Bridge-Plating Osteosynthesis of 20 Comminuted Subtrochanteric Fractures with Dynamic Hip Screw

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Background: A prospective clinical trial was conducted to evaluate the conjunctive use of an extramedullary device and the bridge-plating technique in the treatment of comminuted subtrochanteric fractures with major extension into the femoral shaft.

Methods: A Winquist criteria was used to classify 3 fracture patterns. The type 3 fractures were excluded from this study because of great extent of the fracture zone for which the bridge-plating technique is not indicated. There were 14 men and 6 women, with a mean age of 49 (range, 17-76) years. A dynamic hip screw (DHS) with a long side plate was chosen as the fixation device because of the small learning curve.

Results: The fractures united at a mean of 7.6 (range, 3-15) months postoperatively. Mobility was scored at 9 points in 18 patients and 6 points in 2 patients (Mobility score of Parker & Palmer). Pain was absent in 14, mild in 3, and moderate in 3 patients. Two limbs were shortened by 1 and 1.5 cm, respectively.

Conclusion: Our results indicate that DHS fixation using the bridge-plating technique leads to union of all comminuted Winquist types 1 and 2 fractures without major complications, and it is a valuable alternative to new intramedullary devices. This procedure offers the significant advantage of being less technically demanding.

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Key words: **bridge-plating osteosynthesis, subtrochanteric fracture, dynamic hip screw.**

The subtrochanteric region extends from the upper border of the lesser trochanter to 5 cm distal to it.[1,2] This region is subjected to high compressive forces medially and tensile forces laterally, which can lead to fatigue failure of implants. It represents a transition zone from the cancellous bone of the trochanteric area to the cortical bone of the femoral shaft and is slow to heal when injured. The treatment of the comminuted fracture of the subtrochanteric region is problematic. Only a durable and long implant that is firmly anchored above and below the fracture region will allow early weight bearing.[3] The best treatment for such kind of fractures is biological indirect reduction and splinting by

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a new generation of intramedullary nails, yet it is technically demanding.[4-7]

The DHS (dynamic hip screw, Synthes, Basel, Switzerland) is widely used in the treatment of trochanteric fractures. It provides a firm upper anchorage with a 12.5 mm lag screw in the femoral head proximally and a long side plate (up to 260 mm in length) securely fixed in the femoral shaft distally. But it requires large exposures. The preservation of blood supply with untouched fragment might accelerate union. The treatment should aim at restoration of bone length, axial and torsional alignment. The fragments are not directly manipulated, and their soft tissue attachment is not disturbed; instead the area of comminution is bridged with a plate, which is fixed to the proximal and distal fragments.[8-13] A prospective clinical trial was conducted to evaluate the conjunctive use of the DHS and bridge-plating technique for the treatment of comminuted subtrochanteric fractures.

METHODS

Between January 1997 and September 1998, 20 patients with comminuted subtrochanteric fractures underwent bridge-plating osteosynthesis using DHS. All fractures were caused by high-velocity accidents. Sixteen patients were involved in motor-vehicle accidents, and 4 had fallen from a height. Eleven had multiple traumas. Eighteen fractures were closed, and 2 were open. The Winquist criteria was used to classify the fracture patterns: Type 1, true subtrochanteric fractures, with the proximal fragment intact to a level below the lesser trochanter; type 2, the greater trochanter and piriform fossa intact, but the lesser trochanter fractured; and type 3, the subtrochanteric fracture extending into the greater trochanter and piriform fossa, with or without loss of continuity of the lesser trochanter (Fig. 1).[14] Type 3 fractures were excluded from this study because of the great extent of the fracture zone for which the bridge-plating technique is not indicated. There were 14 men and 6 women with a mean age of 49 (range, 17-76) years in the present study.

The DHS entry site, and the proper length of the plate were judged from the radiographs of the opposite limb. Operations were carried out by the senior surgeon under general or spinal anesthesia. Traction was applied to the injured leg by a supracondylar

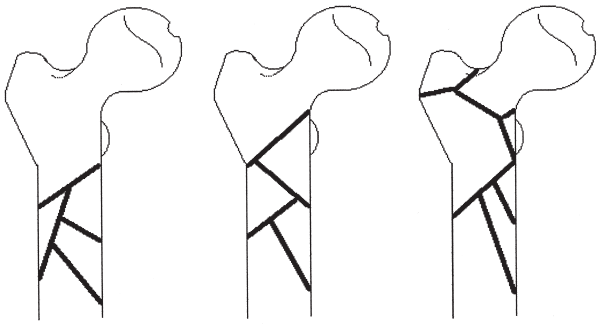

Fig. 1 Winquist classification of subtrochanteric fractures.

Kirschner wire, or by a padded holder on the foot. A padded perineal post was used for countertraction. The unaffected limb was placed in hip abduction and knee flexion. Closed reduction was performed under fluoroscopic guide. A lateral approach was used as described previously.[15] The vastus lateralis was mobilized from the linea aspera and reflected anteriorly, revealing only the lateral aspect of the proximal femur. Hoffman retractors were placed only on the proximal and distal main fragments and not in the area of comminution. The DHS with 135° side plate was mounted to the lag screw, tightened, and secured to the distal fragment with bone holding forceps. The fragments lying medially were indirectly reduced by overtraction and careful manipulation of the larger ones with the aim of bringing them close to the plate and fixing them by interfragment screws. Small fragments were left undisturbed. Axial alignment, rotation, and length were checked, and the plate was fixed by at least 3 screws. Regardless of the severity of comminution, no initial bone graft was used in any patient.

Postoperative management consisted of active exercise of the quadriceps and early ambulation unless associated with other injuries or the poor general conditions. Partial weight bearing (20-30 kg) was allowed as soon as the patient could tolerate it, and full weight bearing was begun after 3 to 6 months based on the degree of comminution of the fracture. Patients were evaluated at 4- to 8-week intervals until fracture union and at 3- to 6-month intervals thereafter. The operation time, blood loss, ambulation level, the union time, and complications were recorded.

The activities of daily living and level of pain were assessed 12 months after fractures. Walking ability was evaluated according to the criteria of Parker (Table 1).[16] Pain was scored as absent when no painkiller were used, mild when only occasional oral painkiller were used, moderate when they were used regularly, or severe when the pain was difficult to treat with oral painkillers or when narcotic analgesics were used regularly.

Table 1. Mobility Score of Parker and Palmer*

Walking ability	No difficulty	Alone with an assistive device	With help from another person	Not at all
Able to walk inside house	3	2	1	0
Able to walk outside house	3	2	1	0
Able to go shopping, to a restaurant, or to visit family	3	2	1	0

*The values are given as the number of points assigned for that answer.
The maximum possible score is 9 points.

RESULTS

Nine were Winquest type 1, and 11 type 2 fractures. Fourteen were operated on the day of admission or the next day. The median length of stay in hospital was 11 (range, 6-17) days. The operation time averaged 60 (range, 50-80) minutes, and blood loss 450 (range, 200-700) ml (Table 2).

Union was defined as callus formation at the fracture site, with the fracture line visible for less than a quarter of the circumference. All fractures united after a mean of 7.6 (range, 3-15) months without additional procedures (Fig. 2, 3). Two patients underwent implant removal because of hip pain after complete union. The patients started to have ambulation training at an average of 2.7 (range, 1-7) days

Table 2. The Demographic Data of the Fractures

Case	Gender	Age	Etiology	Type[b]	Open[c]	M[d]	Time[e]	U[f]	Score[g]	Pain	Complication
1	M	69	MVA[a]	1	-	-	4	6	6	absent	
2	M	72	Fall	2	-	-	7	9	9	moderate	infection[h]
3	F	17	MVA	2	-	+	1	6	9	absent	
4	M	46	Fall	2	-	-	2	6	9	mild	LLD[i]
5	F	62	MVA	2	+ (II)	+	1	6	9	absent	
6	M	34	MVA	1	-	+	3	3	9	absent	
7	M	56	MVA	2	-	-	1	9	9	mild	
8	F	73	MVA	2	-	-	4	12	9	moderate	
9	M	46	MVA	1	-	+	1	6	9	absent	
10	M	28	MVA	1	-	+	1	6	9	absent	
11	F	63	MVA	2	-	+	4	15	9	moderate	LLD
12	M	52	MVA	1	-	-	1	12	9	absent	
13	F	76	Fall	2	-	-	7	15	6	absent	
14	M	59	MVA	2	+ (II)	+	1	6	9	mild	infection
15	M	55	MVA	1	-	-	2	6	9	absent	
16	M	28	MVA	2	-	+	1	6	9	absent	
17	M	34	MVA	1	-	+	1	6	9	absent	
18	F	20	MVA	1	-	+	1	3	9	absent	
19	M	31	Fall	1	-	-	1	6	9	absent	
20	M	58	MVA	2	-	+	2	9	9	absent	

Abbreviations: M: male; F: female
a: Motor vehicle accident; b: Winquist classification of fracture type
c: Gustilo and Anderson classification; d: Multiple trauma;
e: Time to operation in days; f: Time to bone union in months;
g: Mobility score of Park and Palmer; h:Superficial wound infection
i: Leg length discrepancy

Fig. 2 Type 1 fracture (case 9) treated with a DHS using the bridge-plating technique. (A) Initial injury; (B) At 9 months.

Fig. 3 Type 2 fracture (case 16) treated with a DHS using the bridge-plating technique. (A) Initial injury; (B) At 6 months.

after surgery. Full weight bearing was delayed for 3 months in all patients. Mobility was scored as 9 points in 18 patients and 6 points in 2 patients 12 months after fractures. At the same time, pain was absent in 14, mild in 3, and moderate in 3 patients.

Two patients had superficial wound infection and were treated with parenteral antibiotics for 1 week. No additional surgery was performed in these 2 patients. There was no significant varus/valgus malunion but 2 limbs were shortened with by 1 and 1.5 cm respectively and no patient had significant rotational malalignment as determined by clinical examination.

DISCUSSION

In general, 7% to 20% of the proximal femur fracture occurred over the subtrochanteric region.[1,17-19] The treatment of the comminuted subtrochanteric fractures remains a challenge, and there are few reported.[5,20,21] No single treatment option has generally been accepted as the method of choice. There were high rates of delayed union, malunion, and implant failure.[1,22] Classification of these fractures based on therapeutic criteria has undergone modifications through the years.[23,24] The adapted classification system in the present study was developed for general fractures of the long bones. It entails the specific fracture anatomy included in the present study.

The advocated treatment for these fracture patterns is a locked nail for Winquist types 1 and 2 fractures and a dynamic condylar screw or angle blade plate with a long side plate for Winquist type 3 fractures.[23,25-28] Rigid intramedullary devices include the Zickle nail, Russell-Taylor reconstruction nail, and long Gamma nail. Advantages listed for these devices include their load-sharing capacity, decreased operative time, and the possibility of performing a closed reduction.[5,29-31] There are favorable results with intramedullary nailing in extensive proximal femoral fractures, but other experts have noted unacceptably high complication rates with this device. Disadvantages are technical difficulties, the requirement of an intact trochanteric mass, and trouble in controlling rotation and shortening.[6,7,17] Unreamed intramedullary nails have reduced but not eliminated cardiopulmonary complications.[15] Thus, there is still debate whether to nail femur fractures in patients in shock and concomitant chest trauma. It has been suggested that long bone fractures of these patients should be plated or stabilized with an external fixator.

The underlying premise of this study was to evaluate the use of a commonly available extramedullary device for comminuted and extensive subtrochanteric fractures, combined with the bridge- or so-called biological plating technique. The DHS was chosen because it is an easier and safer fixation procedure than the dynamic condylar screw and the angle blade plate. A DHS has been widely used in the treatment of stable peritrochanteric fractures and has been very successful. In contrast to the literature, this study demonstrates a more-expanded use of the DHS with a long side plate. In our experience, the DHS with a long side plate can be used for comminuted subtrochanteric fractures as distal as 20 cm below the lesser trochanter. Some of the problems that have been pointed out with the DHS in the treatment of highly unstable peritrochanteric fractures are worth considering and include the basic problems of lag screw cutout, varus angulation, limb shortening, and femoral shaft medialization. These problems did not occur in our series partially due to delayed full weight bearing for at least 3 months after operation in our patients. In our series, trochanteric fractures with subtrochanteric extension (Winquist type 3 fractures) were treated with a modified trochanteric stabilizing plate and were excluded from this study. In agreement with the majority of the current literature, medial cortex reconstruction and initial bone grafting were not performed in our patients. It appears from this study that better results are achieved by preservation of medial soft tissue, and that a bone graft is unnecessary in comminuted fractures treated with the bridge-plating technique.[1,10] The essence of the concept of bridge plating introduced by Perren is an indirect reduction technique, and the philosophy emphasizes maximal exploitation of implants and reduction tools to avoid unnecessary intraoperative soft-tissue stripping and to achieve stable and satisfactory (although not necessarily anatomic) reduction.[1,10] This is in some contrast to the previous concept of rigid internal fixation of metaphyseal and diaphyseal fractures. Although not all series give details of all scored items, the results in the present

study are quite comparable with those using the new intramedullary devices reported in the literature.[20,21,32]

In conclusion, our findings indicate that DHS fixation using the bridge-plating technique leads to union of all comminuted Winquist types 1 and 2 fractures without major complications, and that it is a valuable alternative to new intramedullary devices. This procedure offers significant advantages of being less technically demanding and more cost effective. The absence of ununited fractures and implant fatigue failure indicates the direct benefits of the bridge-plating technique, and it is comparable with new intramedullary nailing.

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以架橋式鋼板固定法治療20例粉碎性股骨轉子下股骨幹骨折

李柏成　于尚文　謝邦鑫[1]　蘇君毅　陳永仁

背 景： 廣泛性股骨轉子下骨折的手術目前難度仍高，而且尚未有公認的單一治療方法。本研究選擇一種常用之鋼板合併架橋式固定法來治療這類複雜性高的骨折。

方 法： 廣泛性股骨轉子下骨折可用Winquist分類法分成三種不同骨折型態，其中第三型骨折因斷位高而無法使用架橋式鋼板固定法，所以並不包括在本研究中。這20例骨折病人中，包含14位男性及6位女性，平均年齡爲49歲。我們選擇DHS固定器的原因是它已被廣泛使用，而且手術技術上較爲簡便。

結 果： 所有骨折平均七點六個月癒合。活動指數方面：有18例爲9分，2例爲6分。疼痛方面：有14例無疼痛，3例爲輕度，3例爲中度。有2例患肢分別短少1公分及1.5公分。

結 論： 使用DHS固定器合併架橋式鋼板固定法可使所有Winquist第一型及第二型骨折癒合而無顯著之併發症，所以這是除了新式骨髓腔內骨釘固定法外的另一種治療選擇，這種方法的主要好處是較少的技術性需求。我們的臨床結果令人滿意，其結果與新式骨髓腔內骨釘固定法的文獻報告相當。

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關鍵字： 架橋式鋼板固定，股骨轉子下骨折，動態型股螺釘。

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