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SOME EXPERIENCES WITH TREATMENT OF COLLUM FEMORIS FRACTURES BY SVEN JOHANSSON'S METHOD[1])

BY

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The extra-articular osteosynthesis of collum femoris fractures by *Sven Johansson's* method is probably one of the most remarkable advances made in practical surgery during recent years. It is true that even by that method those secondary changes cannot be avoided that take place, for instance in the caput and collum, as a result of the fracture, and that longer experience is still needed with regard to after-treatment and end-results,—especially as to how soon weight may safely be put on the leg. Yet, this method of fixation seems for the patient to bee so decidedly superior to those hitherto employed that it cannot fail to be of the greatest interest to every surgeon. As our *operative procedure* differs in certain details from the one employed by *Sven Johansson,* and *has been carried out with only such armamentarium as is to be found in almost any hosital* a description of it may perhaps be of interest, as a contribution to the discussion concerning the operative technic.

We have done the operation, so far, in 17 cases of collum fracture,—15 medial and 2 lateral. Two of the patients with medial fracture—respectively 55 and 59 years old—were suffering from severe chronic polyarthritis at the time of their accident. All the others were old people with simply the relative brittleness of bones conditioned by their advanced years; their ages being respectively 66, 67, 68, 68, 71, 74, 75, 77, 77, 77, 78, 79, 83, 89, 89; which gives, for the main group, an average of 76 years.

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As regards indications, we have taken a very large view. Of 20 cases of collum fracture received since september 1932, only 3 were not treated by the described method.

These were (1) a woman, 85 years old, cachectic and in poor condition generally,—died a month after from pneumonia; (2) a woman, 78 years old, with senile dementia and multiple fractures,—died in senile marasma five days after admission; (3) a woman, 74 years old, with hemiplegia after a cerebral hemorrhage + purulent bronchitis,—died from bronchopneumonia ten days after admission.

It has been astonishing to see how little the operation affected the patients. Our material is small, but it has given us the impression that the reset and fixed fracture taxed the strength of the sufferer less than the fracture before reposition. There is probably good reason to suppose that in these individuals, whose vitality has become lowered by age, a persistent, long lasting pain constitutes a serious strain on the nervous system, even though the pain sense becomes considerably dulled with advancing years. In several cases, especially during the first year that we used the method here. we waited some days before operating, in order to see how the trauma affected the patient, ensuring in the meantime a certain degree of fixation with sandbags; but of late we have taken to operate earlier; in some cases even immediately after the patient's admission to the hospital.

The operations have been done under lumbar anesthesia; 1 c.c. of 5 per cent. tropacocaine (Merck's ampullæ) being quickly injected between the second and third lumbar vertebra; the patient lying in bed on his (her) sound side during the injection. After anesthesia has set in, the patient is transferred to the operating table where the reposition, the roentgen control and the fixation are to be done. To this end we have found it most practical to use the trochoscope, on which the patient is placed comfortably on cushions. If the trochoscope has no solid top, it is easy—by means of a sheet of plywood, for instance,—to make a base sufficiently firm for the purposes of the further treatment.

If the reposition is to be a success it is necessary, not only that the patient be in a condition of completely slackened muscles and freedom from pain, but also that the trunk be fastened in such a manner that it is not pulled downwards in the course of the manipulation. This is ensured by means of two straps of the kind generally used for fastening the lower ex-

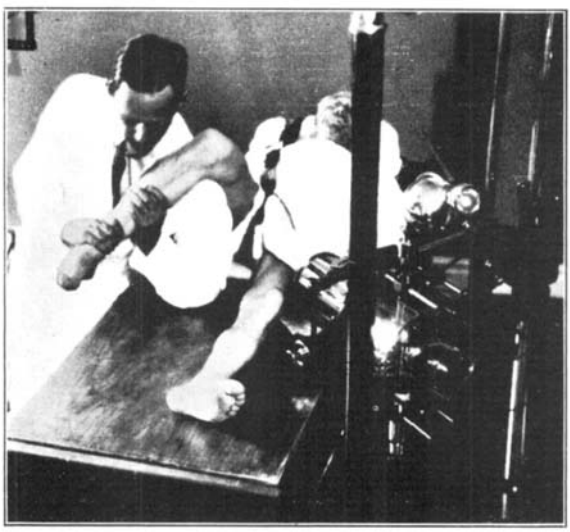

Fig. 1.

tremities during narcosis. One such is passed between the patient's legs already while he is still in his bed, is padded well, and, when the patient has been transferred to the trochoscope, is pulled over the shoulder on the injured side, and is fastened there, by means of another strap, to the head end of the table.

For the purposes of the roentgenography the trochoscope is supplemented by a tube stand which by the emission of horizontal rays as nearly as possible at right angles to the axis of the collum makes it possible to control the position in this projection (see *Figs. 4 and 9*). If now also the under tube is properly adjusted,—that is, centrally underneath the collum,—it is pos-

sible, without making any change in the position of the two tubes, to take pictures in both projections during the entire operation, with the focussing done beforehand. The whole procedure will be clearly seen from *Figs. 3—4* and *8—9*. The Lysholm grid may be used to advantage to secure good pictures.

The fracture is now reset; the reposition being easily effected by placing the injured leg over one's shoulder, with the

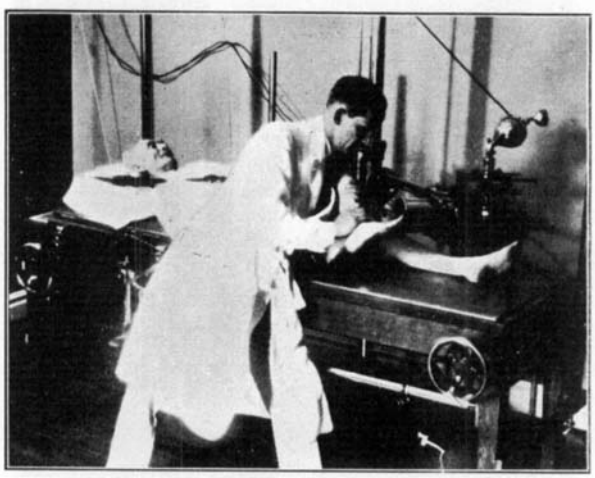

Fig. 2.

hollow of the knee resting on the latter; at the same time gripping the lower leg firmly with both hands and pressing it against one's chest *(Figs. 1 and 2)*. The pull on the leg is then done with the shoulder. In this way one is able to put a good deal of force into one's movements, and to keep them under good control at the same time; which, especially in the case of corpulent patients with heavy legs, helps to make the performance easier. During the reposition the leg is rotated inwards 25 to 30 degrees, and when the manœuvre is completed its result is controlled by straightening the two legs, bringing them close together, and then ascertaining that, with both hips in the same position, the distal points of the medial malleoli are at the same level.

When one has thus satisfied oneself that the reposition has been successfully accomplished, the next step is to secure its maintainance during the following roentgen control and the nailing. This is done by laying a broad strip of non-elastic material, with suitable padding underneath, around the knee, and fastening it with safety pins in such a manner that the

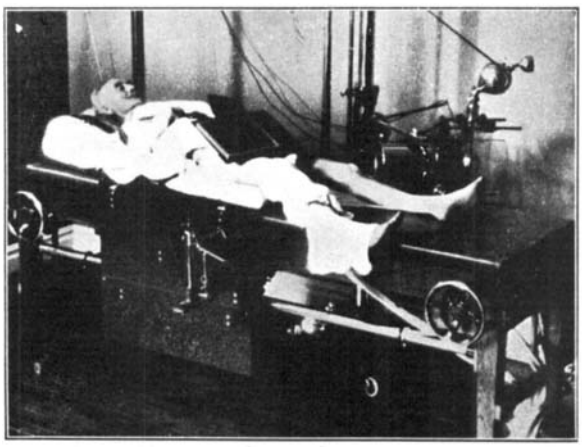

Fig. 3.

loop thus formed is only slightly wider than the circumference of the leg. By a similar bandage arrangement the ankle is fastened securely to the trochoscope, just outside the edge of the latter, in such a way that a certain pull is exerted on the foot in downward and caudal direction. With the bandage around the knee a pull is likewise exerted, in medial and caudal direction. When the two strips have thus been pulled as tight as it is deemed suitable, they are tied together at the foot end of the table; and in this manner the reduced fracture will be satisfactorily maintained in the inwards rotated position. As it is difficult to get the strips of material tied so firmly that the knots won't give more or less, the necessary steadying may be further secured by thightening the strap that passes between the patient's legs to the head end of the trochoscope, thus pul-

ling the trunk higher up. The whole arrangement of these fastenings will be seen from *Figs. 3 and 4.*

It may now be reasonably supposed that by the procedure here described the fracture will have been successfully reduced. The next to be done then is to control the position, and, in connexion with that, to establish the point that are to guide us in determining the direction of the axis of the collum and

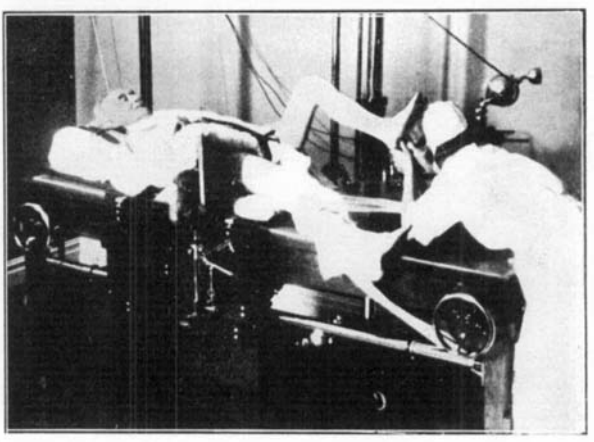

Fig. 4.

marking it on the skin. As *Johansson* points out, it is an important condition for the proper execution of the extra-articular fixation that both the direction in which the guiding wire is to be introduced, and the length of the nail to be used, should be exactly determined beforehand. After a suitable system of marking has been applied to the skin, and after the tube of the trochoscope has been centered medially, from below, to the collum femoris, exposures are made in two projections at right angles to each other,—one vertically, the other horizontally, with the central ray directed as far as possible at right angles to the axis of the collum (see *Figs. 3 and 4*). Our system of marking has been chosen with a view to the simplest and exactest possible indication, on the skin, of the vertical projection of the latter. To that end a small leaden shot is fastened in place

with court plaster over the point of the inguinal ligament where one feels the femoral artery, and another on the lateral side of the thigh, from 5 to 8 cm. distal to the spot where palpation has located the point of the trochanter.

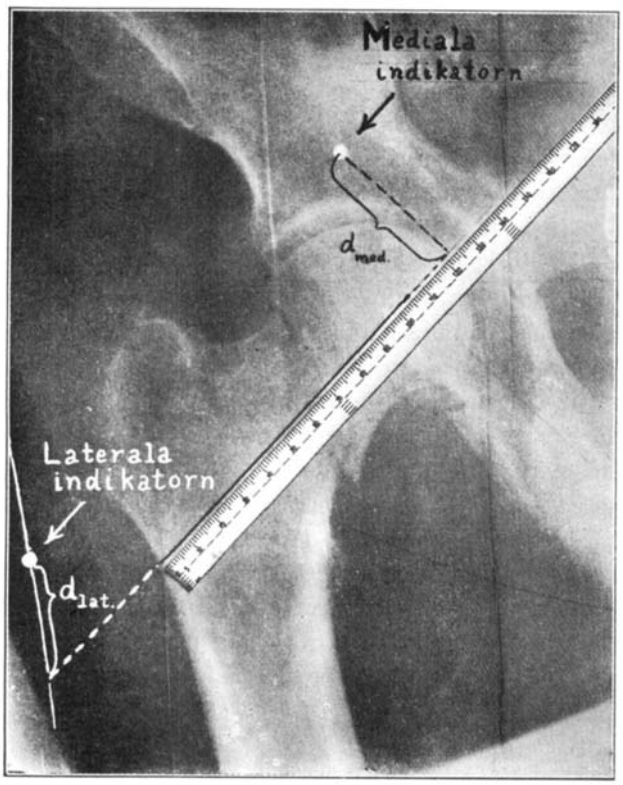

Fig. 5.

After the radiograph has been obtained, and while the film is still wet, a transparent celluloid ruler is placed upon it, along the line of the direction in which one intends to drive in the nail; whereupon the distances from the medial marker to this line—$d_{med.}$ -- and from the lateral marker along the skin to the lateral prolongation of the same line—$d_{lat.}$ —are measured. If absolute exactitude is aimed at, the distances thus measured on

the film must be slightly reduced before they are marked off on the skin, on account of the linear enlargement resulting from the divergence of the rays employed. For practical purposes it will be sufficient if $d_{med.}$ is reduced by 3 per cent., and $d_{lat.}$ by 10 per cent.[1]) The marking off is done from the medial marker along the inguinal ligament, and from the lateral marker along the lateral aspect of the thigh. With the aid of a flexible sound, the line connecting the two points thus obtained is then traced, first with a blue-pencil, afterwards with a lapis pencil; and this line marks the vertical projection of the axis of the collum on the skin. In the case of subjects with loose, flabby musculature and skin it is, of course, important that the skin should not be pulled in one direction or another in the course of this marking and tracing. By means of the lines of direction thus obtained we have in all our cases succeeded in getting the desired position for the guiding wire.

During the exposure in lateral projection the patient's sound leg is held raised by an assistant, as seen in *Fig. 4*. If the rays do not strike the Lysholm grid at right angles, the secondary diaphragm is placed in such a manner that the direction of the central ray, when it is projected vertically onto the grid, will correspond to that of the lead strips. The rest of the technic for obtaining the roentgenographs will be easily understood from *Figs. 3 and 4*. When the leg is rotated inwards in the manner as done in our cases, the axis of the collum will as a rule

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[1]) Since the distance from the leaden marker to the photosensitive surface is not the same in the two places, the correction will not be quite the same in the two instances, and those distances should therefore always be estimated beforehand. The distance D, which must be marked off on the skin in order to make the connecting line between the two points correspond to the line sought for, is found by means of the expression: $D = d\ (1 - \frac{a}{f})$, in which a is the distance marker-to-film, and f the focal distance. If the focal distance worked with is 75 cm., each centimeter of marker-to-film distance will increase the distance measured by 1:75.

The reckoning with reductions of respectively 3 and 10 per cent. is based on a supposed marker-to-film distance over the inguinal ligament of a little more than 2 cm., and a corresponding distance of 7,5 cm. for the lateral marker.

come to lie very nearly horizontal, and we have therefore not considered it necessary to place an extra marker for determining its horizontal projection to the lateral aspect of the thigh; especially as the direction of the collum in that projection can always be very easily controlled during the operation by introducing a finger along the anterior aspect of the neck of the collum.

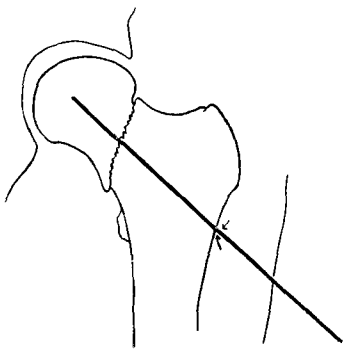

Fig. 6.

We have now come to the stage in the proceedings when the hip region is to be painted with tincture of iodine and wrapped around in preparation for the operation. If the case is handled by one surgeon alone, he uses the time to wash himself while the nurse on duty in the operating room is carrying out these preliminaries; but in order to save time it is better that there should be two surgeons, one of whom is already washed and ready to step in and do the »bloody« part of the operation. An incision, 4 to 5 cm. long, is made, from the point marked on the lateral side of the thigh in direction to the trochanter; whereupon the skin, subcutis and tensor are cut through, right to the bone, which is laid bare by a gentle, blunt widening of the wound.

Next, the guiding wire is introduced by means of the handdrill designed by *Sven Johansson* for that purpose but otherwise on free hand without any aiming apparatus. In the wire has beforehand been made a circular groove 10 cm. from the

point, and lighter marks 9, 8, 7 and 6 cm. from the point. The drill is guided along the horizontal plane which divides the caput-collum region in two equally large halves—an anterior and a posterior,—and in such a manner that it, at the same time, comes to lie in a vertical plane through the guiding line marked on the skin. The horizontal plane that more or less fulfills the first condition can be found by palpation over the

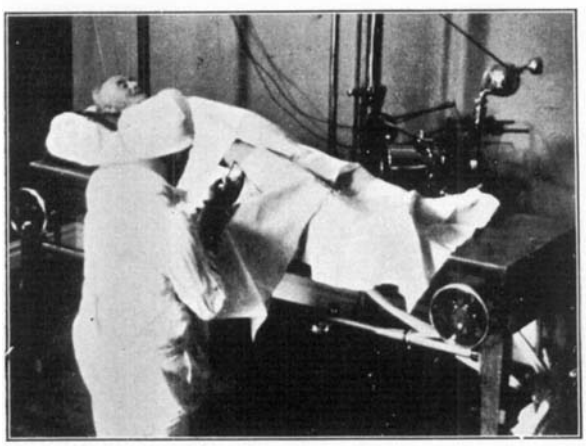

Fig. 7.

lateral aspect of the proximal part of the shaft of the femur. By locating the anterior side of the collum with the finger while the drill is being aimed, one will be able to make sure that its axis really lies in the horizontal plane. In most of our cases it has done so, but if there should be some deviation it will be very easy to correct the direction according to the indication furnished by the palpation *(Fig. 7)*.

It is best to carry the wire in exactly as far as one wishes to have the nail hammered in afterwards; and this distance can be fairly accurately determined from *Fig. 5*. Experience shows that with the focus distance of about 75 cm. used by us, the enlargement of the axis of the collum in the frontal plane is about 10 per cent., and the length as measured on the film must therefore be reduced by that much. The distance to which the

wire has passed in can be controlled during the drilling by drawing the guiding tube back from time to time and noticing the centimeter marks made on the wire.

As a rule, we have aimed at getting the point of the nail to lie from 1 to 1.5 cm. from the vertex of the caput as seen on the frontal picture. To have the nail penetrate for a considerable distance into the caput is probably not so important in cases

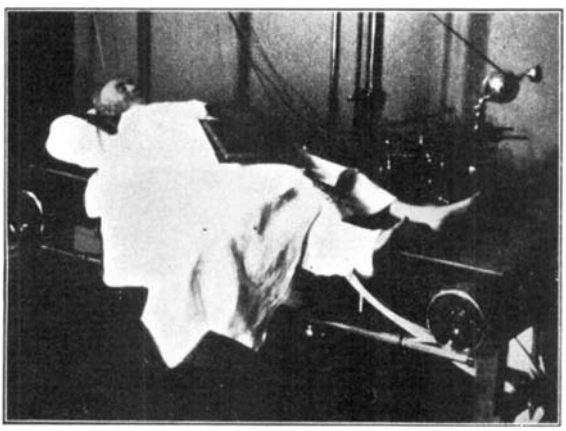

Fig. 8.

of lateral fracture as in cases of medial ones. In the picture *Fig. 5,* the length of the fulldrawn line in the collum femoris is 10.8 cm. As the enlargement, as said above, was very nearly 10 per cent., the distance to which the wire should be introduced was in this case 9.7 cm. It was therefore drilled in about 9.5 cm., whereupon control pictures were taken in both projections. During the exposures the field of operation is covered with sterile towels, of which it is best to have about twenty ready for the purpose. The required length of the nail can now be very exactly calculated on the frontal picture (see the diagram *Fig. 6*). The wire, on which the 10-cm. mark is plainly seen in the picture (indicated with arrows on the diagram), is namely lying exactly in the plane in which the nail will lie afterwards; and by ascertaining the length of the 10-cm. distance on the

film by means of the celluloid ruler—in this case it is 11.0 cm.—one easily and directly finds the degree of the enlargement. The number of millimeters by which the shadow of the 10-cm. distance in the roentgenograph exceeds 10 cm. indicates the percentage of enlargement, which thus, in this case, is 10 per cent. The length of the nail should, consequently, in this case be exactly 10.8—1.08 = 9.7 cm. As it does not matter if its head

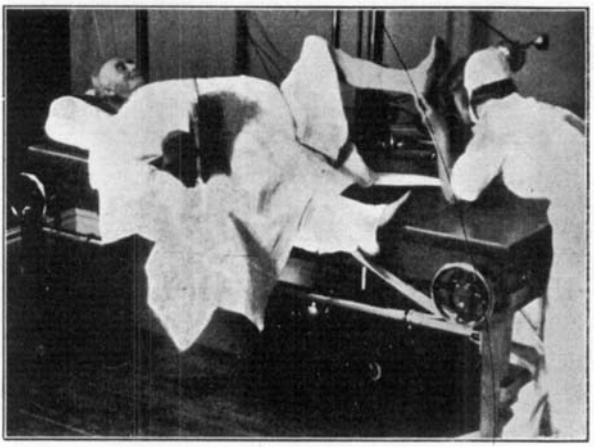

Fig. 9.

remains a few millimeters outside the compacta on the lateral side of the femur, we chose in this case a nail 10 cm. long.

The nail is driven in by means of the instrumentarium constructed by *Sven Johansson.* An important detail to observe is that this should be done in such a manner that two of the wings come to lie symmetrically in cranial direction, whereby the comparatively brittle bone mass in the caput will come to rest on a flat ledge instead of riding on a sharp edge, which would be the case if the nail were twisted 60° to either side from that position. If care is taken to get it to lie as here indicated there will probably be less risk of the fracture ends becoming displaced in relation to each other than would otherwise be the case. Especially where it is a question of extremely porous, brittle bones, as in the case of our two patients with

polyarthritis, we believe that observance of this precaution is of the very greatest importance. In cases where particular brittleness of the bones is suspected it will probably be best not to drive the nail in quite as far as according to calculations, as otherwise there may be a risk of the fracture ends becoming telescoped, even if the trochanteric region has been gone over with a mallet after the reposition. In such cases a fresh roentgen control in vertical projection before the nail is being driven in the last centimeter will therefore be a good precautionary measure.

Fig. 10.

The position of the nail after the osteosynthesis may be controlled in the same manner as when the former set of pictures were taken (*Figs. 8 and 9*). If it should happen that one is not satisfied with the position of the guiding wire as shown by the control pictures of the latter, the position should be rectified before any nailing is done. This will not cause any harm to the patient, and will only take about 10 minutes' extra time.

We have found that by the method described in the foregoing pages it has always been easy to get the nail into the position desired, and that, furthermore, the reposition has been satisfactory. The operation has in no way affected the general condition of the patients, and as, with this procedure, the whole operation takes very little time to perform, there has never been any

difficulty about maintaining the anesthesia. In a couple of instances the operation, counting from the first roentgen exposure to the last skin suture, has taken thirthy-five minutes. Including the anesthetisation and reposition, we may safely reckon with one hour as the total time required for all of the manipulations. The explanation of this comparatively brief time is to be found in the roentgen technic employed; no change in the position of the tubes being necessary for the successive exposures; wherefore the taking of the pictures, both in anterior and in lateral projection, together with their development and the necessary fixation, does not require more than 6 or 7 minutes. The personnel must, of course, be used to work together; and it may be said that the operation is a typical example of »operation based and dependent on organisation«. The instrumentarium required for its »bloody« part is shown in *Fig. 10.* The small markings to be made on the guiding wire one can easily do oneself; the only thing to observe is that the filing is not done so deeply that there is risk of the wire getting broken in the course of the subsequent manipulations. The wire is of 2 mm. gauge, and the circular groove made in it 10 cm. from the point reduces its thickness there to 1.4 mm. This does not unduly impair the solidity of the wire, and yet the marking is deep enough to be clearly visible in the film.

The patient lies considerably more comfortably on the trochoscope than on an extension table. As the pictures show, the table is furnished with sponge-rubber cushions and pillows. The post-operative treatment, the conditions of healing, and the roentgenologic pictures pertaining thereto, is intended to be the subject of a later paper.

SUMMARY

Extra-articular osteosynthesis by *Sven Johansson*'s method can be conveniently done with the patient lying on a trochoscope with two roentgen tubes properly adjusted before the operation. The guiding wire is introduced according to the indications furnished partly by the projection of the axis of the collum marked off on the skin, partly by palpation; the two together

giving a sufficiently exact idea of the collum's position in the horizontal plane. By making a circular groove in the wire, 10 cm. from its point, it is possible, after it has been inserted, to measure the enlargement quite exactly on the film, and thus in a very simple manner to determine the exact length of nail that should be chosen for the osteosynthesis. The operative procedure has been carried out with only such armamentarium as is to bee found in almost any hospital.

RÉSUMÉ

L'ostéo-synthèse extra-articulaire de *Sven Johansson* se pratique sans difficulté par contrôle au moyen du trochosscope, muni de deux tubes Roentgen, mis au point avant l'intervention. On dessine sur la peau la projection de l'axe du collum, et se procure par palpation une idée suffisamment correcte de la situation du collum dans le plan horizontal. Suivant l'orientation ainsi obtenue, on introduit le fil conducteur. Comme ce fil est marqué d'une entaille circulaire à 10 cm. de sa pointe, on peut mesurer très exactement, sur le radiogramme, l'agrandissement du radiogramme. Par un procédé très simple on peut ainsi déterminer la longueur nécessaire de la cheville.

ZUSAMMENFASSUNG

Sven Johansson's extraartikuläre Osteosynthese wird zweckmässigerweise ausgeführt mit Hilfe eines Trochoskops mit 2 vor der Operation eingestellten Röntgenröhren. Das Einlegen des leitenden Drahts geschieht teils nach Massgabe einer auf der Haut angezeichneten Collumachsen-Projektion, teils vermittels Palpation; so ergibt sich eine hinreichend genaue Vorstellung von der Lage des Collums in der Horizontalebene. Dadurch, dass der leitende Draht in 10 cm Abstand von der Spitze mit einer zirkulären Einkerbung markiert wird, kann man nach seiner Einführung auf dem skizzierten Radiogramm ganz genau die Vergrösserung ausmessen. Die Länge des Nagels kann so auf eine einfache Weise exakt bestimmt werden.