The external fixator compared with the sliding hip screw for pertrochanteric fractures of the femur
I. C. Vossinakis, L. S. Badras
From Volos General Hospital, Greece

In a prospective, randomised study we have compared the pertrochanteric external fixator (PF) with the sliding hip screw (SHS) in 100 consecutive patients who were allocated randomly to the two methods of treatment. Details of the patients and the patterns of fracture were similar in both groups. Follow-up was for six months.

Use of the PF was associated with significantly less blood loss, a shorter operating time, reduced postoperative pain, shorter hospitalisation (p < 0.001), earlier mobilisation (p < 0.001) and a reduced rate of mechanical complications (p < 0.01). Superficial infection was significantly more common with the PF (p < 0.01), but without long-term adverse consequences. There were no differences in the healing of the fracture, mortality or final functional outcome. Our results indicate that the external fixator is an effective and safe device for treating pertrochanteric fractures and should be considered as a useful alternative to conventional fixation with the sliding hip screw.


External fixation was introduced for the management of pertrochanteric fractures in the 1950s at about the same time as the first sliding internal fixation devices. Although the first reports on external fixation were encouraging, the method was overshadowed by the use of the sliding hip screw, which has become the standard method of treatment for these fractures. The advantages of external fixation in certain situations, however, have been recognised by several authors. The reported complications of its use in the proximal femur are the main reason for its continued unpopularity. There has, however, been no prospective, randomised study comparing external fixation with any of the methods of internal fixation used in the treatment of pertrochanteric fractures.

In our department encouraging experience with external fixation in elderly, high-risk patients has led to its adoption as the method of choice in this group of patients. A modified device (Pertrochanteric Fixator; Orthofix Srl, Verona, Italy) offers additional theoretical advantages, including a standardised technique, improved stability and less stiffness of the knee. The new device has replaced other fixators in our practice and has given satisfactory results with few complications.

We have undertaken a prospective, randomised study to compare the efficacy of the pertrochanteric fixator (PF) with that of the sliding hip screw (SHS) for the treatment of pertrochanteric fractures. In addition, comparisons were made of the incidence and severity of complications between the two methods of treatment and their impact on the healing of the fracture and rehabilitation.

Patients and Methods

In the two years 1997 and 1998, 100 consecutive patients were admitted with pertrochanteric fractures and recruited into the study. The project was approved by the hospital’s Scientific Committee. The patients gave informed consent. Cognitive status was assessed using the Hasegawa test of dementia; those with dementia (score < 10.5) were not included. We also excluded fractures which were basivertical, pathological, presenting more than one week after injury, with a subtrochanteric extension or reverse obliquity, and patients with associated fractures which could interfere with rehabilitation. Finally, patients at high surgical risk (ASA score >4) were excluded since in our department they are always treated by external fixation.

The patients were randomly allocated to one of the two treatment options, the PF or the SHS by the use of sealed envelopes containing cards, indicating the treatment for each patient. Table I gives the details of the patients in each group. The fractures were classified before operation according to the modified Evans classification (Table II)
using anteroposterior (AP) and lateral image intensification. More than 70% of all fractures were unstable, although most resulted from simple falls indoors. High-energy injuries included three falls from a height in the PF group and two falls from a height and two road-traffic accidents in the SHS group.

All operations were undertaken by one of four orthopaedic surgeons using closed reduction under image intensification. The PF was applied as recommended by the manufacturer, using the special guides and guide-wires (Fig. 1). The entry points for pins were released to prevent soft-tissue deformity. Fixation by SHS was carried out in the standard fashion, attempting a central position of the screw in both AP and lateral planes. One suction drain was used under the deep fascia. All patients in both groups received perioperative chemoprophylaxis (cefuroxime, 750 mg) and thromboprophylaxis with low-molecular-weight heparin (enoxaparin) together with the wearing of graduated compression stockings for two weeks. Mobilisation using a walking frame, allowing full weight-bearing, was attempted from the second postoperative day.

The data recorded for all patients included walking ability before fracture, residential accommodation, mechanism of injury (low or high energy), the type of fracture, ASA score and blood haemoglobin (Hb) level on admission. Perioperative data included the type of procedure (PF or SHS), preparation time, operating time, the quality of reduction, intraoperative blood loss and any complications. After operation, we recorded the level of haemoglobin on the first day, the level of pain, assessed on a four-grade verbal scale on the second day, limitation of hip or ipsilateral knee movements, the time before walking commenced, the duration of hospital stay and the type of accommodation on discharge. Patients were followed up clinically and radiologically for six months; none was lost to follow-up.

**Statistical analysis.** The data were analysed using the SPSS 8.0 statistics software package (SPSS Inc, Chicago, Illinois). For comparison of means for interval or ratio level variables we used the two-tailed Student \( t \)-test, the magnitude of the observations being expressed by the point biserial correlation coefficient (\( r_{pb} \)). For ordinal variables the Mann-Whitney U test was used. Frequencies were tested by the chi-squared test and Yates’ correction was used when expected frequencies were below ten. The Wilcoxon signed-rank and the Friedman tests were used to compare walking ability before and after fracture and to compare original, discharge and final accommodation, respectively. We used Spearman’s correlation coefficient to determine relationships between variables measured on a categorical scale. Finally, multiple and logistic regression was used to examine relationships between demographic variables, methods of treatment, type of fracture and the outcome variables. The magnitude of the relationships for multiple regression is expressed by the semipartial correlation coefficient (\( r_{sp} \)). Significance was determined at the 95% level.

**Results**

The preparation time, including the positioning of the patient and closed reduction under image intensification,
was similar in both groups (18.2 and 17.5 min for PF and SHS, respectively). The operating time was significantly reduced in the PF group (Table III). Multiple regression analysis showed that only the type of operation had a significant effect on the surgical time (rspb = -0.83, p< 0.001). More than half of the fractures were anatomically reduced. The reduction was considered to be anatomical if the neck-shaft angle was reproduced and the gap at the fracture site in both the AP and the lateral planes was less than 2 mm. Minor valgus angulation (<10°) and a gap of less than 5 mm were considered to be acceptable if an anatomical reduction was not possible (Fig. 2). Only three fractures (1 in the SHS and 2 in the PF group) had an unacceptable reduction.

In the PF group the pins were inserted in a satisfactory position, according to the manufacturer’s recommendations, in 43 of 50 fractures. In one patient the most proximal pin protruded into the hip which remained unnoticed until the third postoperative day, when new radiographs were obtained because of pain in the hip. The pin was withdrawn 20 mm without anaesthetic and mobilisation proceeded without delay. The position of the screw in the SHS group was satisfactory in 46 of the 50 fractures.

No other intraoperative complication was observed in the PF group. By contrast, in the SHS group, fracture of the lateral cortex or the greater trochanter occurred in six patients during reaming of the neck. In five others the guide-wire became engaged within the reamer and was advanced into the hip without, however, adverse consequence. Although these complications had no effect on the final outcome, they were significantly more common in the SHS group (chi-squared test = 10.05, p < 0.01).

As expected, blood loss was minimal in the PF group whereas patients in the SHS group lost blood, both during, and after operation by way of the drain. The difference between the two groups was highly significant. Although the preoperative levels of haemoglobin were comparable for the two groups, those on the first postoperative day differed significantly. A highly significant difference was also observed in the subsequent fall in the level of haemoglobin between the two groups (Table III). Finally, the number of patients who required transfusion after operation in each group was very different; 14 patients of the SHS group and one of the PF group were transfused (chi-squared test = 11.3, p < 0.01). The latter suffered upper gastrointestinal haemorrhage.

Multiple regression analysis revealed that both the type of treatment (SHS v PF, rspb = -0.86, p < 0.001) and a high body-weight (rspb = 0.22, p < 0.05) showed a significant relationship with a fall in the postoperative level of haemoglobin.

The fixator was well tolerated and did not interfere with sitting or lying. No clinically significant limitation of hip or knee movements was observed in the patients of either group. The level of pain was recorded for each patient on the second postoperative day, when walking was attempted. On a four-grade verbal scale (none, mild, moderate, severe) patients in the SHS group scored significantly higher than those in the PF group (Mann-Whitney U test = 573.00, p < 0.00001). Multiple regression analysis showed this to be related only to the type of treatment (rspb = -0.48, p < 0.001).

Table III. Comparison of the mean (± SD) time of surgery, blood loss, changes in haemoglobin and hospitalisation time between the PF and SHS groups

<table>
<thead>
<tr>
<th>Variables responsible for the difference</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery time (min)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total blood loss (ml)</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td>Haemoglobin (mg/dl)</td>
<td>NS</td>
</tr>
<tr>
<td>Postop</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Decrease</td>
<td>0.92</td>
</tr>
<tr>
<td>Hospitalisation (days)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

* point biserial correlation coefficient
Although the rehabilitation programme was the same for all patients, the time of the start of walking differed for the two groups; 30 patients in the PF group were able to start supervised walking on the second postoperative day, while only 14 in the SHS group did so. Patients in the PF group began to walk on average one day earlier than those in the SHS group (Mann-Whitney U test = 737.00, p < 0.001). Multiple regression analysis showed that the delay in walking was related to the preoperative walking ability ($r_{sp} = 0.34$, $p < 0.01$) and to accommodation ($r_{sp} = 0.25$, $p < 0.05$), but more so to the level of pain at the beginning of rehabilitation ($r_{sp} = 0.76$, $p < 0.001$).

The length of hospitalisation was significantly shorter in the PF group (Table III). Most patients from both groups returned to their homes at discharge (36 for PF and 32 for SHS). Seven and ten patients in the PF and SHS groups, respectively, were discharged to geriatric homes, while six and five patients, respectively, were discharged to nursing homes. These small differences were not statistically significant. Multiple regression analysis showed that only the type of treatment significantly influenced the length of hospitalisation ($r_{sp} = -0.92$, $p < 0.001$), while the place of discharge was clearly related to the preoperative accommodation ($r_{sp} = 0.54$, $p < 0.001$) and to a less degree to the age of the patients ($r_{sp} = 0.39$, $p < 0.001$). There was no difference in the time required for the healing of the fracture between the two groups. All were judged to be healed at a mean of 11.4 (so 1.2) weeks. None of the variables examined nor the type of fracture was found to influence the time of healing.

The ability to walk at follow-up at six-months was similar for patients in both groups. It was, however, significantly decreased for all patients compared with that before their fracture (Wilcoxon Z test = -6.18, $p < 0.001$); 22 patients in the PF group and 23 in the SHS group showed a reduction of at least one level in their walking ability. There was no significant correlation between the time at which walking began after operation and the level of walking ability at the final follow-up. The details of walking ability are shown in Figure 3.

The type of accommodation at the final follow-up showed no significant difference between the two groups. A significant trend towards institutionalisation compared with both the prefracture status and the accommodation at discharge was seen (Friedman test: $N = 85$, chi-squared test = 17.81, df = 2, $p < 0.001$). Eight of the surviving patients in the PF group and ten of those in the SHS group were more domestically dependent at six months compared with before their fracture (Fig. 4).

Multiple regression analysis showed that the final (6-month) walking ability and accommodation were related to walking ability before the fracture, and accommodation ($p < 0.05$). Furthermore, the final walking ability was also influenced by the type of fracture ($r_{sp} = 0.25$, $p < 0.05$) and in turn this had a significant effect on the final accommodation ($r_{sp} = 0.38$, $p < 0.01$).

The overall mortality rate at six months was 14% in the PF group and 16% in the SHS group. One patient from the PF group and three from the SHS group died in hospital. There was no significant difference in mortality between the two groups.

Postoperative complications. In the PF group a mean
shortening of 14.1 mm was seen in 13 fractures. In the SHS group 11 fractures healed with a mean shortening of 16.4 mm (5 to 30). Varisation at the site of fracture of between 10° and 20° was noted in 12 fractures in the PF group (mean 12.9°; range 10 to 20) and in eight of the SHS group (mean 11.9°; range 10 to 18). The varisation was frequently the cause of the shortening. These differences were not significant. Logistic regression revealed that unstable fractures were more prone to these two complications (p < 0.001), but advanced age also had a significant effect on shortening (p < 0.001).

In a number of cases one of the proximal pins (PF) or the screw (SHS) advanced further into the proximal fragment due to collapse, without cutting out. In the PF group this usually involved the more proximal of the two pins and was seen in 15 fractures, while in the SHS group this occurred in 28. The difference between the two groups was statistically significant (chi-squared test = 6.89, p < 0.01). By contrast, cut-out of the implant was noticed in a much smaller number of patients in each group (three for the PF and five for the SHS). This difference between the groups was not significant. All cases of cut-out in the PF group were treated by retracting the offending pin without anaesthesia. In the SHS group, however, all five patients required a second operation. Unstable fractures were more prone to advancement of the pin (p < 0.001); this was less likely with the PF (p < 0.01). The small number of cases in which a pin or screw cut-out of the femoral head did not allow further analysis.

Medialisation of the distal fragment was seen in five fractures in the SHS group, whereas it was not seen in the PF group (Spearman rank-correlation coefficient r = -0.23, p < 0.05). Five reoperations were undertaken, all in SHS patients. Two were required before healing of the fracture because of mechanical failure; one repeat internal fixation and one bipolar hemiarthroplasty. The remaining three were carried out after healing in order to remove metalwork in patients with superior cut-out. At the end of treatment the increased risk of a subcapital stress fracture was the reason for removal of the implant. No second operations were required in the PF group. External fixators were removed in the outpatient department without anaesthesia.

Deep infection complicated the recovery in one patient (SHS) who had undergone repeat internal fixation because of mechanical failure. The infection developed after the second operation and was treated by debridement and intravenous antibiotics. The implant was left in place until the fracture healed, which was slightly delayed (15 weeks). In the PF group no deep infection was observed. By contrast, superficial infection was, as expected, much more common in the PF group (chi-squared test = 7.70, p < 0.01, $\phi = 0.31$); 15 patients developed pin-track infection, usually involving only the proximal pins. The infections were treated with oral broad-spectrum antibiotics and daily care of the pin sites by visiting nursing staff. No pin required removal or repositioning and all signs of inflammation subsided rapidly after removal of the fixator. In the SHS group three patients had postoperative wound erythema, without discharge, which resolved within three to four days of treatment with intravenous antibiotics. No long-term consequences were observed in the patients with superficial infection. Logistic regression analysis showed that superficial infection was more likely to develop with external fixation (p < 0.01) and with increased body-weight (p < 0.001).

**Discussion**

External fixation for pertrochanteric fractures has been mainly used in elderly high-risk patients. Pertrochan-
teric fractures in multiply-injured patients have also been satisfactorily treated by external fixation\textsuperscript{11} and it has proved to be invaluable for treating complex fractures of the proximal femur which involve the subtrochanteric region.\textsuperscript{12-15} Alcivar\textsuperscript{16} used external fixation as the method of choice for the treatment of pertrochanteric fractures and has reported the largest series. The fixators used in these studies were of several designs. The main advantages of the principle include simple and quick application, minimal blood loss, satisfactory stability and early weight-bearing.

Our results have confirmed these advantages in a group of patients with pertrochanteric fractures. Compared with the SHS, application of the external fixator is easier and takes half the time. SHS fixation, especially in obese or muscular patients, can be a protracted procedure with significant blood loss.\textsuperscript{23,24} Intramedullary devices have been introduced but have not shown significant advantages.\textsuperscript{2,25} In our study external fixation was associated with reduced surgical trauma and blood loss, compared with the SHS.

Mechanical complications require further surgery, delay rehabilitation, prolong hospitalisation and lead to increased social dependency.\textsuperscript{27,28} Although the quality of the bone, the pattern of the fracture and adequacy of reduction play a significant role in the stability of the fixation, our results show that external fixation has a significantly lower incidence of mechanical complications. The reason for this is not clear, but when fixation devices on the lateral aspect of the femur act as tension bands, the distance between the tension band and the loading axis will increase its efficacy. For unstable fractures external fixation has proved to be effective because of the large bone-implant interface and the potential for controlled sliding with impaction.\textsuperscript{11} Another possible explanation is the element of elasticity which produces rapid and abundant callus formation.\textsuperscript{15}

The short and sturdy PF used in our study provided sufficient stability for early weight-bearing, without loss of position. The temporary limitation of movement of the knee, common with some types of external fixation, was not seen.

We tried to quantify postoperative pain on the second day. Patients reported more pain after conventional SHS fixation than after PF fixation, and as a result PF patients began mobilisation slightly earlier.

Additional reported advantages of external fixation include the possibility of application under local anaesthesia for patients who have poor general health in whom other options are not available.\textsuperscript{6,8} Its closed application, without disturbing the fracture haematoma, can theoretically preserve the biological healing potential.\textsuperscript{15} The walking ability and accommodation before the fracture have a significant role in the final functional outcome. For many patients, however, the fracture has a profound impact, resulting in a reduction of their walking capacity and an increase in social dependency, irrespective of the method of fixation. Superficial pin-track infection remains the main complication of external fixation, but it is easily treatable and subsides promptly when the fixator is removed. Although a cost comparison was not among our objectives, an estimate based on the cost of implants and the daily cost of hospital treatment showed that external fixation was slightly cheaper. We believe, however, that the main hospital benefits of external fixation are due to the reduced theatre time and hospital stay.

Our results show that the PF is an effective and safe device for treating pertrochanteric fractures. Compared with the SHS, there is reduced operating time, surgical trauma, blood loss and length of hospitalisation. It should be considered as an alternative for elderly and frail patients, those with multiple injuries, those who refuse transfusion on religious grounds and possibly those with unstable, complex fractures which may not be adequately treated by internal fixation.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


