Experience with the pinless fixator in the treatment of fractures of the lower leg

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Summary

This is a report of the experience we have gathered in the application of the pinless fixator in cases of tibial fracture with soft tissue damage.

In the Berufsgenossenschaftlichen Unfallklinik Ludwigshafen (Clinic for Trauma Surgery) 12 diaphyseal fractures of the tibia were stabilized with the pinless fixator in 1991. In all cases, conversion to an intramedullary nail was intended from the very beginning and was performed in 11 cases. In one case, a conventional external fixator had to be selected instead. The injuries included first and second degree open and closed fractures, mostly from group A of the AO classification. At conversion four bacteriological smear tests from the medullary cavity proved positive. In four cases, transitory peroneal deficiencies were diagnosed. When investigating their cause, it seemed that the present geometry of the pinless arms might be responsible for pressure damage to the soft tissues. Possibly this difficulty could be solved by altering the configuration of these arms. The pinless external fixator has definitely proved its usefulness when later conversion to an intramedullary nail is intended since the final fixation can be performed with the pinless device still in place.

Introduction

It is impossible nowadays to imagine the treatment of injury to the upper and lower limbs without the external fixator. These devices offer excellent stability in the primary treatment of fractures with severe damage to the soft tissue whether open or closed and can be applied with very little additional trauma to the soft tissue. However, the longer treatment takes, the more likely it is that complications will occur when relying on the conventional external fixator. Numerous studies have investigated the problem of Schanz screws or Steinmann nails becoming loose and of soft tissue necrosis at the pin insertion sites. Pin track infections are particularly serious (1-4). These derive primarily from loosening of the pin in the bone and from movement of the soft tissues around Schanz screws close to a joint. Both situations may later be affected by bacterial contamination and/or infection of the bone. An increased risk of osteitis arises when converting to an internal fixation device. Disturbed fracture healing has also been described in numerous cases after primary stabilization with an external fixator. For this reason, efforts are generally made to transfer from an external to an internal fixation device as soon as possible.

Many attempts have been made to reduce the frequency of contamination and infection. Screw design has been repeatedly changed in order to combat the phenomenon of screw loosening and its associated problems. The pinless external fixator for the tibia was designed on the basis that contact with the medullary cavity, inevitable when inserting Schanz screws or Steinmann nails, could be avoided. In addition, it is designed for use in emergency situations and catastrophes.

Principles

The pinless fixator consists of a movable clamp with a central hinge. There is a certain similarity to existing

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1 Abstracts in German, French, Italian, Spanish and Japanese are printed at the end of this supplement.
orthopaedic instruments, e.g. Weber's sharp reduction forceps or the hip clamp by Ganz. Following skin and soft tissue incision, the trocar tips of the clamp are fixed in the outer layer of the cortex by pressing the two handles together and rocking the fixator to and fro. The clamp is stabilized by inserting a screw into the central hinge. A second screw is designed for purposes of adjustment and to fix a rotatable (360°) pin onto which the universal clamps of the AO fixator with the longitudinal rods will be attached.

Indications
The indications which we regarded as suitable for application of the pinless external fixator were fractures of the lower leg with closed soft tissue damage or those open fractures judged as suitable for intramedullary nailing although primary nailing was contraindicated due to the severity of the soft tissue injury (Fig. 1a and b). In other words, it was necessary to judge before intervening whether or not the soft tissues would heal adequately within a reasonable period for nailing to be possible.

Positioning
When mounting the pinless external fixator on the tibia, for which this fixator is best suited, a position has to be selected which takes into account the thickness and the degree of injury to the soft tissue covering. Since the soft tissue is distributed asymmetrically on the lower leg, a ventro-medial configuration is most appropriate whether a pinless fixator or a conventional external fixator has to be inserted. The triangular cross section of the tibia means that anchorage can be found on the lateral side of the anterior tibial ridge and on the medial tibial surface or just slightly behind the dorso-medial tibial ridge. This is absolutely no problem when mounting the pinless fixator on a bone model without soft tissue. However, in clinical practice the condition of the soft tissue plays a vital role.

Results
In 1991 the pinless fixator was applied 12 times at the Berufsgenossenschaftlichen Unfallklinik Ludwigs-hafen. This is equivalent to approximately 20% of all diaphyseal tibial fractures occurring in this period. In 11 cases, conversion to a locked intramedullary nail (V-nail) was performed (Fig. 2a-c). The fractures stabilized using the pinless fixator were two first degree open, one second degree open, five second degree closed and four third degree closed fractures. In terms of classification, the majority of these fractures fell into the Group A category of the AO classification.

Most conversion procedures took place within the first 10 days after the accident. The intraoperative bacteriological smears from the medullary cavity were sterile in seven cases. In four cases (30%), the smears were positive. The complications observed were one case of osteitis after intramedullary nailing. In this case, a conventional external fixator was used as the final fixator after nail removal. In one case, the predicted time of treatment and a suppurating infection of the upper leg required conversion to a conventional external fixator. Furthermore, we observed four transitory peroneal deficiencies and one thrombosis. In two cases, in which the smears were positive, healing could only be achieved by constant, supervised drainage. Once the fracture had healed, implant and drain removal were carried out simultaneously. In two further cases, healing was achieved by extending the period of drainage. Three fractures healed without complication (Tab. 1).

Fig. 1a: 38-year-old motorcyclist with a B 2 fracture of the lower leg. Second degree, closed soft tissue injury. Fracture type suitable for nailing.

Fig. 1b: Pinless fixator in place. Primary intramedullary nailing was impossible due to an extensive abrasion across the tibial head.
Table 1: Overview of patient sample, treatment and results.

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Fracture Classif.</th>
<th>Soft tissue damage</th>
<th>Time to conversion (days)</th>
<th>Implant</th>
<th>Bacteriology</th>
<th>Complications</th>
<th>Comments</th>
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<tbody>
<tr>
<td>1</td>
<td>43.2</td>
<td>B1</td>
<td>G II</td>
<td>10</td>
<td>V-Nail</td>
<td>No samples</td>
<td>Transitory peroneal deficiencies</td>
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<td>28.9</td>
<td>B2</td>
<td>G II</td>
<td>7</td>
<td>V-Nail</td>
<td>sterile</td>
<td>Transitory peroneal deficiencies</td>
<td>Mesh graft</td>
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<tr>
<td>3</td>
<td>25.4</td>
<td>A3</td>
<td>G III</td>
<td>5</td>
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<td>Sterile</td>
<td>Thrombosis, primary peroneal damage</td>
<td>Thrombectomy, Healing with prolonged drainage</td>
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<tr>
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<td>A3</td>
<td>0 I</td>
<td>8</td>
<td>V-Nail</td>
<td>Staph.aur.</td>
<td>Therapy, Healing with prolonged drainage</td>
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<tr>
<td>5</td>
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<td>0 I</td>
<td>9</td>
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<td>Sterile</td>
<td>Osteitis</td>
<td>Healing with drainage until implant removal, several revisions</td>
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<td>G III</td>
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<td>Osteitis</td>
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<td>B2</td>
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<td>Staph.aur.</td>
<td>Delayed healing</td>
<td>Osteitis healing after prolonged drainage</td>
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<tr>
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<td>A1</td>
<td>G II</td>
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<td>Transitory peroneal deficiencies</td>
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Discussion

The experience we have gained in the application of the pinless external fixator must be analyzed according to different factors.

1. Application techniques

The clamp is inserted through two stab incisions on the medial aspect of the tibia and is pressed firmly into the cortex. This position avoids perforation of the muscles. If the skin incisions are correctly located, then the clamp will be well anchored in the tibial cortex. We first had to learn how to improve fixation of the trocar tips in the cortex by moving each clamp to and fro as described above whilst applying pressure to the handles. In the first few cases in which we were not aware of this technique, the clamp was only held in place by the tension within the clamp itself (Fig. 3). Under these conditions, it is relatively easy for the clamp to slip on the smooth, hard surface of the cortex.
Fig. 2a: 25-year-old motorcyclist with a B 1 fracture of the lower leg. Third degree closed soft tissue damage.

Fig. 2b: Radiograph of reduction and stabilization with the pinless external fixator. In the soft tissues laterally, the measuring probe for compartment pressure measurement is visible.

Fig. 2c: Conversion to an intramedullary nail on the 5th day.

Fig. 3: The trocar tips are only resting on the cortex. Anchorage in the outer layer of the cortex by rocking movements was not carried out. The fixator is held in place by the tension in the fixator clamp only.

2. Soft tissue considerations

In our experience selecting the correct position for the skin incision through which the clamp will be inserted was a source of some difficulty especially in the mid-tibia. In cases of soft tissue oedema, the clamp geometry may mean that pressure damages the tissue immediately adjacent to the clamp. The transitory
peroneal deficiencies we observed may be due to this phenomenon. To identify the required anchorage sites on the tibial cortex, the clamp, whose tips lie on a circular circumference, must be opened wide and pressed through both the soft tissue on the extensor surface of the tibia and through the anterior border of the calf muscles on the medial aspect. The geometrical form of the clamp may be instrumental in causing pressure sores and necrosis of the skin if the soft tissue mass is increased. The fact that part of the clamp from the trocar tip to the first curvature is straight means that this part of the clamp exerts unphysiological pressure loads on the skin adjacent to the incision. When opening and closing the clamp the area beneath the straight part of the arm moves on a circular circumference with a radius greater than that of the trocar tips. Since the trocar tips lie on a smaller circumference, the skin incision must be positioned far more laterally and medially than the planned anchorage sites on the cortex. If the skin incision lies exactly above the anchorage site on the tibia, experience has shown that the clamp will slip off the ventro-medial surface of the tibia (Fig. 4a-e). Taking these issues into consideration, we feel that the geometry of the clamp should be modified. Our experience has also shown that if the trocar tips were somewhat sharper, this would improve the stability of the fixator and reduce slippage.

It was found that skin necrosis occurred less frequently when the pinless fixator was applied to the tibial head and the distal tibia. In these areas far fewer complications were observed which could be attributed to clamp geometry. On the tibial head, the clamp can be applied almost exactly ventrally without compromising the soft tissues. The same is true for ventral or ventro-medial application on the Pilon tibiale.

3. Stability

Any fracture requiring a long period of treatment is in our opinion not a suitable indication for the use of the pinless fixator for reasons of stability. The pinless fixator can only function as a temporary implant. After mounting the pinless fixator and attaching a longitudinal rod, a certain amount of instability was evident both intraoperatively and in the postoperative period. This became apparent, for example, when the leg had to be raised from the operating table to be bandaged. It was noticeable in every case that the fragment ends were in contact with each other. For this reason, it is advisable to attach a second longitudinal rod to increase stability. An increase in clinical stability was also achieved if all the clamps could be attached to the second rod. For the sake of stability, a two rod construction is always to be recommended.

Our practical experience so far has shown that when removing the pinless fixator at the time of conversion to an intramedullary nail, the clamps were described as loose by every treating surgeon. In some cases, the

Fig. 4a: Mounting the pinless fixator on a patient who had suffered a fracture of the lower leg and second degree closed soft tissue injury. Once the clamp has been inserted below the tibial head, an indentation of the skin is a sign of pressure on the soft tissue. Here there is a risk of skin necrosis.

Fig. 4b-e: The figures show the various positions in which the pinless fixator can be mounted. (b=top left) Compression of the lateral soft tissues is associated with the risk of peroneal damage. (c=top right) Compression of the medial and lateral soft tissues has to be considered. (d=bottom left) Compression damage to the medial soft tissues is probable. (e=bottom right) There is very little danger of damage to the soft tissues by the arms of the fixator, however, in this position there is a risk that the fixator will slip on the medial cortex.
clamps could easily be removed without adjusting the locking screw. These observations confirm our conclusion that the pinless fixator should only be used for temporary stabilization.

4. Conversion procedure

One definite procedural advantage is that the conversion to an intramedullary nail can be performed with the fixator in situ. If the primary reduction has proven satisfactory, subsequent nailing will not be difficult (Fig. 5a and b). Amongst our patients only those suitable for nailing procedures were primarily stabilized with the pinless external fixator. At conversion there is no need for time-consuming positioning of the limb or extension before nailing.

5. Bacterial contamination

We were only able to explain the relatively high rate of bacterial contamination of the medullary cavity (4 of 12 cases, predominantly closed fractures) by assuming that bacterial migration had taken place from the pin insertion sites by way of subcutaneous haematomas or subcutaneous stripping. Entry into the medullary cavity would then be via the fracture gap. Contamination originating from pressure necrosis of the soft tissues is conceivable.

Conclusion

From the results which we have achieved so far for the 12 patients treated with the pinless fixator we cannot deduce any significant advantages over conventional fixation methods. It cannot be concluded that a great deal of time was saved when mounting the pinless fixator compared with the time needed for a conventional ventral external fixator and four Schanz screws. The course of healing did not demonstrate that the pinless fixator had vastly improved the treatment of tibial fractures with soft tissue injury. One considerable advantage is definitely the fact that machine drilling is unnecessary and that the pinless fixator is of practical use for rapid fixation in exceptional circumstances such as catastrophes and emergency situations in which the necessary technical infrastructure is not available. The additional trauma to the bone due to the trocar tips is considerably less than that resulting from pre-drilling and insertion of Schanz screws or Steinmann nails. Possibly a modification of the clamp geometry would achieve a reduction of the observed complications. When deciding whether to apply the pinless external fixator, a precise assessment of the damage to the soft tissues is of paramount importance.

References


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