Acta orthop. scand. 44, 516–531, 1973

Department of Orthopaedic Surgery, University Hospital, Uppsala, Sweden.

TREATMENT OF FRACTURES BY THE VIDAL-ADREY METHOD

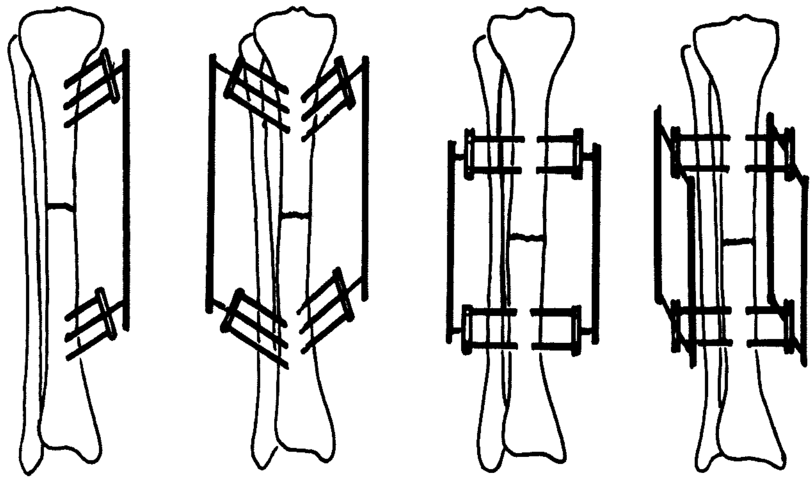
SVEN OLERUD

Accepted 1.v.73

The method of immobilising fractures by transfixion of the bone fragments with nails or screws, which in turn are fixed together by plaster-of-Paris or metal splints, goes under the name transfixation. Lambotte introduced such a method as early as in 1902, and since then it has reappeared from time to time in different versions (Anderson 1934, Judet 1934, Hoffmann 1938, Stader, Jewis & Breidenbach 1942). The Hoffmann transfixation system has been used in Sweden by, among others, Orell (1956) and Felländer (1963), the latter in a study of fractures with delayed healing and pseudarthroses. The occurrence of infectious suppuration around the transfixation nails, and in some cases lack of healing, has resulted in a sceptical attitude towards this method. These adversities have been attributed to a lack of stability. Hoffmann (1951) and other authors (e.g. Ray 1964) have improved the stability considerably by duplicating the instrumentation. A similar effect can be obtained by steel pins passing through the fragments (Cuendet 1933), a method often used in arthrodesis of the knee (Key 1931, Charnley 1953, Müller 1955).

Vidal (1968) achieved considerable improvement of the stability with the Hoffmann apparatus by replacing the rods connecting the Hoffmann fixation clamps by a connecting frame (see Figure 1 d). This idea led to a biomechanical study (Vidal et al. 1970, Adrey 1970) in which the stabilizing capacity of the Hoffmann apparatus was investigated with different external connection arrangements. Four of the systems compared are sketched in Figure 1 and consist of:

(a) Fixation with 3–5 bone screws in each fragment. Each of these groups of screws is held in position by a fixation clamp. These clamps, in turn, are connected to each other by a simple connecting rod.



a b c d

Figure 1. Schematic illustration of different methods of transfixation.
a. Three Hoffmann bone screws in each fragment, connected by a single metal rod.
b. The same as (a) but in a duplicated version.
c. Steinmann pins passing through each fracture fragment, connected on each side fixation clamps and single metal rods.
d. Steinmann pins passing through each fragment, as in (c), but the fixation clamps are connected with other by two metal rods, forming parts of a parallelogram.

(b) Duplication of the system under (a). The respective systems are placed at an angle of 110° in relation to each other. (This is a natural angulation for the tibia.)
(c) Two or three Steinmann pins are placed in each fragment. These pins are connected at each end by fixation clamps and connecting rods.
(d) The same arrangement as under (c). The respective fixation clamps are connected here by two connecting rods, which thus form part of the final frame holding the clamps in position.

The stability, i.e. the force needed to deform the fixation system, increases considerably with the development of the connecting arrangement shown in Figure 1 a–d. This is true for application of force both in the frontal and in the sagittal plane. The most favourable system thus consists of Steinmann pins passing through the fragments and fixed in position by a connecting frame. Application of the system to the tibia in a frontal plane has great advantages from the practical aspect.

The most reliable stability is obviously when the fragments are in contact and press against one another. Such an effect is achieved if the connecting rods are replaced by compression (telescopic) rods (see Figure 2 c), by which the fixations clamps and thereby the fragments can be forced to approach one another.

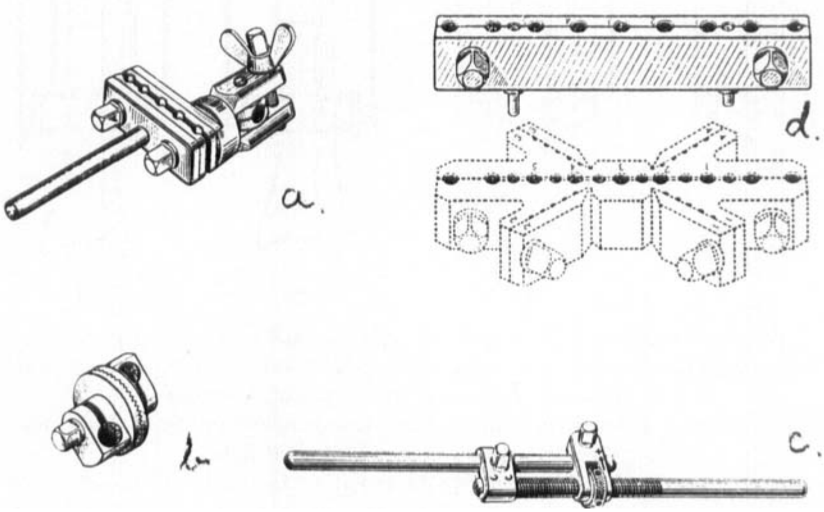


Figure 2.
a. Hoffmann's fixation clamp correctly supplied with a 5 cm long cross bar.
b. The reatining nut, which connects the cross bar and the connecting rod.
c. Compression rod.
d. The special adapter that is mounted on the original Hoffmann adapter is illustrated in the upper part of (d).

In cases with cortical bone defects in which there is only partial contact between the fragments or none at all, the frame system is quite superior to any other external fixation device.

Following the introduction of the Vidal-Adrey arrangement for transfixation of fractures, Hoffmann's original instrument system has been modified and complemented. Thus the fixation clamp has been supplied with a 5 cm long rod (Figure 2 a). This fixation clamp is attached to the connecting rods (in the compression version illustrated in Figure 2 c) via a retaining nut (Figure 2 b), which by a simple manoeuvre locks the connecting rod and the rod of the fixation clamp into the desired position.

Positioning of the Steinmann pins is facilitated by the use of a special instrument (Figure 2 d), which is placed on the adapter originally intended for bone screws. This instrument gives good guidance for the steel pins.

Transfixation by the Vidal-Adrey method may be regarded as a complement to other methods of treatment of fractures and according to its advocates its indications are well defined: (a) open fractures with severe, extensive soft tissue injuries, and (b) infected fractures, particularly infected pseudarthroses.

In the open fracture the immediate measures can thus be limited to excision of devitalised tissue. No further exposure of bone is required, and attention can then be paid to retaining the vascularity of the fracture ends. The wound may be left open with advantage, which is of particular value from the point of view of prophylaxis against infection (vessels and nerves, and also preferably tendons, should, however, be covered with skin primarily if possible). Mounting of the instrument is simple but the positioning of the fracture fragments is somewhat laborious and time-consuming. Three Steinmann pins, 4 mm in diameter, are required in each fracture fragment. When Steinmann pins are used in cortical bone they have to be inserted with a hand drill in order to avoid thermal damage to the bone. Obviously it is best if the pins pass through the centre of the bone. The best stability is obtained if the fracture surfaces are compressed against one another. In cases where this is possible, telescopic rods should be used. The compression applied should be sufficient to cause very slight bending of the Steinmann pins.

In practice it is found, however, that the compression is partly lost during the first week, so that it sometimes has to be reviewed. With clean oblique fractures it is of value to produce a surface perpendicular to the longitudinal axil of the bone, by which the fracture ends can be hooked up. Compression can then be applied, which is otherwise not possible in these cases. If there is an intermediate fragment, this can be attached to the main fragments by an internal compression screw, but otherwise external fixation can be used.

In the case of the femur the instrument is most easily mounted with the patient placed on an extension table. In the distal third of the femur the same technique can be used as for the tibia. In fractures higher up a special technique is used in order to avoid damage to the large vessels. The bone screws are inserted both from the lateral side and from the ventral side of the femur, so that the two groups of screws will lie at an angle of 90° to each other. In the distal part of the femur Steinmann pins are used throughout. The two lateral fixation clamps are connected to each other by the frame described above. The medial fixation clamp is connected to the fixation clamp mounted on the ventral group of bone screws. The tendency to rotation in the system is prevented by mounting the fronto-medial connecting rod against the lateral frame. The mounting system is shown in Figure 9. Compression, using telescopic rods, increases the stability considerably and should be used whenever possible.

Transfixation of the femur with the bone screws placed at an angle to one another would hardly seem suitable in cases where it is an aim to retain an intact knee function, because the bone screws inserted ventrally in the femoral shaft will interfere with the function of the quadriceps. The method should therefore be limited to those cases where, because of other circumstances, retention of an undisturbed knee function is not possible.

The alignment of the fracture need not be absolutely correct from the beginning, as there is a possibility of changing the position later as long as the fracture has not consolidated. The patient can then be placed on an extension table, the clamps released and the position of the fracture adjusted. In comminuted fractures and cases with bone defects adjustment can be made for shortening. With an X-ray image intensifier and television monitor the correct length is measured on the intact side and the fracture side is then corrected. The fixation clamps are then adjusted definitively.

With the transfixation method there is, of course, a risk of infection where the Steinmann pins pass through the skin. Experience has shown, however, that when such infection occurs it is seldom serious. Secondary infection consisting of secretion and granulation tissue around the pins or screws indicates instability. This heals as long as stability exists and drainage of the pin wounds through the skin can be ensured. Reapplication of the transfixation may be required in the event of such a complication.

In order to reduce the possibility of bending of bone screws or Steinmann pins, the fixation clamps should be mounted as close to the skin as possible. A shorter distance than about 2 cm, however, makes it difficult to renew dressings and clean the skin close to the metal pins, which is necessary at intervals.

In the early posttraumatic stage the limb may be suspended in a balanced elevated position to reduce swelling. The cords used for this purpose may suitably be attached to the transfixation material. Care

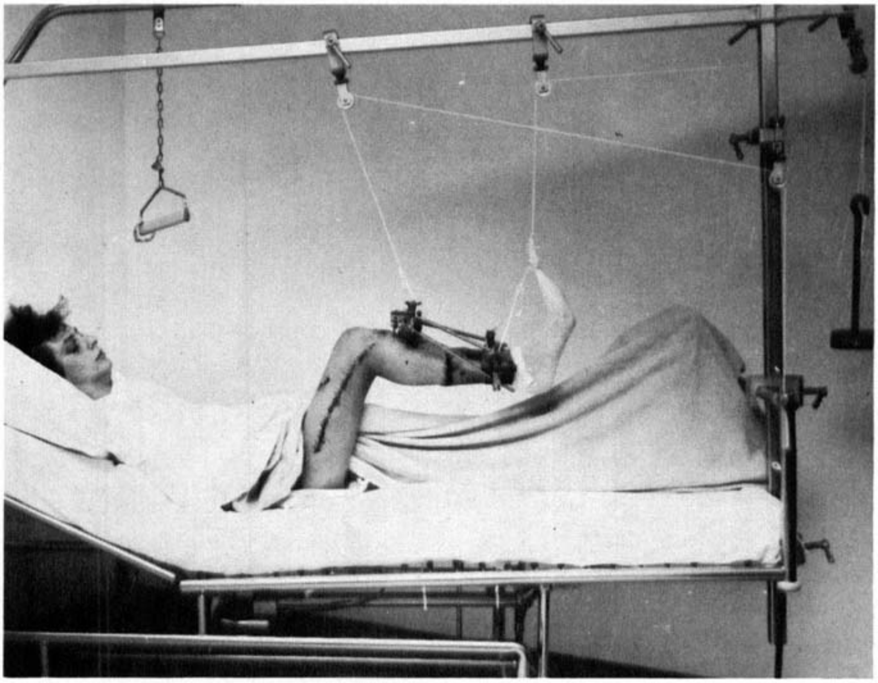


Figure 3. Balanced suspension of the extremity facilitates joint exercises and stimulates the muscles and circulation.

of the skin and wound are facilitated in this way. Conventional dressings are not necessary (Figure 3).

The fixation allows free movements of all joints of the extremity from the beginning (with the exception of femoral fixation). As soon as the acute swelling has subsided the patient is allowed to get up. Compression of the soft tissues is then often advisable, to reduce swelling. Some weight-bearing on the extremity, certainly up to about 10–20 kg, may be permitted. Most patients have no difficulty in managing the instrument themselves at home.

The fracture healing is checked both by roentgenological examination and by loosening the connecting rods and testing the stability. If the fracture seems to be clinically consolidated, the instrument system is removed. At this stage the fracture healing may not be completely reliable, and it may therefore be suitable to apply a PTB walking plaster to the lower extremity for 4–6 weeks.

At the University Hospital in Uppsala the duplicated version of the

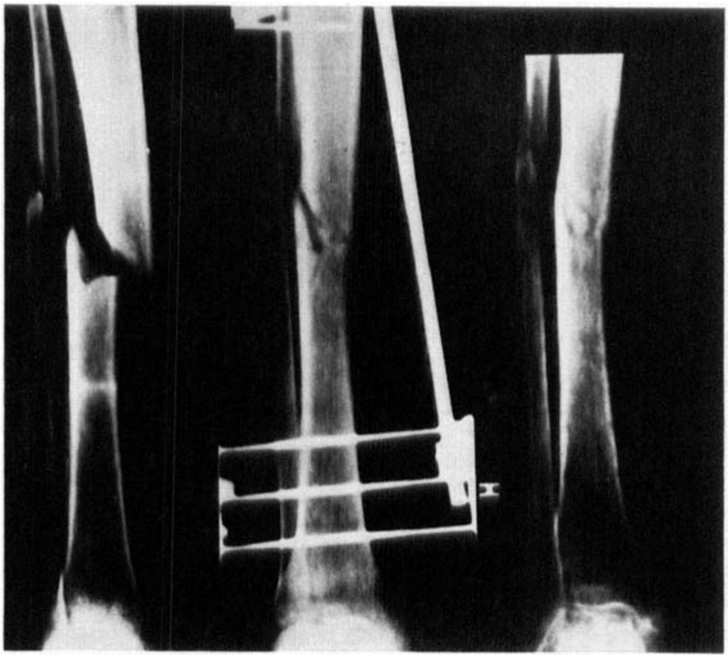


Figure 4. Roentgenograms of the fracture described in Case 1 (see text).

Hoffmann instrument has been used previously on a few occasions and with special indications. But since the work of the Montpellier group (Vidal, Bonnel, Adrey, Rabischong) has become known we have followed the transfixation principles of these authors more systematically. The following case reports illustrate the indications for which we have used the method described.

Case 1. A 60-year-old male cyclist was run over by a car. He sustained a tibial fracture (Figure 4) with skin necrosis, almost the size of the palm of a hand, over the anterior and medial aspect of the tibia. After primary traction for 7 days the fracture was treated with transfixation. At the same time, in collaboration with a plastic surgeon, a skin flap was taken from the back of the calf, which was then covered with a split skin craft. Satisfactory healing of the skin and soft tissues ensued. The fracture showed early callus development with complete consolidation after 3 months. The patient was completely restored 4 months after the accident.

Case 2. A 17-year-old boy had a motorcycle accident and sustained an open supracondylar intraarticular fracture and also an open tibial fracture with extensive soft tissue injuries (Figure 5 a); the tibial fracture included complete loss of about 10 cm of the tibial shaft (Figure 6). The tibial fracture was transfixed by the Vidal-Adrey method (Figure 5 b) and at the same time the wound was thoroughly

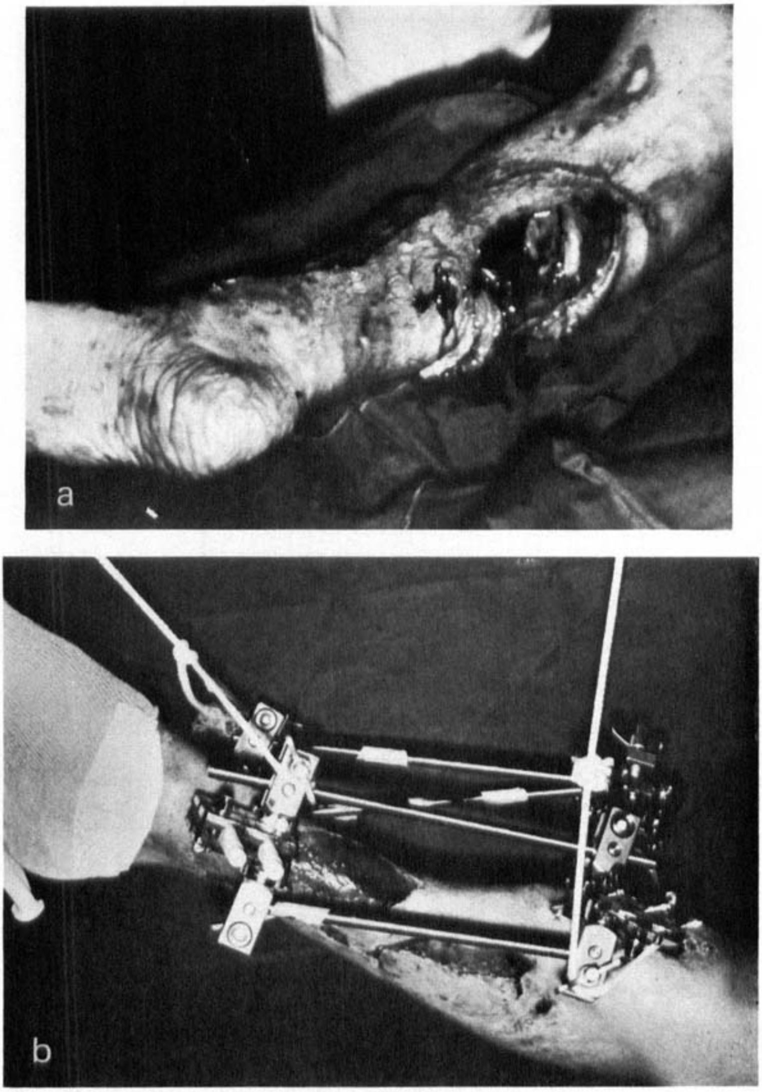


Figure 5.
a. The injured leg in Case 2 (see text).
b. Three weeks after the double frame fixation there were clean granulation surfaces ready for split skin grafting.

cleaned. The skin was only partially sutured and large parts of the wound were initially left open. In the same session the femoral fracture was treated with a stable angle-plate osteosynthesis.

The leg was treated in balanced suspension (Figure 3). Split skin grafting was

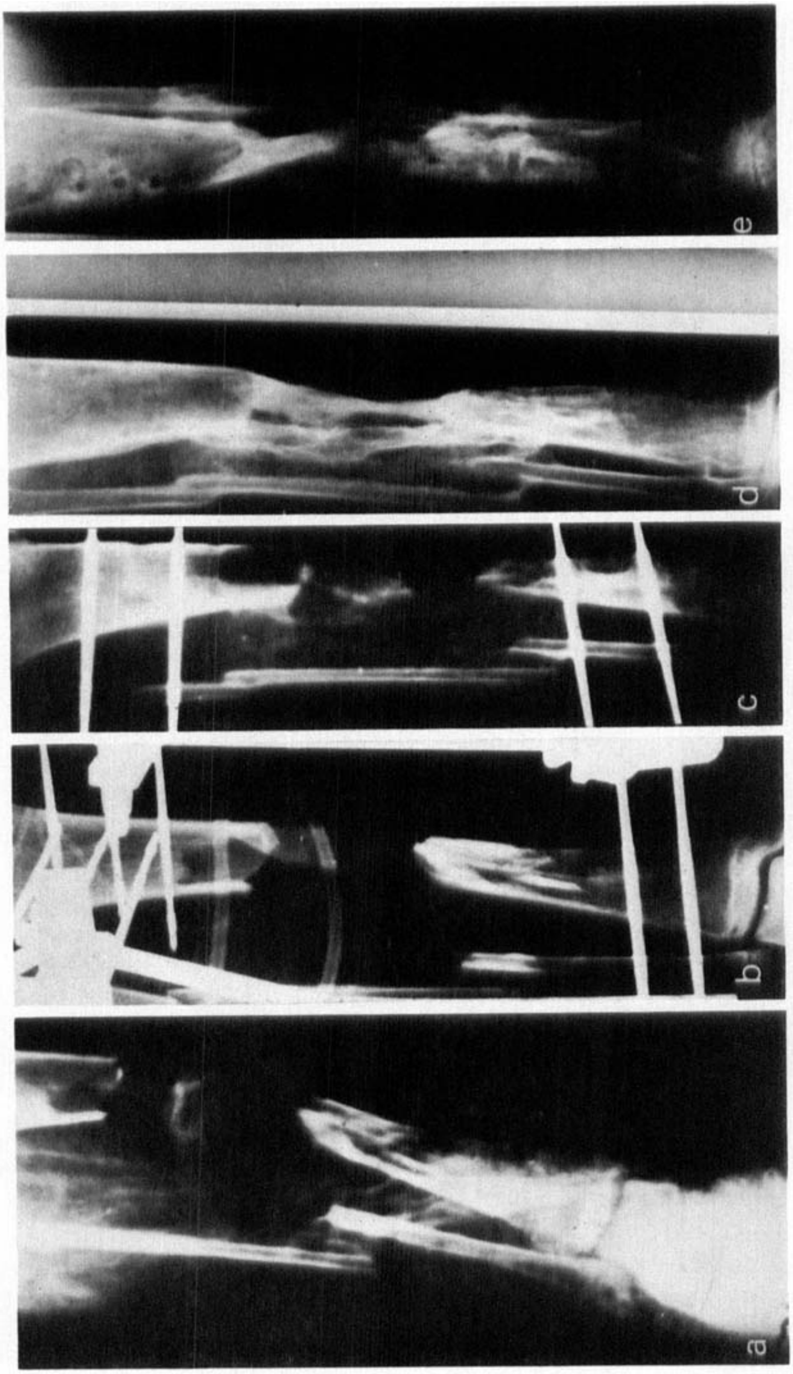


Figure 6. Series of roentgenograms of the fractures in Case 2 (see text).

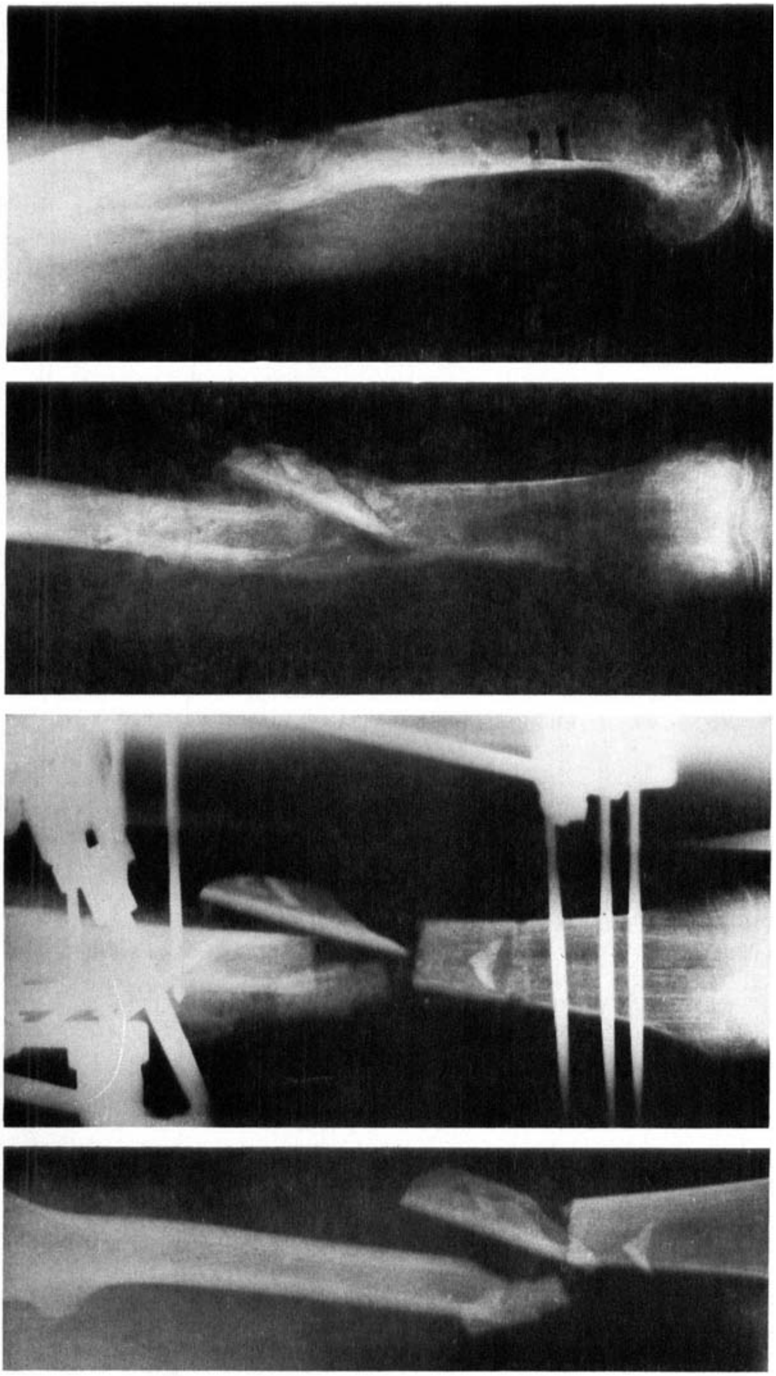


Figure 7. Roentgenograms of Case 3 (see text).

applied to the open areas on the lower leg except for the area where the bone of the tibia was exposed (Figure 5 b). Cancellous bone grafting was performed on the lateral side of the tibial fragments and along the bone defect 2½ months after the accident. Six weeks later a further bone graft was applied to the interosseous membrane from the posterior side to connect tibia to fibula above and below the defect. The patient was hospitalized initially for 4½ months, and subsequently for short periods for the necessary surgical measures. Knee and ankle exercises were encouraged throughout the healing phase. Partial weight-bearing was allowed after about 6 months. Shortening of the tibia by 2½ cm had to be accepted. Seven months after the accident the fracture was consolidated (Figure 6 d). A PTB plaster was used for a further 3 months, and 12 months after the accident the patient was able to walk without either plaster or crutches. After 16 months the patient only had a slight limp, which was corrected by a 2 cm compensation.

Case 3. A 17-year-old girl sustained a comminuted crush fracture of the left femoral shaft. There was considerable skin damage, covering practically the whole of the dorsal aspect of the thigh. Roentgenograms showed a large cortical bone defect (Figure 7 b). Traction was applied primarily for 4 weeks until the thoracic and abdominal injuries had healed, after which Vidal-Adrey transfixation of the femoral fracture was undertaken (Figure 7 b). After a further 14 days the patient was placed on an extension table for correction of angles and bone length with the aid of an X-ray image intensifier with television monitor. After two bone graft procedures bridging callus filled the bone defect (Figure 7 c). Ten months after the accident the patient was able to walk without crutches and after another 4 months no actual limp existed. The knee function is somewhat reduced, however, with a flexion range from 0° to 100°.

Case 4. This patient, a 34-year-old woman, had a fracture of the femoral shaft which was treated primarily with a Küntscher nail. The fracture was severely infected from the very beginning. After one year the nail was removed without the fracture having healed and a plaster-of-Paris was applied for the following 8 months, after which sequestrectomy was performed (Figure 8 a). Two and a half years after the accident further sequestrectomy was performed + a bone graft + transfixation (Figure 8 b). Even after this operation there was exacerbation of the infection, necessitating further drainage measures. Although there was satisfactory stability, which after 6 months was increased by compression by replacing the connecting rods by telescopic rods (Figure 9), the callus formation was rather poor, and a further bone graft was therefore performed. After 12 months the instruments could be removed. Three months later full weight-bearing was allowed.

Case 5. A 70-year-old man was involved in a traffic accident and sustained multiple injuries. In addition to a grotesque supracondylar intraarticular open femoral fracture (Figure 10), there was considerable soft tissue damage below the knee on the same extremity. He also had a radio-ulnar fracture combined with a practically total injury to the brachial plexus. After tuberosity-tibial traction for a month, restoration of the femoral condyle plane with a minimum of osteosynthesis material was undertaken. Stabilisation by Vidal-Adrey transfixation technique was performed, and after a further 6 weeks a cancellous bone graft. Three

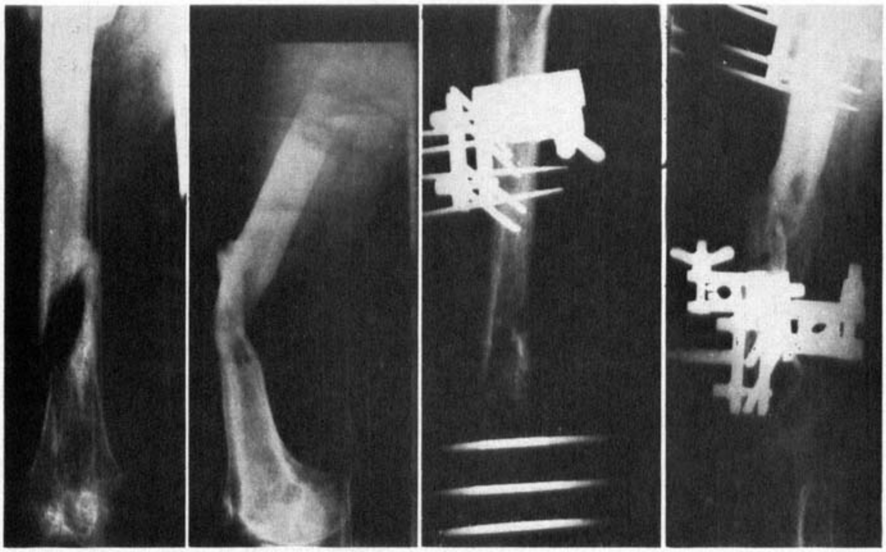


Figure 8. Roentgenograms of Case 4 (see text). Fixation of the femoral fracture consisted of four ventrally and four laterally inserted screws in the proximal part of the femur. Steinmann pins were passed through the femoral condyle area.

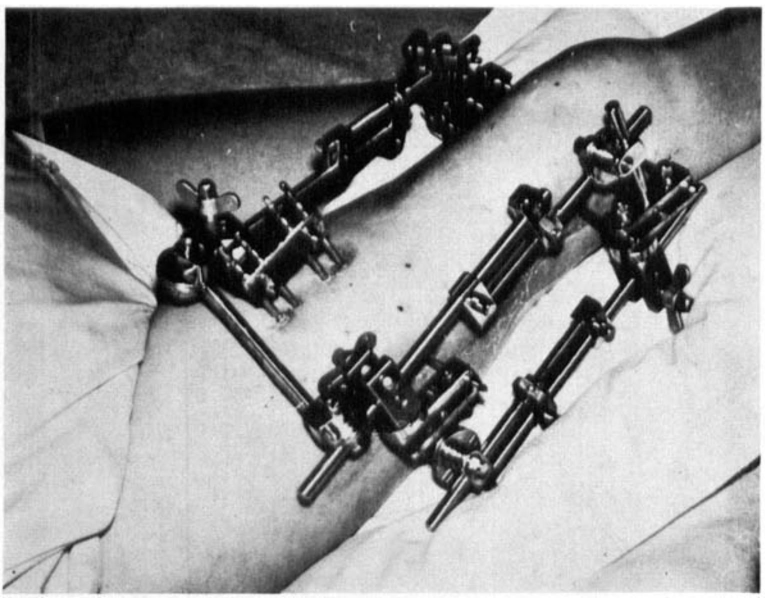


Figure 9. In order to increase the stability, compression of the pseudarthrosis was performed in this case with telescopic side-rods.

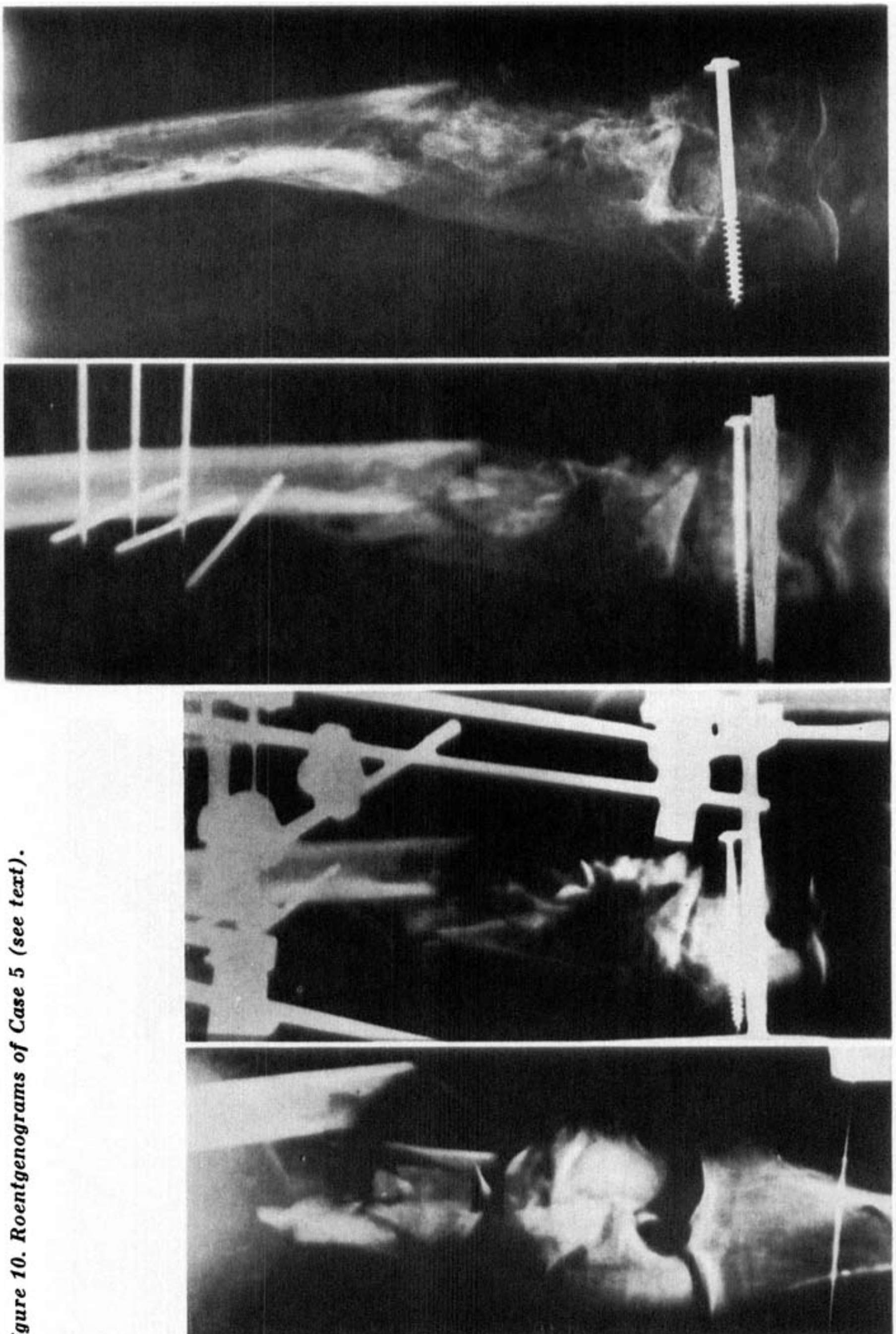


Figure 10. Roentgenograms of Case 5 (see text).

months after the accident mobilization of the patient was gradually started, with walking exercises in a walking chair and partial weight-bearing. Twelve months after the accident the transfixation material was removed. Fourteen days afterwards there were signs of refracture. Further transfixation in the same manner as earlier and another bone graft were performed. After a further 4 months the fracture was clinically and roentgenologically consolidated, and the transfixation material was removed (Figure 10 c and d).

COMMENTS

In the cases described above treatment with transfixation was performed on definite indications, and offered decided advantages. In Case 1 satisfactory fixation was obtained at an early stage, which rendered possible early skin grafting to compensate the extensive skin damage. Internal fixation was avoided, as in the prevailing situation it might have involved certain risks. Considering the circumstances there was surprisingly early consolidation of the fracture, and good vascularization in the fracture ends certainly contributed in this respect.

In Cases 2 and 5 the injuries were so extensive that amputation was seriously considered as an alternative measure at the time of admission. However, the transfixation procedure gave adequate fixation and stability. The fairly large bone defects were refilled with cancellous bone grafts with the transfixation instrument still in place. In Case 2 remarkably rapid consolidation took place, while in Case 5 this was very slow, certainly in part due to the relatively advanced age of the patient.

The transfixation in Case 3 meant a considerable advantage in permitting a skin graft on the back of the injured thigh, and made it possible to retain the length of the extremity as well as the correct conditions with respect to the frontal and sagittal plane, and the correct degree of rotation. The knee function naturally suffered from this fixation procedure, and the total flexion capacity 14 months after the accident ranged from 0° to 85°, but then improved spontaneously to 100°.

In Case 4 the transfixation procedure greatly facilitated the flushing and draining necessitated by the infection. Further, the reliability of the method rendered relatively early ambulation possible, and the patient was able to walk fairly easily with the aid of crutches. She was thus able to spend long periods at home, which must be considered a decided advantage from the aspect of both the patient and the hospital services.

Transfixation by the Vidal-Adrey technique does not only provide an alternative form of treatment of certain fractures. Under especially severe circumstances this method seems to be the only reasonable approach if the risk of complications is to be kept at a minimum and yet a fully acceptable final result obtained.

SUMMARY

Treatment of fractures with transfixation procedures has taken place throughout the 20th century. Both the methods and the instruments used have had certain disadvantages, especially in the form of deficient stability. However, with the Hoffmann instrument connected to Steinmann pins passing through the bone and over a frame on each side of the fracture, the stability has been increased considerably. Secretion and suppuration around the metal pins as disadvantages of the transfixation system no longer constitute any problem. This technique is especially suitable in open fractures and in infected cases, particularly infected pseudarthroses. The method in itself gives complete stability, and therefore no further fixation is necessary. Because of this stability, joint movements and mobilization can be started at a very early stage after injury, which is of great value especially in fractures with extensive soft tissue injuries. In such fractures, in particular, this new transfixation technique appears to be a very valuable form of treatment.

REFERENCES

Adrey, J. (1970) Hoffmann's external anchorage coupled in frame arrangement. Biomechanical survey of the leg fractures. Thesis, Editions Gead, Paris.

Anderson, R. (1934) Fractures of the radius and ulna. A new anatomical method of treatment. *J. Bone Jt Surg.* **16**, 379–393.

Charnley, J. (1948) Positive pressure in arthrodesis of the knee joint. *J. Bone Jt Surg.* **30**-B, 478–486.

Charnley, J. (1953) *Compression arthrodeses.* Livingstone, Edinburgh and London.

Cuendet, S. (1933) Appareil pour réduction et contention des fractures sous thalamiques de calcaneum. *42e Congrès Francais de Chirurgie,* pp. 781–786.

Felländer, M. (1963) Treatment of fractures and pseudarthroses of the long bones by Hoffmann's transfixation methods (osteotaxis). *Acta orthop. scand.* **33**, 132–150.

Hoffmann, R. (1951) *L'ostéotaxis, ostéosynthese transcutanée par fiches et rotules.* Editions Gead, Paris.

Hoffmann, R. (1938) Rotules à os pour la réduction dirigée, non sanglante, des fractures, *Congrès Français de Chirurgie,* pp. 601–610, Paris.

Hoffmann, R. (1954) Ostéotaxis. Ostéosynthèse externe par fiches et rotules. *Acta chir. scand.* **107**, 72–88.

Judet, H. (1934) Nouvelle instrumentation pour l'ostéosynthèse à tuteur externe. Bull. Soc. Chirurgie, Paris.

Key, A. (1932) Positive pressure in arthrodesis for tuberculosis of the knee joint. *Sth. med. J., (Bgham, Ala.)* **25**, 574–579.

Lambotte. Cit. Hoffmann 1951 and Adrey 1970.

Müller, M. E. (1955) Die Kompressionsosteosynthese unter besonderer Berücksichtigung der Kniearthrodese. *Helv. chir. Acta* **22**, 474.

Orell, S. (1956) Die Bedeutung biomechanischer Faktoren bei der Knochenheilung. Einige Fälle von Transfixation von Diaphysenfrakturen. *Helv. chir. Acta* **23**, 1.

Ray, A. (1964) Technique, résultats, indications de l'emploi du fixateur externe d'Hoffmann. (A propos de 135 observations). Thèse Lyon (Impr. des Beaux-Aris).

Stader, O., Lewis, K. M. & Breidenbach, L. (1942) The stader reduction splint for treating fractures of the shafts of the long bones. *Ann. Surg.* **116**, 623–636.

Vidal, J. (1968) Notre expérience du F.E. dH. à propos de 46 observations. Les indications de son emploi. *Montpellier chir.* **14**, 451–460.

Vidal, J., Rabischong, P., Bonnel, F. & Adrey, J. (1970) Etude biomécanique du fixateur externe d'Hoffmann dans les fractures de jambe. *Montpellier chir.* **16**, 43–52.

Correspondence to:

Sven Olerud
Dept. of Orthopaedic Surgery
University Hospital
Uppsala, Sweden