FROM KYSTHOSPITALET VED STAVERN, NORWAY. HEAD: H. STÖREN

TWO CASES OF ENCIRCLING FRACTURES[1]

By

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Much has been written in the literature on encircling fractures following wiring, so that the presentation of further cases may seem superfluous. In view of the fact that many surgeons still advocate the use of wiring in treatment of oblique diaphyseal fractures, the subject may still be looked upon as sub judice. Additional cases illustrating the origin of these fractures should, therefore, still be of interest.

Watson Jones takes a definite stand against any form of wiring, even Parham's band. He writes: "It is tempting to immobilise a spiral long oblique fracture with encircling wire or a Parham's band. Perfect fixation can be secured but the pressure of the metal causes absorption of the underlying bone and refracture at this level has been reported many times. Even strong catgut suture tied tightly round a bone can cause sufficient bone absorption to produce an almost spontaneous fracture."

In U.S.A., wiring is not a recognised procedure (Alvik). By contrast, here in Norway, wiring is still widely employed and, in some clinics, used as routine in the treatment of crural fractures. For example, the 3rd surgical unit at Ullevål Sykehus advocates the use of wire whilst the 2nd surgical unit and Drammen Sykehus use Parham's band.

There have been few large scale follow-ups. One investigation with a view to determining the incidence of pseudo-arthrosis was carried out at Drammen Sykehus. 1468 fractures occurring in a ten year period, 1943–1952, were reviewed. Definite pseudo-arthrosis was found in 8 cases. Two of these cases occurred in patients where wiring had been used but only one of these, with necrosis and fracture, was due to the wire. The second case with wiring and one case where Parham's band was used—the only pseudo-arthrosis amongst 69 cases using the band —were shown to be due to other causes. Important points regarding the

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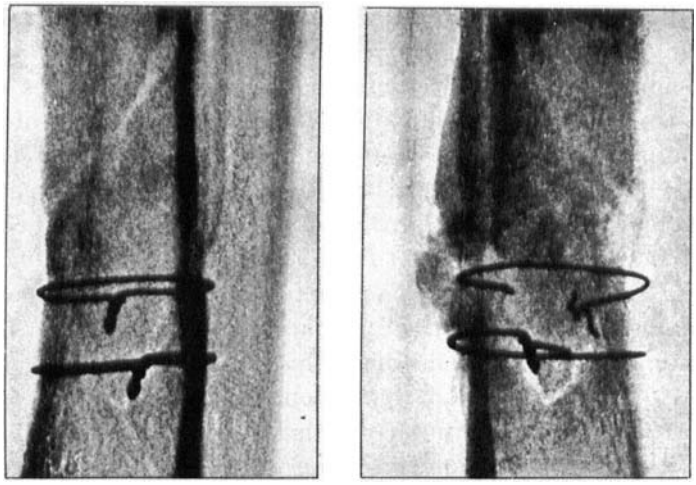
use of Parham's band in Drammen are, that it is never tightened hard and it is removed after six weeks. It is not used in fractures of the femur but, amongst the cases reviewed, was one of fracture of the humerus. The same methods are employed at the 2nd surgical unit, Ullevål Sykehus.

Besides the three units mentioned, the use of encircling wires is advocated by other widely experienced Norwegian surgeons.

Harbitz (1936) presented a follow-up of 26 crural fractures treated by encircling wire at the 3rd surgical unit, Ullevål Sykehus. Subsequently, as head of the surgical unit of a busy central hospital, he has, for 20 years, used cerclage systematically without observing refracture due to wiring. He maintains that refracture is avoided by ensuring an adequately long period of immobilisation. Even when X-ray appearance suggests that the fracture is consolidated, this may not actually be the case.

In the follow-up from Ullevål Sykehus referred to above, one case appears to illustrate this point and is quoted here by kind permission of the author. (Reference: Norsk mag. for legevidenskap juni 1937, s. 804). The patient was a 24 year old man with a spiral fracture at the junction of the middle and lower thirds of the left cruris. Plaster was applied for a period of ten weeks. Light weightbearing was allowed after this period, at first using two, and later one stick. X-ray (Fig. 1 a) showed ideal alignment but no visible callus formation—as is often the case in fractures which are perfectly reduced. The patient did not appear for follow-up until sent for 7 months after the application of cerclage. He had a slight limp and said that he tired easily and had some pain at the fracture site. Clinically, no pain was elicited at the fracture site and there was no abnormal movement. X-ray (Fig. 1 b) showed axis deviation at the fracture site and both wires had frayed through. After removal of the wire threads, pain disappeared. At follow-up 5 months later, there was no change in alignment but there was still considerable callus and a visible fracture fissure.

The explanation given by Harbitz is that, in this case, proper consolidation had not occurred—in spite of the X-ray appearance and thorough clinical examination—at the time that the plaster was changed and light weightbearing, with the aid of two sticks, allowed at the tenth week. As a result of weightbearing, bending occurred at the fracture site leading in turn to breaking of the wires. He takes the resorption round the cerclage wires to be due to this same bending. (Fig. 1 a: X-ray at 2½ months—1 b: X-ray after 5 months of weightbearing).



a b

Fig. 1.

From the materials of Ullevål Hospital: a) Apparently firm consolidation after cerclage for spiral fracture of tibia.—b) After 7 months the X-ray control shows: Deviation of the axis, bursting of the cerclage wires and bone resorbtion around the latter. In the opinion of the writer this case must be regarded as a c lage refraction, but is not regarded as such in the follow-up-examination by the writer who performed it.

This case can also be interpreted as one of bony resorption around the upper cerclage thread with refracture leading to a slowly developing axis deviation and breaking of the threads. X-ray (b) points to this as there is considerable resorption of a degree in which transverse refracture and instability during weightbearing cannot be excluded. The breaking and subsequent removal of the threads saved the situation and the commencing refracture healed. Wiring fractures tend to arise insidiously. Abundant callus around the wires, as in this case, is seen in many cases where refracture occurs.

J. A. Arnesen, Sarpsborg Sykehus, uses wiring and, in 1951, presented 34 fractures of tibia treated by this method. Erosion round one of the wires and deviation at the fracture site occurred in two cases, one of which was accompanied by spontaneous fracture. Arneson is of the opinion that erosion and refracture are due to bad alignment of the fragments at the fracture site and incomplete solidification but he also suggests that the use of a tightening device may play a role. He does not use wire tighteners. Contrary to this, Kirschner—one of the first to use wiring for internal fixation of fractures of the tibia—maintained that

the wire should be well tightened in order to obtain a solid fixation and exclude any possibility of movement at the fracture site.

Oluf Johansson (1951) presented a follow-up of 50 cases of tibial fractures treated by wiring and stated: "There is no danger of necrosis due to trauma even if the wires are tightened with great force. Should necrosis occur, the cause is to be sought elsewhere." He concludes: "Disturbances in the healing process may occur which can be referred to the wires" i.e. *if the external fixation by plaster is not maintained adequately until definite consolidation* of the fracture has taken place, there is a possibility of the wires leading to bone rarefaction. He maintains, as opposed to Watson Jones, that, after complete healing, the wires will not affect the underlying bone.

In 1955, the same author published three new cases of pseudo-arthrosis following wiring of oblique fractures of the tibia. He still maintains that bone resorption was due to movement at the fracture site and that this movement—the result of too short a period of immobilisaion—caused the pseudo-arthrosis underlying the wires. He advises, however, that at any sign of delayed union, the wires be removed and adequate external immobilisation be maintained until there is both clinical and X-ray consolidation. As regards the tightening of wires, the author has altered his views and is even more emphatic than Arnesen in stating that: "If applied mechanically, wiring causes damage to the soft tissues."

In 1954, Oluf Olsson reviewed 44 cases of fractures of tibia treated by wiring, nine of which developed necrosis and, of these, three showed spontaneous fracture. His work included animal experiments from which he concluded that neither pressure nor type of metal used could in itself cause necrosis around the wires. The deciding factor was *pressure of the wire on the bone ends.* As a result of the fracture *their blood supply was involved to a varying extent, being deprived of the medulla and the more or less destroyed periosteal arteries.* According to his theory, encircling fractures result from the method as such and not from technical details such as unsuitable osteosynthesis materials or overtightening of the wires. He recommends that the osteosynthesis materials be removed as soon as healing permits.

Watson Jones draws attention to the fact that *bone resorption can take place around metal long after the original fracture has healed.* He stresses mainly the action of pressure in wiring but also emphasises the electrolytic activity of the metals used. If alloys consist of elements remote in the electrolytic series, electrolysis results. If the elements are

close to each other on the scale, their potential difference is small and the alloy neutral. This is the case with vitallium and also with 18 and 12 SMO stainless steel alloys. Of the fifty different alloys of stainless steel, there are still many which give rise to electrolytic reactions.

Oluf Olsson's animal experiments showed that the use of metal wires on healthy rabbit tibias did not result in bony tissue necrosis. G. A. Landloff (1950) observed in animal experiments that considerable bone resorption took place when catgut was used to encircle the bone. Spontaneous fractures also resulted. There was negligible bone resorption if the catgut was not tied but allowed to lie loosely around the bone. He concluded that the necrosis was due to pressure effect of the swelling catgut.

Olaf Johansson found, using catgut in rabbits, that more bone resorption occurred using iodized catgut than using non-iodized. Only very small resorption furrows could be seen after using iodine-free catgut and no resorption took place using metal wires. He concluded, as opposed to Olsson, that in the case of catgut, a certain chemical reaction took place resulting in a reduction of the resistance of the bone to pressure.

I myself have had similar experience in 24 cases of non-rigid pes planus transversus treated ad modum Hohmann using silk to approximate the metatarsals. The silk suture threads which bound the subcapital parts of 1st and 5th metatarsals, eventually ate their way into the bone and, in two cases, resulted in a fracture line in the remainder of the metatarsal. Having eaten into the bone, the suture slackened and pressure ceased. The bone healed around the thread and on the X-ray, one can see, in cross-section, the canal in the bone caused by the silk. Complete fracture or pseudo-arthrosis never resulted in these cases. The silk used was always freshly boiled and not kept in antiseptic fluid, ensuring that chemotaxic action was animal. One may venture to regard these cases as evidence of the significance of the pressure factor in resorption of bone underlying the threads. The inconstant pressure varies, increasing each time the patient becomes weightbearing. The pressure is analogous to that which Arnesen, Harbitz and Johansson state as the cause for bone resorption in wiring—the fracture is incompletely united and gives a little at each step. In one case using silk suture, weight-bearing pressure on the 1st metatarsal was abolished by arthrodesis of the bases of 1st and 2nd metatarsals, and no resorption took place.

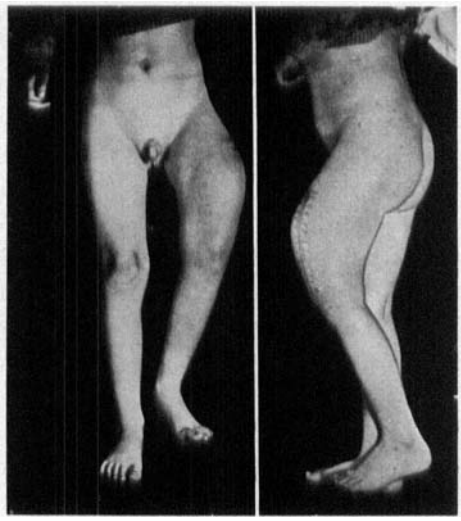


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Fig. 2.

Fracture of the thigh of 6 years old boy in originally good position after cerclage. Came 4½ months after removal of the plaster of Paris to the Coastal Hospital near Stavern in this condition. (Compare X-ray Fig. 6).

Fig. 3.

The original fracture of the same patient.

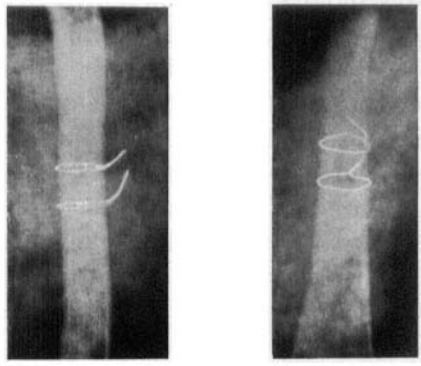

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Fig. 4.

Shows the position in plaster of Paris shortly after cerclage has been put on.

I shall now present two cases of typical wiring refracture of the femur.

Case 1. Gunnar K. born on 27/8/48, first seen at Kysthospitalet Out-Patients on 28/9/54.

a b

Fig. 5.

After 8 weeks in plaster of Paris: Growth of callus, but deviation of axis and fracture split still visible, and besides already distinct bone resorbtion around the wires.

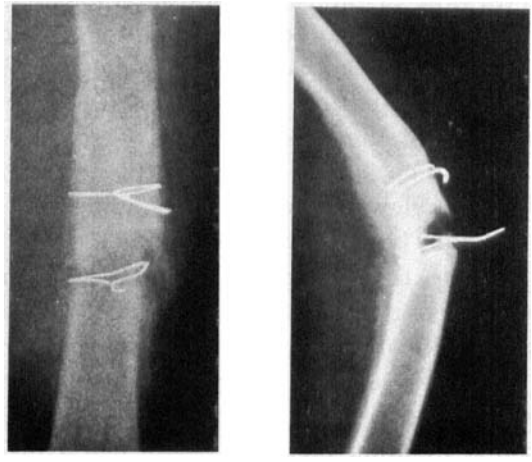

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Fig. 6.

4½ months after removal of the plaster of Paris complete cross fracture can be seen, corresponding to the resorbtion around the distale cerclage wire.

On 13/2/54, he sustained a left femoral fracture which was operated upon the same day at a hospital elsewhere. Two wires were used, a fingerbreadth's distance between them, and a hip plaster applied. The X-ray at that time showed faulty alignment at the fracture site. When the

plaster was removed twelve weeks later, the X-ray still showed deviation but, nevertheless, weightbearing was allowed as the X-ray appeared to show good consolidation. After a while, the thigh became so painful that the boy could no longer bear weight and had to walk with the aid of crutches.

On examination at the Kysthospitalet Out-Patients department on 28/9/54, the patient walked with the aid of crutches and could not stand on his left leg because of pain. There was considerable curvature of the left thigh and abnormal movement at the fracture site. There was a vertical operation scar overlying the convexity (Fig. 2). Examination of X-rays taken at the time of the accident (Fig. 3), showed that there had been an oblique fracture of the femur, fully reduced and fixed by two encircling wires (Fig. 4 a and b). There was no axis deviation. The plaster was changed after eight weeks and concurrent X-rays (Fig. 5 a and b) show a degree of axis deviation, forward curvature and a slight varus. This occurred whilst the patient had been recumbent in plaster. Antero-posterior X-ray (5 a) shows that the fracture fissure is still present, with some healing in the centre and lateral parts. Lateral views show corresponding healing with callus formation. One can already see at this stage considerable bone resorption round the distal encircling wire (Fig. 5 b). On examination at the Out-Patients Department 4½ months after removal of the plaster, clinical signs were as described and X-rays (Fig. 6 a and b) showed a great deal of resorption round the distal wire and lateral views show a corresponding transverse fracture with forward bending. The distal thread is lying loose in the fissure. On 12/10/54, pseudo-arthrosis was performed under ether anæsthesia. The surfaces of the pseudo-arthrosis were resected, only one mm. thick layer of cartilage requiring removal before exposing freshly bleeding bone surfaces. These were pressed against each other using an encircling wire. Bone chips were placed in the groove chiselled out across the fracture fissure. Fixation was then performed using a Lane's plate and plaster. The hip joint was immobilised in 30' flexion and 10' abduction. Full consolidation took place after four months.

Discussion: Bone resorption has, indisputably, occurred round the distal wire whilst the boy was immobilised in plaster and non-weightbearing. Incorrect alignment, in the form of antecurvature and slight varus, developed subsequently. Enquiries elicited the information that, when first placed in plaster, the hip joint was immobilised in extension. The hip flexors, the strongest group of muscles attached to the proximal fragment, had thus pulled it into flexion, the distal fragment being

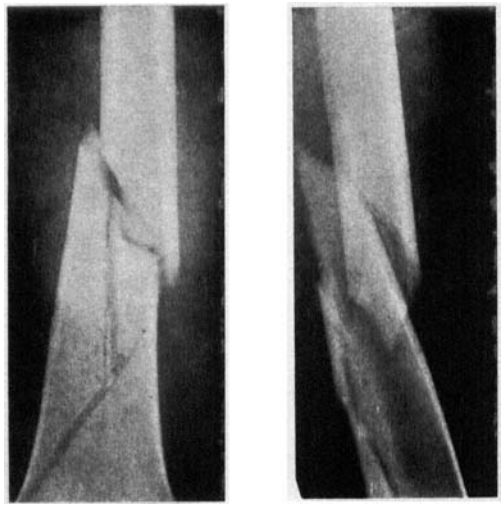

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Fig. 7.
The original slanting fracture of the thigh of a 51 years old woman.

held down by the plaster. This resulted in the antecurvature of the plaster and the varus deformity. After the commencement of weightbearing, fracture at the wiring site arose from:

1. The bone resorption already commencing around the wires, and
2. Incorrect position whilst weightbearing with resultant oblique axis pressure.

Case 2. Ellen B., 51 year old woman, was seen at the Kysthospitalet Out-Patients Department on 28/5/56. She had sustained a fracture of the left femur on 21/2/55. Original X-rays (Fig.7) showed a torsion fracture with splintering of the lower third of femur. She was treated at another hospital first, by traction applied through the tibial tuberosity. Owing to unsatisfactory alignment, open reduction, fixation by Parham's band and application of plaster, were carried out on 16/4/55. The plaster was removed on 29/7/55, there being then slight varus deformity and backward bowing. X-rays taken on 19/8/55 (Fig. 8) showed good consolidation, and weightbearing was begun, first with the aid of crutches and, in January 1956, with the use of sticks. These were discarded in April, 1956, X-ray showing good consolidation. After walking unaided for three weeks, pain developed in the left thigh and swelling appeared. This worsened so that the patient could no longer bear weight

a b

Fig. 8.
Complete healing in good position after osteosyntesis with Parham's wires of the same patient.

on the left leg because of pain and a feeling that the leg was giving way. When seen at the Out-Patient Department at Kysthospitalet on 25/5/56, the patient was supported by her husband, being unable to bear weight. There was swelling at the lover end of the left femur with direct and indirect pain on pressure. There was a degree of varus and abnormal movement. X-rays now showed a new break running transversely with a degree of obliquity between the two Parham's bands (Fig. 9 a and b). Operation was performed on 31/5/56. Minimal resection was carried out at the fracture fissure and osteosynthesis, using Lane's plate and bone transplantation, was performed. The two Parham's bands were removed, the distal one lying loosely in the fracture fissure. The proximal one was not in contact with the fissure but was loosely tied and slack. Freely bleeding spongiosa was exposed a few millimetres under the fracture surfaces. These were pressed together using wire mattress sutures and fixation secured with Lane's plates and plaster. Eleven weeks later, consolidation had taken place, the plaster was removed and the patient allowed up. At follow-up six months later, there was solid consolidation, no pain and normal gait.

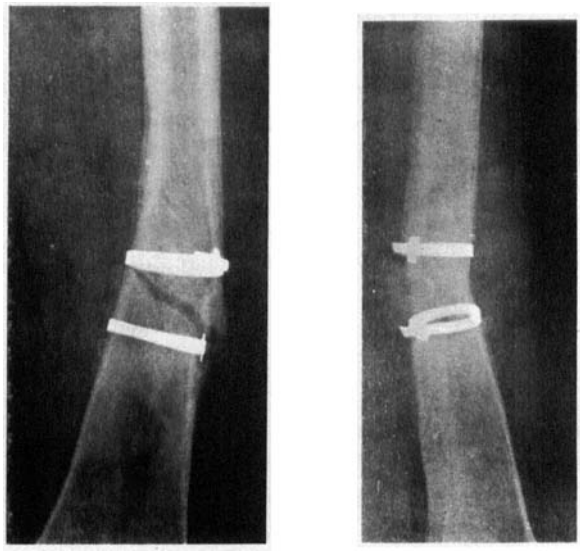

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Fig. 9.
The same patient 9½ months later, shows fresh cross fracture between the two Parham's wires including the bed for the distale one.

Discussion: This patient was first operated upon late, six weeks after the original fracture, the distal Parham's band being used to secure a loose fragment. Together with plaster, fixation was adequate to hold position. 3½ months later there was good consolidation, good alignment apart from slight varus and curvature. Weightbearing was gradual, crutches being used for three months and sticks for a further three. Despite this cautious progress both with plaster and weightbearing, the patient developed refracture at the site of the tightly applied distal Parham's band. There was no resorption at the site of the loosely-tied proximal band. This would indicate the correctness of the assumption that tightening of encircling wires or Parham's bands has an influence on bone resorption.

SUMMARY

The author mentions various opinions regarding the use of encircling wires is diaphyseal fractures and reviews work in this field. It would appear that fractures due to encircling wires would be de-

tected more frequently at follow-up of fracture cases if attention be drawn to them. One case showing this is reviewed.

The conclusion that a degree of mobility at the fracture site can be a cause of bone resorption around the cerclage wires (Arneson, Harbitz, Jacobsen, Oluf Johanson), is supported by the author's experience of using silk suture ad modum Hohmann in cases of pes planus transversus.

The author then presents two typical cases of encircling fracture in fracture of the femur.

RESUME

L'auteur mentionne différentes opinions concernant l'utilisation de fil encerclant dans les cas de fracture diaphysaire et passe en revue les travaux publiés sur la question. Il constate que l'on découvre frequemment des fractures dues au fil encerclant lorsqu'on réexamine les cas de fracture. Un cas de ce genre est rapporté.

La conclusion qu'un certain degré de mobilité à l'endroit de la fracture peut être la cause d'une résorption de l'os auteour du fil de cerclage (Arnesen, Harbitz, Jacobsen, Oluf Johanson) est appuyée par l'expérience de l'auteur qui utilise des sutures de soie ad modum Hohmann dans les cas de pes planus transversus.

L'auteur présente ensuite deux cas typiques de fracture d'encerclage dans une fracture du fémur.

ZUSAMMENFASSUNG

Der Verfasser erwähnt verschiedene Auffassungen bezüglich der Verwendung von Umschlingungsdrähten bei Diaphysenbrüchen und gibt eine Übersicht der Arbeit in diesem Gebiete. Es scheint, dass Brüche als eine Folge von Umschlingungsdrähten bei der Nachuntersuchung häufiger entdeckt werden könnten, wenn die Aufmerksamkeit darauf hingelenkt werden würde. Ein Fall, der dies zeigt wird berichtet. Die Schlussfolgerung, dass ein gewisser Grad von Bewegelichkeit am Bruchorte als Ursache von Knochenresorption in der Umgebung des Drahtes angesehen werden kann (Arnesen, Harbitz, Jacobsen, Oluf Johanson), wird durch die Erfahrung des Verfassers bei der Verwendung von Seidenfäden nach Hohmanns Methode in Fällen von pes planus transversus unterstützt. Der Verfasser weist schliesslich zwei Fälle von Umschlingungsbrüchen bei Oberschenkelbrüchen vor.

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