

EVOLUTION IN AXIS-TRACTION—AN ADVANCE
UPON THE METHOD OF UTILIZING THE PRIN-
CIPLE OF AXIS-TRACTION IN VOGUE IN
OBSTETRIC PRACTICE UNIMPROVED
SINCE ITS INTRODUCTION BY
TARNIER IN 1877.

BY

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(With two illustrations)

IN the March (1905) issue of the AMERICAN JOURNAL OF OBSTETRICS (*q.v.*) the writer described an apparatus designed to further develop the practical application, particularly in institution work, of the principle of axis-traction, and at the same time to provide for original research work along certain lines that are of great theoretic and practical interest and importance. He now wishes to report the preliminary results of practical trial based upon two high forceps deliveries in the conduct of which his improved method was personally employed.

To be sure, these two cases furnish only relative criteria for judgment, extremely limited criteria indeed, affording rather scant but fairly safe ground for honest inductive reasoning. The writer is well aware of the necessity, because of the exacting but reasonable requirements of the scientific method as applied to medicine, for supplemental work. To a conservative pitch, as

thus expressed, are keyed the writer's remarks in the following report.

So far as these two cases are concerned the results have been quite gratifying and the claims made in the original paper above alluded to apparently justified. With respect to ease of manipulation, smooth operation and facility of delivery, the writer's predictions have been borne out. The light weight (5 lbs.), portability in sections, not unattractive appearance and the simplicity of the mechanism are much in the instrument's favor besides.

Except the rods, which are made of plated brass, the instrument is constructed mainly of McAdamite, an aluminum composition about one third the weight of steel and about equal in tensile and torsional strength to "mild" steel. The traction tape is steel and the two large McAdamite castings are enameled in white; the rest of the instrument is plated.

For mechanical details the reader is again referred to the original paper, which is correct in the main, although a traction dynamometer has been substituted for the coiled and calibrated spring device, which, owing to excessive friction of bearing surfaces, proved a disappointment.

CASE I.—This case is of special interest, for the difficulties met with were by no means commonplace. (Flattened and generally contracted pelvis, large head, brow presentation, cord around neck, hydramnios, unusual weight of child.)

Mrs. M., 4-para, æt. 32, nativity Ireland. Obstetric history: Patient was delivered of her first child December 18, 1900; occipito-posterior, extremely difficult high forceps by Drs. M. L. Bodkin and J. L. Macumber; head badly damaged, child lost. Second child delivered by the author March 11, 1902; occipito-anterior, difficult high forceps, cephalic damage, child lost. Third delivery by the author February 24, 1903; occipito-anterior, arduous high forceps, child badly asphyxiated and barely saved. Author assisted in both deliveries by Dr. George Drury; Tarnier forceps employed. Perineum lacerated and restored by primary operation each time. The fourth and last delivery, in which the axis-tractor was used for the first time by the author, occurred July 20, 1905, at 11:30 P. M., in an east-side tenement house in Manhattan.

Obstetric examination two weeks before labor: Patient undersized, general health good, heart, lungs, and kidneys normal. Fetal movements not active and heart not heard. Head floating

above brim but not satisfactorily palpated, owing to hydramnios,

Lozenge of Michaelis not well enough marked to be of any import. (Posterior superior spines three inches apart.) Synostosis of coccyx. Pelvis small at outlet. Total circumference 30 inches. Intertrochanteric diameter 11 inches. Sacrum normal in size and concavity—from side to side as well as longitudinally. Height of symphysis two inches and posterior surface paralleled with long axis of sacrum high up. Old bilateral lacerations slight.

External diameters:—

Anterior interspinous.....	8 ¾ inches
Posterior interspinous.....	3 “
Intercristal	10 “
	(R.) 7 ½ “
Ext. oblique	(L.) 7 ½ “
Baudelocque	6 “

Internal diameters:—

Conjugata diagonalis.....	4 inches
Conjugata vera.....	3 ½ “

Outlet:

Sacropubic.....	4 ½ “
Pubococcygeal	4 “
Transverse	3 ½ “

The patient fell in labor at full term early on July 20, but did not send for the writer until 7 P.M. Upon arrival at 9 P.M. the brow was found presenting at the brim, the exact position being left fronto-anterior. Pains strong, dilatation of cervix complete. Under ether anesthesia a left mento-anterior was finally substituted for the brow. Baudelocque's manipulations were first attempted and an occipito-posterior brought about, but semi-extension promptly recurred, whereas the mento-anterior was maintained. Unfortunately, these operations consumed some little time and chiefly account for the subsequent loss of the child. The writer was assisted by Dr. G. Morgan Muren and an intelligent woman.

Tarnier forceps applied and the axis-tractor attached. Bladder and rectum empty; full dilatation. Version or internal manual rotation considered inadmissible because of the unsafe retraction of the uterus upon the child. In addition to the contraindication of Winckel the writer confesses to a personal predilection for forceps under the circumstances. Webster considers even Baudelocque's method in brow cases in contracted pelvis difficult and risky with respect to the possibility of rupturing the uterus.

and they certainly fall short of version in seriousness. Ether was employed because it was thought that the anesthesia could be more safely prolonged if that were necessary and the operation performed more deliberately, and because it was thought that the danger of post-partum hemorrhage would be minimized, the latter being reckoned with because of the hydramnios. It is barely possible that retraction of the uterus upon the child would not have occurred in the same degree with chloroform, the latter favoring muscular relaxation more than ether.*

Delivery was accomplished in about 40 minutes with a maximum traction at the brim of 70 lbs. As the head traveled downward each successive traction became less and less. Rotation of forceps easily followed; usual mechanism of a mento-anterior throughout, the mouth, nose, forehead, vertex, and occiput appearing successively. Cord around neck tightly. Perineum intact, placenta expelled; *m.xxx* ergotole hypodermatically. Uterus contracted well; no shock nor hemorrhage. Subsequent convalescence of mother uneventful; ergot daily; no rise of temperature. Pelvic examination on tenth day disclosed old bilateral lacerations—slight, uterus anteflexed; fundus at level of brim, symphysis intact and os externum admitting one finger. Examination on the fifteenth day found fundus below level of symphysis pubis.

The child, suffering from asphyxia pallida at birth, died one hour after delivery. No forceps marks discernible on head. Caput over brow.

Diameters of head:

Biparietal	4 $\frac{1}{4}$ inches
Fronto-mental	3 $\frac{3}{4}$ "
Occipito-frontal	5 $\frac{1}{4}$ "
Occipito-mental	6 "
Suboccipito-bregmatic	4 "
Bitemporal	3 $\frac{1}{2}$ "
Bimastoid	3 $\frac{1}{2}$ "
Circumference of head.....	15 "

Diameters of trunk:

Bis-acromial	6 inches
Bis-trochanteric	4 "
Length of child.....	23 "
Weight of child.....	11 lbs.

*Milne Murray holds that in contracted pelves axis-traction is as safe as version for both mother and child. Many authorities do not agree with him. Williams rules out the forceps entirely in contracted pelves. These antithetic positions represent dogmatic extremes. Each case ought to be judged on its merits and dogmatic rules avoided. Under certain circumstances version occupies a unique and unassailable place which even perfected axis-traction, as represented by the competent employment of the axis-tractor, will never menace.

Conclusions.—The condition of the child at birth seemed in no wise different from that of the first, second, and third children, all of whom suffered from asphyxia, the resuscitation of the third being barely effected.

Being a face presentation, it is possible that there were premature attempts at respiration. This may have happened as well before as after the application of the forceps. The amount of traction was well within the orthodox limit, the delivery was not unduly prolonged, there was no traumatism to the head. The intrauterine manipulation involved in converting the brow may, considering also the fact that the cord was tightly wound around the neck, have served to disturb the circulatory equilibrium of the fetus. It might be noted here that after this patient's second delivery the child did not live as long as did this last one, although it was an occipito-anterior and there were no preliminary manipulations.

It seems fair to conclude then that the loss of the child cannot be attributed to the mode of delivery, so far as the axis-tractor is concerned. It may also be justly claimed that the delivery of a mento-anterior through a contracted pelvis in forty minutes with a very reasonable amount of traction and with no maternal mishap is a rather creditable record for the instrument, tending to sustain the theoretic claims made for it

CASE II.—MRS. A., primip., æt. 31. Delivered October 6, 1905, at St. Mary's Maternity, Brooklyn; service of Dr. P. Joseph York; house obstetrician, Dr. Francis B. Doyle. Head well engaged, dilatation complete; indication for forceps—inertia uteri. Position left occipito-anterior, obstetric conjugate normal. Delivery of a living child accomplished in thirty minutes with a maximum traction of forty-five pounds; very slight laceration of perineum. Fetal diameters and weight normal (average); no traumatism to the head. Post-partum convalescence uneventful. Cervix not lacerated.

Modus Operandi.—Having complied in a given case with the conditions laid down in the author's preliminary paper, apply the Tarnier forceps (cephalic application in the cavity, pelvic at the brim), swing the axis-tractor into the median line and connect the steel tape to the traction rods of the Tarnier instrument through the intermediate section of the latter, as shown in the cut, the dynamometer being interposed. Raise or lower the axis-tractor to the proper angle by revolving the handwheel to the left or



Jacobson's Axis-Tractor.

right (to the left raises, to the right lowers) and put on a few pounds traction by revolving the crank, until the tape is taut. See that the traction rods are parallel with the forceps handles. If the forceps handles are out of the median line align the axis-tractor, in its longitudinal axis, directly beneath them. At all points of the operation keep the rods parallel to the handles by means of the hand-wheel and also keep the axis-tractor aligned with the handles through the lateral adaptability of the instrument afforded by the universal joints which join the rods of the apparatus to the table clamp. During tractions, hold the instrument in the median line by means of the left hand grasping the hand-wheel.

All being ready, slowly put on traction, increasing it gradually until the forceps is observed to slightly advance. Traction should not be permitted to consume more than the normal duration, one or two minutes. Note the amount of traction registered by the dynamometer when the forceps begins to advance since this will be the maximum and subsequent tractions may be expected to diminish. Unless the forceps tends to advance too quickly, sustain each traction for about a minute at an optimum degree, otherwise desist sooner and use less traction the next time. Take off traction slowly and gradually. When the needle has reached zero pause for two or three minutes, or longer if thought best, during which time the fixation screw across the forceps handles should be loosened.

Repeat the foregoing, taking about twenty minutes in a primipara to bring the head down to the pelvic floor and about the same time for the perineal stage.*

If the forceps rotates a good deal detach the axis-tractor and reapply the former. As the head advances it will be found that less and less traction is needed. Two assistants must maintain the patient's position on the table and in its center. Miller's leg holders, the upper part of which goes on the patient like a vest and

*The time that one may take to effect delivery depends upon the rate of operation of the traction device and upon the degree of force applied, though an effective check upon rash employment of the latter is the fact that not more than eighty-five pounds can be pulled. There is little excuse for exceeding by three or four pounds the precise amount of traction called for in a given case, and no excuse for ten pounds. As to the rate of delivery, endeavor to imitate nature when competent, and remember that the resistance of the advancing head increases as the square of the rate of motion, and that therefore violence to the maternal soft parts depends largely upon too rapid delivery.

hence does not cut the neck or shoulders, are useful—unless Walcher's position is used.

The needle of the dynamometer, which is absolutely accurate, being true to the scale whether traveling forward or backward, will record a falling off of pounds traction when the forceps advances. The same thing will happen, though more rapidly, if the forceps is slipping. In the latter case, of course, it will also be found impossible to run up the traction.

Employ traction as far as possible only during the pains, or at regular intervals; in other words, imitate or assist nature.

It is not necessary, or even desirable, to effect an advance of the head with the first two or three tractions. By properly sus-



Dynamometer Used with Axis-Tractor.

taining a moderate amount of traction, advance will finally be effected with less power than would otherwise be required.

If the case is an occipito-posterior deal with it as indicated in the preliminary paper. If it is rotated to the front in the cavity by means of the forceps, normal rotation failing, the usual precautions must be taken to prevent injury of the maternal tissues by the tips of the instrument. When the head is not fully engaged, manual correction of this and other vicious vertex positions is, in suitable cases, sometimes feasible before application of forceps. In the case of an occipito-posterior the head is pushed cautiously up and aside, the hand passed well up, the shoulders seized and

rotation of the trunk as well as of the head effected, after which the axis-tractor may be attached.

If it is thought wise and expedient to deliver an occipito-posterior as such, carry the head through the brim with the axis-tractor and if the occiput tends to rotate anteriorly or can be "teased" around, as Marx expresses it, complete the delivery. If marked rotation occurs, detach the axis-tractor, swing to one side, reapply forceps and reattach axis-tractor; do this more than once if necessary. If the occiput fails to rotate anteriorly after the head is in the cavity detach the axis-tractor and complete delivery by Brodhead's method, except perhaps in case of those occasional multiparæ in whom a bad rupture of the perineum is possible of prevention when the occiput is delivered posterior.

Webster advises the Walcher position during the perineal stage, since it relaxes the perineum very considerably.

The fixation screw across the handles of the Tarnier forceps is not indispensable, according to Jewett and Marx. The latter states that the blades are really kept in place by the impact of the fetal head and the pelvic wall. This is contrary to the general accepted idea respecting the function of the fixation screw, as well as to the idea that Tarnier, himself, seems to have held, but these gentlemen have satisfied themselves in practice that the above statement is true. If the screw be used it is said that pressure necrosis, scarring and intracranial lesions are more likely to result, but these results are to a considerable extent chargeable to neglect to loosen it between tractions (this loosening also favors rotation, according to Webster). It certainly need not and should not be used as a compression screw.

The traction crank should be sterilized and the hand-wheel covered with sterilized gauze, these being the only parts touched. A sterilized towel may be laid over the table clamp, extending out over the upper bar and under the dynamometer and steel tape, and allowed to drop down on either side, thus covering much of the apparatus.

The instrument is merely a tractor and not a rotator. It will follow rotating forceps but will not inaugurate rotation. In short, it exerts no directive influence but must be made to do whatever the forceps handles do, they being the invariable guides. If the forceps has to be "teased" around in occipito-posterior cases when the axis-tractor is being used, this must be done by means of the forceps handles in the usual manner.

Traction being measured and it being impossible to exceed eighty-five pounds, the fact that the instrument almost abolishes the sense of resistance—because of the multiplication of the power applied—cannot be made a ground for adverse argument with respect to what would otherwise constitute a dangerous feature of the instrument.* One could hardly make out a favorable case for guess work as against mathematical exactness.

A little practice with the instrument, the steel tape and dynamometer being attached to a clothes-line, which is attached in turn to the legs of a table at the end opposite to which the apparatus is clamped, will enable one to become familiar with the mode of utilizing the power and otherwise operating the device.

It is probable that with it a force of fifty pounds need rarely be exceeded. Whatever the force, it is applied more gently, steadily, and precisely by this instrument of precision than was ever force emanating from an obstetrician's arms, and when any given amount of traction is sustained for a minute or two it is *sustained uniformly*. If it is fifty pounds it remains fifty pounds so long as one wishes. Anything more scientific than this cannot be expected nor achieved.

Powerful mechanical devices, *as such*, are to be condemned. It has been said of the Bossi dilator that in the apparent ease with which it works lies its greatest danger (E. P. Davis). Such arraignment of the author's instrument would be manifestly unfair, for in the registering of the amount of traction employed we have an absolutely safe, conservative, and scientific control of the situation.

The minimizing of the force employed in instrumental extraction is one of its chief claims to consideration. This materially discounts the damage factor, for it may be laid down as a general law that in proportion as the traction force used in effecting delivery by means of the forceps is reduced so is the damage factor reduced, regarding both maternal and fetal structures. The degree of compression exerted by the forceps on the fetal head is about one-half the traction force in pounds, according to Delore.

With respect to the saving of labor and the maintenance of steadiness and balance, so to speak, on the part of the operator, so that he is better enabled to conduct a delivery, one may compare the obstetrician's command over the operation of delivery by means

*The power applied is multiplied 25 times—to pull 75 pounds rebuies but three pounds of actual hand power at the crank.

of the axis-tractor to that which the engineer has whose throttle hand is not unsteadied when driving his locomotive by the hard and constant work of raking the fire and shoveling the coal.

Effectiveness in forceps work is largely a matter of conformity to the mechanical requirements and this postulate the axis-tractor sustains in fact as well as in theory. The writer believes that in the cases—and they are not few—in which difficulty in instrumental delivery cannot be foreseen nor afterward explained by obvious maternal or fetal conditions operating as direct factors in occasioning dystocia, that we are as much justified in referring the trouble to the obstetrician as a factor as to the passages or passanger, not in a discreditable sense, but because of the relative imperfection of our *conventional* methods and their mode of application, and the Tarnier forceps as *ordinarily* employed is included in this generalization. Making this plainer, let us picture in our imaginations a graphic representation of the aberrations of the force applied that probably occur in a high instrumental delivery in the hands of a skillful obstetrician. It is not possible for any human being, however skillful in the obstetric art, to act perfectly, accurately, and uniformly, for half an hour or more, as a source of and distributor of the force required in forceps work, be the operation high or median, even if the Tarnier forceps be the instrument employed. We *talk* about accurate traction in the pelvic axis, avoidance of misdirection of traction, and of excessive traction, as if all these things were already within the realm of mathematical-like attainment, ignoring, apparently, the fact that nothing like perfect accuracy is attainable with our conventional methods. It has been shown experimentally that manual tractions with the forceps, instead of being regular and continuous, or uniformly sustained at their maximum, are abrupt and broken at short intervals, and never uniformly sustained. (Joulin.)

Could an obstetric schema by some means be made in the course of a high delivery in skillful hands, unattended by any gross defects of the passages or passanger, with normal position, good flexion and moulding, and properly applied instruments (simply the powers being at fault), showing, as the sphygmogram shows the aberrations of abnormal arterial pulsations, similar aberrations from the supposed conformity to the pelvic axis throughout the operation, and also showing the irregular variations with respect to the power applied, what a revelation it would undoubtedly be! The Tarnier would tend to minimize the former, to be sure, but it would not alter the latter finding.

The point that the writer wishes to make is that it is probably these departures from the mechanical requirements that have much to do as factors in dystocia, assuming other adequate causes to be undiscoverable. The more nearly we can, by improving our methods, approximate a mathematical ideal in axis-traction, the more surely will we relegate the difficulties discussed, in part or in whole, from obstetric work, and the more certainly attain relatively perfect accuracy. That the latter is attainable in practice the axis-tractor may be expected to demonstrate.

In the presence of gross maternal or fetal defects in which the high forceps operation is elected as the one of choice or necessity, it seems to the writer that accuracy in the force and direction of traction becomes proportionately more imperative, and failure or success must be largely dependent upon the degree of approach to or departure from such accuracy. The probability of a successful outcome in these cases (meaning by "successful," instrumental delivery devoid of variable, excessive, or misdirected traction and consequent damage of one sort or another) must bear a direct ratio to the closeness of the approximation to the mechanical requirements, in so far as human ingenuity can conform to the severe conditions that are sometimes imposed upon us in obstetric practice. This is not only a self-evident proposition, but is supported in a way by the evidence furnished by the clinical results sometimes observed.*

Instrumental delivery is at best a poor substitute for nature when competent. Consider the 71.58 per cent. of spontaneous deliveries at Johns Hopkins in a large series of cases of contracted pelvis (the writer knows of a *precipitate* labor in a case in which Cesarean section was planned, and invitations to witness it issued),† and recall how much more efficient the forceps is when aided by the natural expulsive efforts, with anesthesia of the obstetric degree only. It is because the axis-tractor secures the closest approximation to the operation of nature, in so far as accuracy, steadiness and precision are concerned, that it permits of facile delivery with such a remarkable absence of visible traumatism with respect to the cranial vault of the child and the genital tract of the mother.

†We see this occasionally in the case of exceptionally skillful operators, like Milne Murray, who has successfully delivered with forceps cases in which the conjugate was considerably less than three inches. Webster reports safe delivery of cases in which the conjugate was three and one-quarter.

†Sixty-six and three-tenths per cent. at the Sloane Maternity.

The writer has never meant to put forth as the chief recommendation of the axis-tractor the fact that it is a labor saver. That is merely an incidental but by no means an unimportant advantage, for reasons that are perfectly obvious.* Above all other advantages must be placed the fact that with it delivery may be accomplished with a minimum amount of traction, by reason of the accurate, precise and steady application of the power, not a pound more of traction than is actually needed being used.

The fact is fully appreciated that there are men who claim to have never had any special difficulty in effecting instrumental delivery. Some of these claimants have not even found it necessary or expedient to employ axis-traction. Of such as these the writer can only say that they have been very fortunate in their obstetric practice, and that their experience suggests that of the men who have never lost their pneumonia or typhoid patients; also that of a distinguished obstetrician who makes the statement in his text-book that he has never had any marked difficulty in delivering the after-coming head after podalic version, even in the presence of a fair degree of contraction.

Although research work with the axis-tractor may at first interest obstetricians more than clinical possibilities, the writer believes that the latter will ultimately be the field of its greatest usefulness and that there is a real necessity for such an apparatus, and he does not believe that his arguments in support of the method have been too finely drawn.

Delivery by the axis-tractor will, it is believed, be found to offer the following advantages: 1. Accurate measurement of traction. 2. Perfectly steady "pull." 3. Optimum traction at any given stage of delivery capable of being uniformly sustained for a reasonable time; no variation. 4. The direction of traction is mathematically exact with respect to the pelvic axis. The axis-tractor obviates the danger incidental to traction in *any* tangent of the pelvic axis. Properly used there can be no tangential pull.†

*Cazeaux, deploring the excessive fatigue incurred by the obstetrician in difficult forceps deliveries, ascribes it chiefly to the energy expended in counterpoising one's self during traction.

†"The term axis-traction has been strangely and exclusively appropriated to the sense of an adherence to the axis in its antero-posterior curvature, ignoring the fact that precisely the same relations exist with reference to lateral deviations, and that it can make no difference whether we vary the coincidence of the axis of traction with the axis of motion and resistance by motions from side to side, or from front to back, or by rotary actions; the difference is simply in the degree to which the deviations may be carried—all equally hurtful." (Albert Smith.)

5. Traction being perfectly steady and absolutely precise, a minimum degree suffices to accomplish delivery.* This fact is emphasized as of first importance. 6. The apparatus adapts itself perfectly to rotation of the forceps. 7. Physical exertion on the part of the *accoucheur* is practically obviated; all forceps deliveries are divested of difficulty with respect to expenditure of physical force, an *incidental* advantage of some moment.† 8. Manipulation of the instrument is simple and easy; mechanism simple. 9. Reduction of damage factor to lowest terms; makes for greater safety and conservatism in forceps work. 10. It exerts no directive influence *of itself*, taking its cue entirely from the forceps handles as indicators of the proper line of traction; in other words, the transit of the head through the curve of Carus and its evolutions therein are directed by the walls of the birth canal. 11. Slipping of forceps fraught with absolutely no danger. 12. Owing to control of the rate of advance of the forceps, *i.e.*, if the patient is well anesthetized, the danger of bad perineal tears is greatly lessened in cases in which strong manual traction is so apt to eventuate in unexpectedly sudden advance, with consequent rupture of the perineum (*e.g.*, occipito-posteriors delivered as such). 13. In selected cases in which the pelvis is contracted its use should improve the prognosis. The writer would not attempt to define what should mark the limit of contraction, preferring to leave this important definition to others, but he suggests that this question might sometimes be made to depend more on the amount of traction tentatively employed than upon the degree of contraction, unless the latter is absolutely prohibitive. If a reasonable number of sustained, eighty-pound, one-minute tractions fail to effect progress, than we may properly conclude that some other procedure is in order. It is the writer's belief that such failure will be relatively rare in the case of the axis-tractor in comparison with manual traction under identical conditions. 14. None of the well-known advantages of the axis-traction forceps is abrogated and additional advantages are offered.

It is imperative that the conditions governing its use, as laid down in the preliminary paper, be strictly adhered to.

The procedure enables us to actually attain conditions that

*Just as the Tarnier forceps, as ordinarily used, in comparison with the classical instrument, reduces, *caeteris paribus*, the amount of pounds traction requisite to accomplish delivery, so the axis-tractor effects a still further reduction.

†It is to be borne in mind that the *prime* object of the axis-tractor is the further development of the principle and practice of axis-traction.

should be nearly ideal in institution work, or at least considerable in advance of what can be attained by ordinary methods. Of course expertness is absolutely essential. "It is not the instrument that operates," said Baudelocque, "but the hand which directs it."

We must not forever limit ourselves with respect to further development of the principle of which the Tarnier forceps has been, thus far, the only practical expression, when it is clearly within our power to attain a still higher degree of efficiency, to the end that the forceps operation shall be placed upon an absolutely scientific plane and that the means be perfected by which we make practical application of the principle the obstetric relations of which were first discerned by Hermann of Berne (although his forceps did not give proper expression to his clear enough mathematical calculations), next by Hubert of Louvain, and then by Tarnier, with his successful application.

The early exploiters of mechanical traction, working prior to Tarnier's enunciation in 1877 of the successful application in practice of the principle of axis-traction, employed it for its own sake and in no sense as a means to the end aimed at by the author of this paper. It is the combination of perfected mechanical traction with axis-traction that realizes the theoretic and at the same time the clinical ideal. Mechanical traction has no place in conjunction with the ordinary forceps. Properly applied, its scientific features are satisfactory. Its improper application in the past explains the desuetude into which it has undeservedly fallen and the failure to apply it, perfected, to axis-traction, explains the imperfection of the latter as heretofore employed.

Chassagny (1860) was the father of mechanical traction. Pros and Joulin made subsequent attempts. Finally Tarnier and lastly Pouillet made additional efforts in this direction. All their devices were long since abandoned.

In the treatise of Tarnier and Budin (1901) the question of mechanical traction is considered still an open one. Singularly enough, Tarnier, although this was a subject that interested him greatly and one with which he experimented at some length, does not appear, so far as the writer can ascertain, to have attempted to apply the principle of mechanical traction in connection with his axis-traction forceps. He used the ordinary forceps in his experiments. Had he utilized the former in a perfected form he would have satisfied the two principles upon the proper application of which he himself conditioned success, to wit: 1. The

traction must not be applied to the handles or shanks of the forceps. 2. The traction must at all times be exerted in that line which the principle of axis-traction recognizes as the only correct one.

It is altogether probable that such an idea must have occurred to him, for he fully recognized the desirability of satisfactory mechanical traction and had himself solved the problem of how to properly direct traction in the pelvic axis. If so, his difficulty may have consisted in devising the requisite apparatus. The writer can thoroughly appreciate this, for it has taken the best efforts of an expert in mechanics (Mr. Clifton W. Wilder) to work out, in three years, an apparatus that satisfies the requirements, and this in a period characterized by a highly advanced state of the two fields of science jointly involved.

A word as to the relation of the author's apparatus to the mechanical traction devices that have preceded it. He admits two relations—his apparatus is a mechanical device and one of its functions is mechanical traction. The fundamental idea of the author's device is, however, not mechanical traction *per se*,* the latter being merely utilized as a means of attaining an end, viz., perfect axis-traction. By no other means could the latter desideratum have been attained. Incidentally, and necessarily, there has been an evolution in the method of providing the mechanical traction. Therefore, as to priority, the author admits none other than that essentially involved, to wit, axis-traction, of which principle his device is a development in practical application; *modus operandi*, mechanics, aim and scope, effectually distinguish the axis-tractor from what may be termed obstetric junk.

The failure of the distinguished obstetricians alluded to to satisfy the exacting requirements with their crude and curious arrangements of ropes, straps, cords, and chains have led *accoucheurs* to think of mechanical traction as impracticable and unattainable and they have expended their energies of late in other ways. Failure has also bred prejudice against the principle itself. The great mind of Tarnier, however, perceived the inherent soundness of the principle, even after his own deplorable experience (four dead infants and two mothers out of seven cases), and he believed that in the future all objections against

*The devices of Chassagny and his disciples may be regarded in the light of primitive efforts toward what has constituted but a subordinate and incidental phase of the author's program.

*mechanical traction would be overcome, and that, perfected, it was destined to prove of great value in a clinical way.**

The writer understands that in America at least two attempts have been made in the direction of mechanical traction, the late John Byrne being sponsor for one, and a living obstetrician of note for the other. Their utter failure explains the absence from the literature of any account of their methods and experiences.

Tarnier declared that manual traction was bound to vary according to the muscular force of different individuals and their ability to apply it, and in mechanical traction, could it be properly applied, he saw great advantages. Guéniot and Pajot also shared in the belief that the latter was capable of being perfected. Bailly, Charpentier, Depaul, and Pajot condemned all the apparatus used by their colleagues.

The various objections that have hitherto been urged against mechanical traction are all invalidated by the author's apparatus. They are as follows: 1. Blind force substituted for the sentient guiding hand. 2. Traction invariable and progressive—continuous. 3. Slipping during traction fraught with danger. 4. Interference with lateral movements of the forceps (rotation). 5. Likelihood of force being applied obliquely to pelvic walls, resulting in loss of direct force and probable maternal damage. 6. Greater liability of damage to the fetal head because of the foregoing objections. 7. Too much time consumed in manipulation. Barnes condemned mechanical traction on the ground that it obviated the use of the forceps as a lateral lever. Of course, to the present-day obstetricians this quality would be regarded as anything but an objection. It was also said that manual traction was capable of accomplishing the same thing, *i.e.* delivery of the child, even through a contracted pelvis, if delivery were at all possible.

Our attempts at instrumental aid should be based upon the idea of applying extractive force as early as possible as nature applies expulsive force during pains—steadily, rising gradually to an efficient maximum, then sustained for a short time, falling again without abruptness, then an intermission, the force at all times being directed so as to effect the transit of the head to the best mechanical advantage: that is to say, exactly in the curvilinear axis of the birth canal; and particularly should we strive to attain the desired result in a given case with an amount of traction no

*Charpentier.

greater than nature herself would probably have utilized had she been competent.

"Perfected" mechanical traction may have certain disadvantages, as probably no one will deny manual traction also has. The practical question is, does the sum of the advantages of the former, when used in conjunction with the axis-traction *forceps*, exceed the sum of the advantages of the latter?

There is a field for research work with the axis-tractor which should yield valuable results. The writer is disposed to place but little reliance upon such data as we have with respect to the force expended by nature or artificially in effecting delivery. The methods which have been hitherto utilized in formulating conclusions have been open to errors and fallacies of various sorts. Their devisers deserve great commendation for their painstaking and ingenious attempts, and it is true that they have not been entirely profitless in their influence upon conservatism in forceps work. The results of Schatz are given as from 17 to 55 lbs., and Williams regards his method as "rather accurate." A rubber bag in the uterus is connected with a manometer. The intra-uterine pressure in the intervals between contractions is found to average about 20 millimeters (height of mercury column), 5 due to tonicity of uterine walls and 15 to the contents. During pains the column rises to 80-250 millimeters—corresponding to a force of $8\frac{1}{2}$ - $27\frac{1}{2}$ lbs. (to this must be added the voluntary forces). The force increases markedly when the fetus is partially expelled from the uterus.

The various methods of measuring the force exerted in labor are as follows:

I. The method of Schatz, described above (tocodynamometer).

II. Measuring the bulk and extent of the voluntary and involuntary muscles concerned in the function (Haughton).

III. By determining the force necessary to rupture the fetal membranes (Poppel, Duncan, Ribemont).

IV. By the tocograph (Poulet).

V. By measuring the force required to hold the head back at the vulva.

VI. By forceps fixed upon a Salter's spiral balance used as a dynamometer. (Simpson.)

VII. By the use of various types of dynamometers attached to forceps.

Duncan's maximum estimate was 80 lbs. (including the abdominal muscles); average about 50 lbs. Haughton (quoted by Playfair) estimates the *uterine* forces as about 54 lbs. ordinarily and attributes most power to the abdominal muscles. Joulin attributes a maximum power of 100 lbs. to the uterine contractions alone, but states that it rarely exceeds 80 lbs. He minimizes the importance of the abdominal muscles as factors, thus differing from Haughton. Williams states that more than 50 lbs. is seldom required to hold the head back at the vulva. Simpson's method showed that from 25 to 50 lbs. were required to deliver. Delore and Tarnier state that 132 lbs. may be called for, and they fix this as a safe maximum for tractive force, on the ground that the degree of compression, which they say constitutes the chief damage factor, is equal to about half the tractive force, and that experiments have shown the fetal head to be capable of withstanding compression equal to about 65 lbs. Williams appears to regard about 100 lbs. as the limit, since it has been shown that 120 lbs. is sufficient to tear the child's head from the body. 100 lbs. is certainly the greatest limit that we should ever reach, for various reasons other than Williams's; for, analyzed, his reasoning is not sound. The child's shoulders and body in parturition tend to follow the head, whereas in such laboratory experiments as the above they are made to effectually resist traction on the neck and head.

Aside from the inherent defects of the methods pursued by these investigators, the above results show a suspicious disparity. The data furnished by the author's apparatus would not be open to criticism upon any grounds referable to purely mechanical defects, for the last degree of precision would obtain and resulting records would stand by themselves as the first really accurate ones, *i.e.*, if the assumption is sound that, other things being equal, *vis à fronte*, accurately directed (mechanical axis-traction) and barely sufficient to slowly effect delivery, is approximately equivalent, in terms of pounds, to *vis à tergo*.

The writer has striven to avoid overstatement and has endeavored to bear in mind one's liability to minimize the disadvantages of one's own projects; or, on the other hand, fail to see them at all. He has, perhaps, fallen into all of these errors, but if such be the case his self-satisfaction will be short-lived, for in the crucible of obstetric trial and criticism the gold and the dross are sure to be ultimately dissociated. Finally, if his paper

reveals to experts defective knowledge of the principles of obstetric science, or imperfect acquaintance with the technics of obstetric art, he can only plead in extenuation the fact that he is a general practitioner whose opportunities and incentives have in no wise been comparable to those of men with adequate institutional facilities.

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