The paraskeletal clamp-on plate

Part I. A new alternative for retaining the surgically reduced position of bone fractures

U. MENNEN

Summary

A paraskeletal clamp-on plate has been developed which maintains the operatively reduced position of a fractured long bone during the healing phase while having a minimal effect on the healing process.

The plate consists of a central ridge with paired finger-like projections on each side, constructed in such a manner that on head-on projection the ridge and two projections form just more than a semicircle. The points of the projections, which are wedge-shaped and bent at right-angles towards the centre, are squeezed into the bone with a crimping tool.

Indications for this plate include simple displaced or comminuted fractures of the forearm in adults and children.

The technique is simple, the operating time significantly shortened and the healing time notably reduced; fracture union is sound without signs of disuse osteopenia, stress protection or damage to the bony architecture due to drill holes. A second removal operation is not needed and the complication incidence is remarkably low, as is the financial outlay.

In order to maintain a reduced position of bone fractures after open reduction while healing takes place, a fixation device of some sort is needed. Certainly the two most important factors to consider during internal fixation procedures are: (i) additional trauma to an already traumatized area must be kept at a minimum; and (ii) an optimal environment in which healing of the fracture can occur must be secured.

Since the invention of plates, screws, intramedullary nails and pins, many disadvantages have resulted from interference with the blood supply to the fracture site owing to the necessity for dissection and the stripping of soft tissues, and particularly from damage to the endosteal blood vessels by drill holes, intramedullary reaming, and the placing of screws, nails or pins. These disadvantages include delayed union and non-union,\(^{1-7}\) fractures of the plate or bone through a screw hole;\(^{1-3,12,14-22}\) damage to the endosteal blood vessels, serving as 'stress concentrators' and thereby leading to refracture. Cerclage wiring and the semi-rigid Partridge plate with straps were designed to eliminate the problems of endosteal vascular impairment. However, circumferential devices have acquired a notorious reputation. The new plate under discussion reaches two-thirds around the bone, leaving the deep soft-tissue structures totally intact.

The paraskeletal clamp-on plate

The new clamp-on plate has the following technical features: (i) a pressed-out groove in the central portion, which increases the rigidity of the plate and prevents longitudinal deformation when being applied (Figs 1 and 2); (ii) attached to this central 'backbone' are paired, semicircular tooth-like projections, fashioned in such a way as to embrace the bone two-thirds around its circumference. For this reason a selection of different sizes (from small to large, short to long) and shapes (parallel and tapered) is available; (iii) the tips of these projections have wedge-shaped, sharpened, turned-in points which are pressed into the bone by a crimping tool during the application of the plate, reaching a depth of only 1 - 2 mm (Fig. 3); (iv) by virtue of these wedge-shaped points and the fact that the semicircular shape of the plate is bent into a slightly oval form during the consuming, expensive and technically demanding. Acute and chronic osteomyelitis is not infrequently seen.\(^{1,12,13-22}\) Second removal operations and subsequent protection of the limb add to the morbidity rate.

The search to overcome these disadvantages led to the development of a plate which could be described as being paraskeletal when applied to the bone, because it does not lie flush against the bone (as the Sherman, Muller and Judet plates and many others do), and it therefore does not have the disadvantage of weakening the bone owing to disuse osteopenia under the plate. Another feature of this plate is that drill holes and screws are not required for its fixation to the bone, whereas these are commonly used for most other plates and damage endosteal blood vessels, serving as 'stress concentrators' and thereby leading to refracture.

Department of Orthopaedic Surgery, H. F. Verwoerd Hospital and University of Pretoria

U. MENNEN, M.B. CH.B., F.R.C.S. (GLASG.), F.R.C.S. (EDIN.), F.C.S. (S.A.) (ORTHOP.), M.MED. (ORTHOP.), M.D. (ORTHOP.), Associate Professor and Principal Surgeon

Reprint requests to: Prof. U. Mennen, Dept of Orthopaedic Surgery, H. F. Verwoerd Hospital, Private Bag X169, Pretoria, 0001 RSA.

Fig. 1. Oblique view of the paraskeletal clamp-on plate showing pressed-out groove in the central longitudinal ridge.
Fig. 2. Artistic representation of the plate secured to a bone, with technical drawings depicting various views including critical ranges of measurements.

Fig. 3. Schematic end-view of the paraskeletal clamp-on plate (a) before the crimping procedure and (b) after the crimping procedure (G = pressed-out groove; R = central longitudinal ridge; T = paired, semicircular tooth-like projection; N = inverted tip of projections; and P = sharpened wedge-shaped tip).

crimping process, a gap is created between the plate with its projections and the bone, leaving the periosteum, muscle and tendon insertions undisturbed; thus the plate is only in contact with the bone at the sharpened tips; and (v) the metal used for this plate is high-quality stainless steel (AISI type 316L) with a carbon content of less than 0.03%.

Instruments used with this method are supplied with a selection of plates in a stainless-steel holder, and comprise: (i) a crimping device to engage the turned-in points with the bone; (ii) plate-removing forceps; (iii) a 3.5 mm diameter tungsten ball-tipped burr; (iv) two small plate-holding clamps; (v) two bone-holding clamps; (vi) a projection spreader to be used where the bone might be too wide at some point for the distance between the sharpened points of the plate; and (vii) a calliper to measure the bone diameter, facilitating the selection of the correct-size plate.

Method of application

The technique used to apply the plate is quite simple, and consists of minimal soft-tissue dissection, thereby preserving periosteum, muscle and tendon insertions and venous drainage.

The fracture is reduced by two bone-holding clamps, set sufficiently apart to allow placing of the plate. A plate which will embrace at least 50% of the circumference of the fractured bone is selected by using the calliper, and is applied over the fracture site. Before the bone-holding clamps are removed, the plate is held in position on the bone by two small plate-holding clamps, thereby securing the reduced position during the crimping procedure. The sharpened points are compressed into the bone by the crimping tool so that the applied plate maintains the reduced position, having caused the minimum amount of trauma. After wound closure a protective splint of some sort (to prevent all rotatory movements) is applied (e.g. an above-elbow plaster of Paris cast for a radius and/or ulna fracture) until union is evident on radiography (Fig. 4) (this point will be fully explained under 'Discussion').

Should the plate need to be removed, the projections are simply bent back by the removing forceps, thus disengaging the points from the bone; it is usually necessary to disengage the projections on one side only. In those cases in which new bone has formed between the projections, the gripping action of the plate-removing forceps can be assisted by the burr to create small depressions next to the points.
be able to heal per primam, and this is more important than internal fixation and intentional early mobilization to prevent adhesions and stiffness.

The second critical technical aspect is the choice of the correct size of plate. Plates that are too small will slip off. Using the calliper to select the correct size will eliminate the mistake of choosing the wrong size.

The fact that complete clinical and radiological healing takes place within a very reasonable period of time (average for 174 fractures treated, 12.5 weeks (see Part II, Table I)), similar to that for healing of the undisplaced conservatively treated fractures (11.3 weeks), emphasizes the atraumatic nature of this method.26-30 The importance of preserving not only the intramedullary vessels but also the para-osseous draining system is the underlying reason for these good results. Damaging the outflow system will lead to congestion and therefore an impairment of arterial blood inflow. Furthermore, the bone is not weakened by any means (e.g. drill holes, screws, disuse osteopenia, cancellation of the cortex, undue stresses) thanks to the unique method of application of the plate and its inherent isoelastic properties. It goes without saying that plated bones tend to be very vulnerable for a certain postoperative period, and especially up to 2 years after the removal of plates and screws, owing to the stress-concentration effect of holes.

A second removal operation is very seldom, if ever, needed with the paraskeletal clamp-on plate. The financial outlay for instruments is minimal compared with that required for other complicated methods. Since this clamp-on method is technically so simple, no special training courses or facilities are needed.

The treatment of comminuted fractures has always been a problem in the past. Plates and screws tended to devitalize fragments even more, leading to non-union or delayed union. The paraskeletal clamp-on plate has proved to be ideal for severely comminuted fractures since the plate is simply clamped over the fragments.

Taking all these arguments into account, this new method of retaining the internally reduced position of fractures with the paraskeletal clamp-on plate, can be recommended with great confidence for the treatment of fractures of the forearm.

REFERENCES


Discussion

Experimental and clinical experience with the paraskeletal clamp-on plate has without any doubt proved it to be superior to conventional methods of internal fixation for fractures of the radius and/or ulna by plates and screws as far as simplicity, financial outlay, morbidity, complications and treatment time are concerned. Full details of experience with this plate are presented elsewhere. 26-30

Many methods, procedures or techniques have been criticized or have fallen into disuse because of a failure of some surgeons to adhere meticulously to the carefully described, step-by-step techniques developed by the original surgeon. However, if the simple method of applying and removing this clamp-on plate is followed as described above, excellent results will be assured.

The procedure is also described in detail in a manual. *

Certain critical aspects have to be re-emphasized. The primary function of this plate is to retain the reduced position of a fracture ('bone stitch') while healing takes place. It is not able to withstand rotatory stresses and for this reason an external support to prevent any rotatory movements has to be applied.

Although this might appear to be a regression to primitive methods compared with the perfectly devised internal fixation methods of the A-O (Association for the Study of Internal Fixation) group of Switzerland,31 the eventual result is the final arbiter. All will agree that there are more unknown factors and forces in the body that influence bone healing than known ones. It is not only unwise but also dangerous to over-emphasize the mechanical aspect of biomechanics while ignoring important biological factors such as intra-osseous blood supply and peri-osseous venous drainage, soft-tissue support, iso-elastic (physiological) movement and limiting the amount of foreign and dead material at the fracture site. These all amount to the preservation (as far as possible) of the known factors involved in fracture healing, and the aim of the clamp-on plate is to retain the reduced position of a forearm fracture while an optimal environment is preserved to enable fracture healing to take place.

One cannot over-emphasize the basic principle that tissues need to be handled with respect. Traumatized tissue needs rest to

* Technique Manual: The Mennen Plate. Obtainable from ARD (Pty) Ltd, PO Box 26115, Arcadia, Pretoria, 0007 RSA.
The paraskeletal clamp-on plate
Part II. Clinical experience with fractures of the radius and/or ulna

U. MENNEN

Summary
Clinical experience with 282 fractures of the radius and/or ulna treated by means of the paraskeletal clamp-on plate is presented and compared with results for 66 fractures not operated upon and 31 fractures for which conventional plating methods were used.

As far as the healing time (average 12.3 weeks), post-healing joint movements, complication rate, morbidity rate, financial outlay, simplicity and versatility are concerned, the paraskeletal clamp-on plate proved to be greatly superior to conventional methods of internal fixation for forearm fractures.

A large variety of internal fixation devices for fractures is in current use. Each of these have pros and cons, these being based mainly on biological and mechanical principles. These principles are factors which are known to be essential for bone healing. Since many more (but unknown) factors are involved during the healing process, it follows logically that the known ones should be preserved as far as possible.

Another aspect of internal fixation to be considered is the incorrect overemphasis of mechanical principles, often with disregard for the biological principles. For example, intra-medullary reaming as well as drill holes screws destroy the endosteal vessels which carry the all-important osteoblast progenitor cells. Plates and screws not only weaken the bony architecture owing to disuse osteopenia (or cancellization of the cortex, most probably by means of a stress or shield-protection effect, first described in Wolff's law) and also to the stress-concentration effect of drill holes, which leads to refractures.

Furthermore, plating and screwing impedes venous drainage from the bone, thereby causing venous congestion and diminished inflow of arterial blood.

These and other disadvantageous side-effects of the conventional internal fixation of fractures have in the development of an alternative method, the paraskeletal clamp-on plate, to try and overcome these problems. The technical aspects, operative technique and research background and results have all been published elsewhere. This article deals primarily with clinical findings and experience.

Patients and methods
Since June 1979 more than 450 forearm fractures have been treated by the Department of Orthopaedic Surgery at H. F. Verwoerd and Kalafong Hospitals in Pretoria. In this article results in four groups comprising the first 379 of these 450 forearm fractures are compared.

The groups were delineated as follows: group A — 66 undisplaced, closed forearm fractures treated by cast-bracing only; group B — 13 compound forearm fractures treated by thorough debridement, secondary wound closure and above-