
3. There is nothing corresponding to a door closing in the nail or tooth.
In the case of the child on the contrary:-

1. Instead of being fixed in a socket, it is loosely floating in the Liquor Amnii.
2. Instead of being passive, it is acted on very powerfully by the tissues within which it is situated in order that it be expelled.
3. Its exit is closed by the external organs of parturition i.e. the Vulva and the perineum, these forming a kind of door to bar its exit.

I do not think that we sufficiently estimate the expulsive force which is exerted by the uterus and abdominal muscles when they are in full action. Various estimates have been given, from 35 lbs upwards. Sir James Y. Simpson gives the amount at 120 lbs. about. Any one who has attempted to lift from the ground a weight of even half-a-hundredweight will know how very much this is; and I doubt if ordinarily the Accoucheur applies anything like so much to the forceps-handles in traction.

This then is the force which is being exerted to expel the fetus during the active contraction of the maternal tissues. The obstacle to the outward progress of the child is that the external portion of the parturient canal blocks the way.

We are now in a position to understand what are the different forms of resistance which have to be overcome by the traction applied by the Accoucheur to the forceps-handles. They are three; as follows.

1. Overcoming the friction of the maternal canal.
2. Direct traction of the fetal head, so as to advance it on its outward journey.

3. Dilatation of the maternal canal.

1. As regards friction. In ordinary cases where the labour is terminated within a few hours, the walls of the parturient canal are amply lubricated with mucous secretion. This reduces the friction on the forceps-blades to almost nothing. It follows therefore that of the force exerted by the Accoucheur, the proportion which goes to overcome the friction of the parturient canal is very small indeed.

2. Direct traction on the fetal head, so as to advance it on its journey.

After what has been said it will be readily understood that, provided there is no obstruction in the more external portion of the birth-canal, then only a comparatively small force is required to propel the fetus along the patent parturient passage. A simple experiment will suffice to show that a force of a few lbs. will be ample for this. Probably 2 or 3 lbs will suffice. But let us put this at, say, 10 lbs.

We have seen that the uterus and abdominal tissues exert an expulsive force of probably between 50 and 100 lbs. Let us put this at say 50 lbs so as to be well within the mark. So we have the expulsive force of 50 lbs exerted; the force necessary to propel the fetus along the patent passage, 10 lbs. What then does the remaining 40 lbs do? It can only be expended in dilating the maternal passage.
Now suppose the Accoucheur, having decided that the case is one for forceps, proceeds to apply this instrument. What is the effect of the force which he applies? Let us assume that he applies a force of 50 lbs. This, with the 50 lbs exerted by the maternal tissues, makes a total expulsive force of 100 lbs. which is being expended in advancing the fetus forward. But we have seen that, provided the parturient canal is patent and well-lubricated a force of less than 10 lbs. is sufficient to propel it outwards.

It will be evident therefore that of the force expended by the Accoucheur in traction only a very small portion goes as traction of the fetal head.

3. Dilatation of the Maternal canal.

From what has been said it will be evident that only a very small portion of the force exerted by the Accoucheur goes to overcome friction and in direct traction of the head. There is only one other way in which it can be expended that is in DILATATION of the MATERNAL TISSUES.

This is borne out by the experiment already referred to, (page 40), of drawing the empty forceps-blades out of the birth-canal of the dummy mother.

Another consideration which leads to the conclusion that there is comparatively little traction directly on the fetal head is that usually there is no mark on the head of the new-born child. If there were any considerable amount of such traction it is almost certain that the head would be severely marked. But this is not so in
the great majority of cases.

From what I have said I think it will be evident that it is not quite accurate to regard the force exerted by the Accoucheur in traction on the forceps-blades as being expended in Traction of the fetal head. On the contrary the great bulk of this force actually goes to dilate the maternal parturient canal.
WEDGE-ACTION of MIDWIFERY FORCEPS.

WHEN dealing with the 'ANOMALIES of FORCEPS-ACTION.' (page 10.) I drew attention to the rather extraordinary fact that it often occurs, when the forceps placed in position on the fetal head within the maternal pelvic canal, that very rapid delivery often takes place and this without any increase of uterine action, or traction by the Accoucheur on the forceps-handles.

I now come to consider what this action really is, for I have never seen any attempt at explaining it in any literature I have read on this subject.

So far as the present teaching regarding the action of forceps goes, it is only the action of the inner surfaces of the blades that is referred to. For traction and compression, the two chief actions mentioned, are both of them effected by the inner surfaces of the blades in much the same way as a pair of dentist's forceps grasps a tooth.

But in the case of Midwifery forceps the outer surfaces of the blades also are in contact with tissues. The special tissues they are in contact with are the maternal tissues. I will now proceed to show you that these outer surfaces also have an action in the process of parturition which has been overlooked in the past.

To show what I mean I now refer to the diagram on page 13, showing the forceps-blades divided into two parts—an Anterior, and a posterior part.
The anterior portion of the inner surfaces is that which is concerned with traction and compression of the head.

But the posterior part of the outer surfaces of the blades has another action. It increases the acuteness of the WEDGE formed by the fetal head. In this way the presence of the forceps-blades in position within the parturient canal enables the uterine force to act at greater advantage, so facilitating the descent of the head to its birth.

The following diagram will illustrate my meaning:-
The angle B.A.C. may be taken to represent that of the descending head as forced downwards by the 'Vis a tergo' and acting as a wedge to dilate the maternal canal; the angle E.D.F., that formed by the effective surfaces of the forceps-blades acting in the same way; here the angle B.A.C. is nearly 90 degrees; while the angle E.D.F. is only about 40 degrees, i.e. only half of the other.

It is a well-known Mechanical law that the more acute the angle the more effective the wedge. A simple calculation will show that, other things being equal, a wedge whose angle is only 40 degrees is more than twice as effective as one whose angle is 90 degrees.

Now, in parturition the expulsive force exerted by the maternal tissues remains unaltered by the intro-
the same whether the forceps-blades are in position or not. But the placing of the blades in position over the fetal head reduces the effective angle of the wedge to about one-half, and so the maternal expulsive force is able to act at greater advantage.

This is the explanation of the fact that in many cases the mere placing in position of the forceps-blades over the descending head, without any traction whatsoever on the part of the Accoucheur, or any increase of uterine contractions is often speedily followed by the birth of the child.

NOTE:-

It might perhaps be argued that in this Wedge-action there is a lever action of the Second class. This however is a purely theoretical question and so I do not discuss it.
Actions of the FIXATION-SCREW.

The most obvious action of the Fixation-screw is of course to keep the two halves of the forceps in position when they have been placed over the fetal head. It is this action which gives to the screw its name, and in this action the screw takes the place of the tape which Chamberlen tied round the lock of his original forceps. As there cannot possibly be any question of this action I pass on without further comment.

But the fixation-screw has other actions than this of keeping the two halves of the forceps in position. The teaching, however, as to what these actions are is, to put it mildly, very vague indeed.

My space is too limited to allow of my quoting the different authors in full. But I would refer the reader to the text-book of Professor Webster, page 704. Also to the Manual of Dr. Calabin, who gives a much more full statement of this action of forceps, at pages 687-688.

I will sum up briefly the present teaching of the action of the screw as follows:—It is taught:

'That tightening the fixation-screw when the forceps is in position over the fetal head in parturition tends to increase the pressure on the head; while loosening the screw tends to diminish this pressure.'

In this, it will be observed there is no distinction drawn between the action of forceps in the High and the Low operations.

I must here draw attention to the somewhat remarkable fact that of the Axis-traction forceps offered for
sale by the instrument-makers there are some in which the fixation-screw is placed at the near-end of the handles; while others have their screw placed at the crossing of the two blades. There are some other forms e.g. that of Murdoch Cameron, etc, where the screw is at the near end, but as these seem to involve other mechanical principles I do not take up time by considering them.

The illustration I take of those Midwifery forceps which have their screw at the near end of the handles is that of Stawell, and for briefness I will refer to this as the Stawell-type of forceps. I give a diagram to show the relative position of the screw in this type.

I will have to refer to this type of forceps later, and so now will only say that I consider this type to be quite unpractical, and that it only serves to show how very much one may be misled by a mistaken theory.

I come now to consider the ordinary type of Axis-traction forceps taking as my example the forceps of Sir A.R. Simpson, the former Professor of Midwifery of our University. This is the form which, so far as I know, has been followed as to the position of the screw, in all the forceps which have their origin in the Edinburgh School of Medicine, and so I suppose will be accepted as the ordinary type.
I give an diagram showing the position of the screw in the ordinary type of Axis traction forceps.

Diag. 28.

Axis traction force ordinary type


My present contention is that, with the screw placed at the crossing of the two halves of the forceps, it is a simple impossibility, by any tightening of the fixation-screw whatever, to bring about compression of the fetal head. (see Note on page 78 a.)

The present teaching regarding the action of this screw is based on the supposition that Midwifery forceps act throughout the entire parturient process in exactly the same way as do scissors. I now reproduce the diagram I gave on page 21, showing scissors opened out as they are when commencing to act on, say, a piece of cloth.

Diag. 29. Scissors opened

The force is applied at the points p, p.

I think that it will be at once apparent that if it is desired to cut the cloth with the scissors, the place where the pressure must be applied must be at the handles; i.e. at the point indicated by the arrows, p, p. Also that to apply the pressure over the
junction of the halves of the forceps, i.e. at the point indicated by the arrows m. m. is absolutely futile, and only a waste of energy.

In order that a comparison may be made I again produce the diagram I gave of the forceps opened out so as to act in the same way as do the scissors.

Diag 30. Forceps opened wide to act as scissors do.

Pressure exerted at the points \( m. m. \) is ineffective. That at the points \( m. m. \) is futile in compressing the head.

As with the scissors, so with the forceps: if pressure is applied so as to compress the head, the position at which this pressure must be applied is at the near ends of the forceps handles, i.e. at the points indicated by the arrows \( b. p. \); further that pressure applied to the handles at their point of crossing, i.e. at the points indicated by the arrows \( m. m. \) is absolutely ineffective to produce compression of the head.

Stawell has carried out this idea by placing the screw at the near end of the forceps handles, and if it is the case, as Galabin teaches, that tightening the fixation-screw increases the pressure on the head, then Stawell has acted consistently in placing the screw as he does. But as I have shown this teaching is not correct.

I think that a consideration of what I have presented will satisfy any one who has followed me, that
in the High operation, tightening the screw causing the two halves of the forceps is absolutely ineffective in compressing the head. (See note on page 78 a.)

As regards the Stawell-type of forceps I will only say that both Webster and Calabin agree that compression of the head is not a desirable effect; therefore it must be evident that any position of the screw which tends to produce compression is a mistake.

I come now to consider the action of the fixation-screw in the Low operation, and reproduce the diagram I gave on page 24, showing the position assumed by the two halves of the forceps in this operation.

Diag. 31. Position assumed by forceps blades in low operation.

Near ends of handle touching at crossing-point.

You will observe that in this position the two handles are in apposition at their near ends, and are separated at the point of crossing.

I reproduce also the diagram I gave of another instrument which acts in exactly the same way: viz.

Luer's cross action Tracheal dilating forceps.

Diag. 32. Luer's cross action Tracheal dilating forceps.

A moment's consideration will convince you that
it is absolutely impossible, by any pressure to the handles to make use of this instrument as a grasping instrument.

So with Midwifery forceps in the Low operation. I have already demonstrated that these forceps in the low operation acts as a lever of the third class, see pages 32-33.

It will be evident therefore that just as pressure on the handles of the Luer's Tracheal forceps result in dilating its distal ends; so pressure on the handles of the Midwifery forceps when these are acting within the maternal pelvis, will produce dilatation of the blades, and that this will tend to counteract the pressure which is being exerted by the soft tissues of the maternal canal which are compressing the head.

So that it is quite a mistake to think that tightening up the fixation-screw tends to increase the pressure on the head during parturition. Indeed a very simple experiment will demonstrate that the very opposite is the case.

In order to demonstrate this I ask you to place two volumes in position, back to back, about 3\textfrac{3}{8} inches apart. Then place between them an Axis-traction forceps of the ordinary type, i.e. one with the fixation-screw near to the crossing of the two halves of the instrument; 

Thus:
To represent the elastic pressure of the walls of the maternal parturient passage, let an Assistant apply slight pressure to the books so as to bring them together, while at the same time the screw is gradually loosened. I have indicated this by the arrows $\text{p}$. $\text{p}$. in the diagram. As the Assistant applies pressure and the screw becomes loosened it will be found that the two blades become approximated, as is shown in the next diagram:—
Now proceed to tighten up the screw; and it will be found that the blades again become separated until they resume the position they had at the first, as shown in the previous diagram, as.

Any one who will perform this simple experiment will be satisfied that the present teaching regarding the action of the fixation-screw is wrong; that it is not the case that, while the forceps are acting in an ordinary case of parturition, the tightening of the screw causes an increase of the pressure on the head, but that the very contrary is the result.

Another point which may be briefly considered here:—Which is the proper position for the fixation-screw? As Stawell places it, or at the crossing of the two parts of the forceps as in the ordinary type of this instrument. I think that there cannot be a possibility of doubt that Stawell is wrong in this, and that the ordinary type of instrument is correct.

I have shown that, in the high operation, to have the screw at the near end of the handles is wrong. In the low operation it is still more wrong, for in this position, it is badly placed for keeping the two blades of the forceps in position over the head of the child, while as to exerting pressure either on the head or on the maternal soft tissues it is absolutely ineffective. As well might one apply compression at the fixed end of a Luer's Tracheal forceps with the idea of either approximating or of separating the extreme ends of the blades. I have shown this by the arrows in the diagram No. 32.
I now proceed to sum up what are the actions of
the fixation-screw in the ordinary type of Axis-traction
forceps in each of the three positions which are possible
in ordinary parturition.

A. In the HIGH OPERATION. Excluding the very slight possible
compression due to the Screw not being placed exactly
at the centre of the crossing of the two parts of
the Forceps; the only action the screw can have is
that of holding in their places the two parts of the
instrument. See note, page 78A.

B. In the LOW OPERATION.
(a) When the Screw is loosened; the Maternal tissues
are free to compress the fetal head.
(b) When the Screw is being tightened up; the pressure
of the soft tissues lining the interior of the
maternal pelvis is resisted; and so the Compression
of the head is diminished.
(c) When the Screw is fully tightened up; the forceps
is converted into a rigid instrument, and the two
parts of which have no action whatever the one on
the other.
MIDWIFERY FORCEPS as a RIGID INSTRUMENT.

If any one will place together the two parts of an Axis-traction forceps of the ordinary type, and tighten up the fixation-screw so as to lock the two portions together he will appreciate that the two blades no longer have any action the one on the other, but that they have now become so united together that they form a rigid instrument. I give a diagram showing the forceps in this position:

Diag 35. Forceps as a Rigid Instrument

It is now no longer possible, without destroying the integrity of the instrument to move the one part on the other at all. So that the instrument has now ceased to be a forceps, but, as Playfair puts it, "The two blades practically form a single instrument."

I need not occupy your time with an elaborate exposition of this aspect of forceps-action, but will simply state the actions which Midwifery forceps has when thus converted into a rigid instrument. As I understand it the actions are as follows:

1. It forms a rigid casing which shields the fetal head from injury.
2. Prevents compression of the head by the maternal tissues.
2. Gives RIGIDITY to the angle formed by the two blades so enabling them the more effectively to perform their action as a WEDGE.

4. Guides the head on its outward journey.

As to the 1st. and 3rd. of these actions, what I refer to will be so self-evident that I do not need to enlarge upon them. I may perhaps however explain about the second a little.

On page 29-30 of this thesis I have demonstrated that, when the handles of a Midwifery forceps are not firmly grasped together so as to approximate the two halves of the handles throughout their entire length the forceps blades tend to assume a position of having the near-ends of the handles in apposition, and the crossing ends separated the one from the other. I show forceps in this position

**Dia. 36.**

To show the natural tissue compressing the forceps blades through them the fetal head

Notice the handles continue in an apposition at their near ends separated at the point of crossing of the blades, not the point f.
It will be evident that, in this case, the maternal tissues are free to exert pressure on the forceps-blades and through them to compress the fetal head.

I now shew the Axis-traction forceps with their screw tightened up.

It will be evident that in this case the two blades are kept dilated; the compression of the maternal soft tissues resisted; and so the pressure of the head relieved.

I think however that what I have said previously on this point renders further emphasis unnecessary.

With regard to the Guiding action of forceps;—I
include in this a number of slight actions which have been noticed, e.g.

(a) Guiding the head into the channel intended for it.
(b) Facilitating its passage past abnormal obstacles.
(c) The so-called pendulum action.

These actions often undoubtedly are present, but at most any one of them is only slight, and of quite minor importance. They need not therefore detain us longer.
Before proceeding to my conclusions I may be allowed to mention a few considerations which will clear the ground of possible criticisms of the theories I have advanced.

A. That the LOW OPERATION of FORCEPS is much more frequent than is the HIGH OPERATION.

It is must be the experience of every practical Accoucheur that when he puts on the forceps it is in the great majority of cases, after the head has entered the maternal pelvis, i.e. the great majority of Forceps-cases are Low-operation cases.

But in all those cases where the forceps is put on in order to perform the HIGH OPERATION, the Low-operation must always follow. Therefore in such cases the Low-operation must be as frequent as the High-operation.

But in addition to the Low-operation cases which follow after the High-operation cases, there are a greater number of Low-operation cases which occur independently of High-operations.

It must therefore be evident that the total number of Low-operation cases must vastly exceed the number of High-operation cases; and that of the two, the Low-operation cases are those which present themselves most frequently and most urgently to the Accoucheur.

This is borne out by the position of the Fixation-.
screw in the ordinary type of Axis-traction forceps; this being placed at the position required for the Low operation.

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B. That a very decided pressure is exerted by the soft tissues lining the inner aspect of the maternal pelvis on the descending head.

Those who have experience of Axis-traction forceps of the ordinary type must have noticed that, when the blades are in position over the head, it often happens that a very considerable force is required to tighten up the screw; and that in such cases the head is comparatively well engaged within the maternal pelvis.

I am aware that in other cases, when the head is still high up above the maternal pelvis-brim, after placing the forceps in position the handles remain apart at their near ends, and in such cases some force is required to approximate these near ends. In such cases the forceps is acting in the HIGH OPERATION and the forceps are acting as ordinary Scissors.

But in the other cases I refer to it happens that it is the blade-ends of the handles that are separated, the difficulty of approximating is at the screw, and often a considerable force is necessary to tighten it up. In such cases it can only be the soft tissues lining the inner aspect of the maternal pelvis that is exerting pressure on the forceps-blades to force them together.

A consideration of this will, I think, convince any one that there must be a very decided pressure exerted
in the Low-operation by the tissues of the maternal canal on the descending head

C. The name of 'FORCEPS'.

I think those who have followed me will allow it to have been an unfortunate thing that the name of 'FORCEPS' has been given to this instrument. Most people understand, when they hear of a 'Forceps', an instrument which grasps and extracts some object in much the same way as does a pair of pincers when it seizes and extracts a nail from out of a piece of wood. From what I have said it will be recognised that Midwifery forceps have not an action at all resembling this.

I can quite believe that the name of 'FORCEPS' has taken such a hold of the instrument with which we are dealing that it will be impossible ever entirely to get rid of it. A great deal of the mischief of this name will however be overcome if it is realised that this term of 'FORCEPS' has had its meaning so extended during the past half-century that now it is applied to instruments which have a very different, and indeed (in some cases) even a diametrically opposite meaning from that which is usually associated with the term. Thus I have shown you that we have an instrument intended to dilate the Trachea which is called by the name of a 'FORCEROSE'.

I think that this difficulty might be almost entirely overcome if the instrument were no longer called simply by the name of 'FORCEPS' but by the name 'DILATING-FORCEROSE', and if it were explained that in its chief action it acts as a DILATOR of the birth-canal.
D. ADVANTAGES OF FIXATION-SCREW.

From what has been said it will be evident that the presence of the fixation-screw makes the AXIS-TRACTION forceps an immensely superior instrument to those which are not possessed of this screw.

With the older forms of Midwifery forceps the maternal soft tissues lining the inner surface of the pelvis of the mother, are able, (acting through the forceps-blades) to compress the fetal head as it descends.

So long as the head is above the pelvic brim of the mother, i.e. within the area of the HIGH OPERATION, any compression exerted by the maternal tissues is not harmful to the head to any extent. But when the head enters within the area of the LOW OPERATION it is very different. We know how vital is the head of the child, and how different in kind the pressure becomes when the head enters well into the pelvis. Here is the unyielding ring of bony structures, the soft tissues inside which form only a thin lining. We know too how dangerous it is to the little life, if the compression of these tissues is either severe or long-continued.

It is just here that the fixation-screw enables the forceps to help the little life, dilating the maternal tissues and so saving the head from compression.

E. BEST FORM OF MIDWIFERY FORCEPS.

In this paper I have not considered the French form of Midwifery forceps. Nor have I examined the many
variations which appear to have been proposed but not carried into practice. Indeed I have limited myself to those forms of which I have had practical experience. I suppose that I am near the truth when I say that for the British Practitioner the choice of instruments is restricted to the older forms of Short or Long forceps, or to those of the more recent forceps which have a fixation-screw, either situated at the near-end of the handles, as in the Stawell type, or at the crossing of the two parts of the instrument, as in the forceps of Sir A.R. Simpson.

Of these I have no hesitation in saying that the instrument of our former Professor is immensely the best instrument. I have shown that Stawell is altogether at fault in the position he places his fixation-screw. Those forceps which have no fixation-screw are defective in so far that they allow the soft tissues lining the maternal pelvic to compress the fetal head as it descends. This, the screw enables the forceps of Sir A.R. Simpson to prevent.

It does not come within the scope of this Thesis to discuss the actions of the Traction-rods. So I have nothing to say as to the different questions which arise in connection with these. But, without discussing these points, the conclusion that my consideration of the forceps I have seen is, that of them all the most scientific are those which have their Fixation-screw at the crossing of the two portions of the instrument.
CONCLUSIONS.

From what I have written I think I am entitled to claim that the present teaching with regard to the actions of Midwifery forceps is not accurate. It is taught that this instrument acts as a TRACTOR, which action is intended, and also as a COMPRESSOR, which action is not desired.

As regards Compression:—I have shown that, while in the HIGH-OPERATION there is in some cases an amount of Compression, still with the ordinary AXIS-TRACTION excluding the tractive Compression referred to in the note on page 78, it is simply impossible, in either the High or the Low operation, by tightening up the Fixation-screw to compress the head. But that on the contrary, the tightening up of the screw approximates the handles in such a way that the cavity between the two blades is dilated;—thus the pressure of the maternal tissues is resisted and Compression of the head is prevented.

As regards TRACTION:—It is I think a tremendous error to regard the action of Midwifery-forceps as at all comparable to that of a pair of pincers when this instrument draws a nail out of a piece of wood.

What really happens is that the forceps-blades with the screw fully tightened up, forms a rigid case enclosing the head. As this passes outward it gradually opens up, i.e. dilates the passage, and (as the way is thus opened up) the head, acted on by the maternal expulsive powers, travels along, following closely up
behind the dilating portion of the forceps-blades

I have shown on pages 45 and 46 of this Thesis, that the expulsive force of the maternal tissues is vastly more than is required to expel the child, provided the parturient canal is sufficiently dilated. A little thought therefore must make it evident that this extra force can only go to dilate the maternal passage.

The key to the understanding of the action of Midwifery forceps is, to distinguish the different forceps-operations, and the possible positions the blades of this instrument may occupy when within the parturient canal.

I now give a condensed statement of what these are:

A. In the HIGH-OPERATION.

Here the two blades at their greatest width apart are separated by a greater distance than 3½ inches. In this position the forceps acts as a double lever of the FIRST CLASS; the action being the same as that of an ordinary pair of Scissors.

B. In the LOW-OPERATION.

(a) When the fixation-screw is not fully tightened up. Here the two blades are separated by less than 3½ 3½ inches. In this position the forceps acts as a double lever of the THIRD CLASS; the action being the same as that of a Luer's CROSS-ACTION TRACHEAL-DILATING FORCEPS.

(b) When the fixation-screw is fully tightened up. Here the two blades at their greatest distance
apart are separated by a distance of 3% inches exactly. In this position the two blades have absolutely no lever action at all, the one on the other; but together they form a rigid instrument.

I now give a brief statement, focussing what I have said of the actions of Midwifery forceps in each of the positions which this instrument may assume when within the parturient canal.

As regards TRACTION:— In cases where the maternal contractions are not entirely absent: the greatest portion of the force which the Accoucheur applies to the Forceps-handles in pulling goes to dilate the maternal passage in front of the descending head. As the way is opened up the maternal expulsive force keeps the head well forward within the protective case formed by the locked forceps-blades; and together, the maternal expulsive force (minus what is required to overcome the friction, etc.) added to the force exerted by the Accoucheur in traction on the forceps-handles;— these act together to dilate the birth-passage, so opening a way for the child to pass out.

As regards COMPRESSION:— In the HIGH-OPERATION it is the case that Midwifery forceps does compress the head, reducing the diameter of that portion which happens to come within the grasp of the forceps until its diameter is reduced down to the 3% inches which has been allowed as the transverse diameter of the maternal canal. But at this point all compression absolutely ceases;— as I have already shown that it is an absolute
impossibility that these forceps can in any way whatever compress the head so as to reduce its diameter below 3\% inches.

In the Low Operation what compression there is results from the pressure of the soft tissues of the maternal pelvic canal; and it is this pressure which the forceps-blades, when the screw is tightened up, tends to resist, and in so doing saves the head from compression.

The actions of Midwifery Forceps then are as follows:-

A. In the High-Operation. The actions are:

(a) Compression of the head, until the portion within the forceps-grasp is reduced to a diameter of 3\% inches. At this point compression ceases entirely.

(b) Wedge-action, opening the birth-passage.

(c) Guiding the head; this action includes several slight actions. e.g. Traction of the head, which (if it occurs at all) can only do so rarely and to a very slight degree.

The Fixation-Screw in the High operation tends to keep the two portions of the instrument in their relative positions. The screw has no other action than this in the High-operation.

B. In the Low-Operation.

(a) Dilates the maternal canal; the forceps (acting as a WEDGE) increasing the effective angle of the head.

(b) Guiding the head into its proper course, and past any obstacles there may be.
The FIXATION-SCREW, when fully tightened up acts as
follows;-
(a) Keeps the two portions of the instrument in position.
So enabling the instrument to act the more effectively as a
(a) Dilator of the Maternal canal; and as a
(b) Protective-casing for the head, shielding it from Compression and from injury.
NEW VIEW of INSTRUMENTAL ASSISTANCE in LABOUR.

The present view of Instrumental interference in labour is:

By Traction and Compression of the Fetal Head to extract it from the maternal parturient canal, in much the same way as a tooth is drawn out of its socket by a pair of Dentist's forceps.

It is only to be deplored that Obstetricians have become so accustomed to this view that they have ceased to recognise that it is a most repellent one, and only tends to create on the part both of the practitioner and of the friends of the patient a prejudice against instrumental interference of any kind.

I have shown that the present view is a mistaken one; that the true action of Midwifery forceps of the type of that of Sir A.R. Simpson's is, that it acts; not on the fetal head, by Traction and Compression; but on the maternal tissues, by dilatation, and that the fixation-screw, instead of tending to Compress the head when it is tightened up, tends on the contrary to resist the pressure of the maternal tissues, and so to diminish the Compression on the head. In order to emphasise this action I have suggested that the instrument should be named, not 'FORCEPS' only, but 'DILATING-FORCEPS'.
I should like if I had the space to explain at length the advantages that may be expected to result from this change of view of what the action is of instrumental assistance in labour; but this would extend my Thesis to a undue length.

I must therefore content myself with simply naming a few of the benefits that will accrue.

A. The Accoucheur will cease to associate instrumental interference with operations on the fetal head. He will regard it as acting on the maternal tissues so as to dilate them and so to protect the head from compression and injury.

We can well understand how much more readily the Accoucheur will be to use 'DILATING-FORCEPS' than he now is to use 'FORCEPS'.

B. On the friends of the patient.

We can easily understand that they will be much more ready to give their consent to an operation undertaken in order to "Dilate the Mother's parturient canal" than to one which is said to be intended to compress the child's head and draw it out of the birth passage as a nail is drawn out of a piece of wood by a pair of pincers.

C. Thus instrumental assistance in labour will become much more frequent than now is the case; and this in its turn will result in the labours being completed in a shorter time, with less danger to the mother and child, and altogether much more satisfactory results all round.

"A plea for the early termination of Labour" would
form a splendid subject for a THESIS, and I am only sorry that my space now is so limited that I cannot enlarge on the advantages of such a course. I have already published several papers urging the more frequent use of Instruments in Labour-cases. I will name only one of these papers, i.e. "The proper time for instrumental interference in Labour," which was published in "The INDIAN MEDICAL CAZETTE" of May, 1898.

D. An intelligent understanding of what really are the actions of Midwifery forces will lead to the gradual discarding of the older forms of forces which have not got the fixation-screw, and the adoption of those which (like that associated with the name of our late Professor) have the fixation-screw placed at the crossing of the two parts of the instrument.

E. To these considerations I will only add that these new ideas of the action of this instrument as a dilating-foresceps will, I feel sure, lead to the Accoucheur, regarding the instrument, not with the hesitation and doubt which at present exists, but with confidence and certainty, in which the friends of the patient will share. Thus the result will be a very considerable advance in Midwifery practise all round.
BRIEF RE-STATEMENT of PROOF of VIEWS NOW ADVANCED.

I now close this THESIS by again putting forward what I consider to be an absolute proof that the present teaching regarding the actions of Midwifery forceps is inaccurate. This is:

That, excluding the trivial exception referred to 'in the Note on next page, with Forceps having their 'Fixation-screw at the crossing of the two parts of the 'Instrument, it is a simple impossibility, by tightening 'up the Screw, to apply Compression to the Fetal head.

But that, on the contrary, the tightening up of 'the Screw, if it has any action other than securing in 'their position the two parts of the instrument, tends, 'in the LOW OPERATION to dilate the forceps-blades, and 'so, by counteracting the pressure of the maternal tissues, 'to diminish the Compression of the head.'

The present teaching is that the tightening up of 'the Screw, in all positions throughout the entire course of parturition, tends to Compress the head;-

In this THESIS it has been shown that this is not 'the case;-

Therefore it has been demonstrated that the present teaching is not accurate.

To those who have followed what I have written it 'will be evident that the demonstration given is as complete and as convincing as are any of the propositions of EUCLID.
NOTE:—follow Page 78.

In every Axis-traction Midwifery Forceps I have seen the Fixation-screw is placed, not exactly over the point of crossing of the two portions of the instrument, but as near to this point as the construction of the instrument will allow. In the Forceps I am in the habit of using, the Screw is seven-eighths of an inch along the handle from the exact centre of the crossing, towards the near-end of the handles; this in a handle of a total length of 5½ inches.

In so far as the Screw is thus placed along and nearer to the near-end of the handles, in just the same proportion does the forceps partake of the action which I have described as that of the Stawell-type of Instrument. In such instruments there may be, and probably often is, in the High operation, a very slight amount of Compression of the fetal Head. But in such cases the power applied at a great disadvantage;—in the instrument I use the power exerted in compression is reduced to one-tenth of what is applied at the Screw.

But even in such instruments it is an absolute impossibility to apply Compression so as to reduce the transverse diameter of the Head below 3½ inches; or in other words it is impossible in the Low Operation to apply any Compression to the Head at all.
It is only putting what I am contending for in another way, to state the case as it applies to Midwifery-forceps generally. This I do as follows:--

A... That COMPRESSION of the fetal head may and does occur so long as the two blades of the forceps, at their greatest distance apart, are separated more than three-and-three-eighths inches. More especially is this so in those instruments which have their fixation-screw placed at the near-end of the handles, as is the case with the Stawell-type of forceps. But

B... this Compression absolutely ceases when the handles are approximated throughout their entire length, so bringing the two blades to a distance of exactly 3\(\frac{1}{8}\) inches apart at their greatest width. And

C... when the distance between the two blades, at their greatest width apart, is less than 3\(\frac{1}{8}\) inches, then it is an absolute impossibility, with any form of Midwifery-forceps whatever, by applying pressure to the handles, to Compress the fetal head.

If this one idea is appreciated, then all I now contend for must, and will, follow as a logical consequence. And I venture to say that the result will not be any less than a complete revolution in our ideas of INSTRUMENTAL ASSISTANCE in OBSTETRICS.

FINIS.