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Cemented Internal Fixation for Supracondylar Femur Fractures in Osteoporotic Patients

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Summary: Seventeen, supracondylar femur fractures in 15 severely osteoporotic patients (average age, 81.9 years) were treated with a 95° supracondylar plate and dynamic compression screw supplemented with intramedullary methyl methacrylate and massive cancellous bone graft harvested from the distal femoral metaphysis. Interfragmentary compression and rigid fracture fixation was obtained in all cases with the use of the A-O compression device. Patients were allowed early protected weight bearing without external immobilization. At follow-up observation (average, 2.1 years), bony union was noted in all cases, and knee flexion averaged 100.4°. There were no malunions or cases of implant failure. Complications included two early postoperative deaths and three femur fractures above the plate. This technique was effective in rapidly restoring patient mobility while avoiding the complications of implant failure. **Key Words:** Intramedullary methyl methacrylate—Interfragmentary compression—Cancellous bone grafting—Early weight bearing.

The modern concept of the treatment of long bone fractures in the elderly patient is relatively standardized, particularly with regard to fractures of the lower extremity. Because of the negative physiologic effect of prolonged bed rest in patients over 65, treatment methods have gradually progressed to stabilization of fractures in these patients to permit early mobilization and perhaps ambulation. Nowhere is this concept better illustrated than in the patient with a hip fracture. Early mobilization has markedly decreased the incidence of bronchopneumonia, genitourinary infection, decubitus ulcers, phlebitis, etc (18). Although femoral shaft fracture is less commonly seen in the elderly patient, several methods of internal fixation are available that allow early mobilization and weight bearing. The Küntscher rod, the Grosse-Kempf interlocking nail, and the Zickel rod for subtrochanteric fractures are all employed to achieve this purpose.

However, the supracondylar fracture in the elderly patient with osteoporotic bone remains a challenge for the orthopaedic surgeon. Supracondylar fractures make up 4% of all femoral fractures (11). Eighty-five percent of these are in patients over the age of 50 years (11). The widened canal of the supracondylar area with thin cortices and poor bone stock has frustrated attempts of surgeons to employ either intramedullary rods or screws and plates for the purpose of stabilizing the fractures sufficiently to permit early mobilization and ambulation (11). Comminution of the fracture and extension of the fracture into the knee joint add to the difficulty.

We became interested in this problem with the aim of achieving the following goals: to devise an operation that would be applicable to all supra-

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condylar and intercondylar fractures in osteoporotic bone, to achieve functional reduction and rigid immobilization with anatomic reduction of the joint, to permit early mobilization with partial weight bearing on the affected side, and to accomplish early osseous union of the fracture.

MATERIALS AND METHODS

Fifteen patients with 17 supracondylar fractures were treated with the technique of cemented internal fixation as described later. Two patients had bilateral fractures. All patients had radiographic evidence of osteoporosis. All patients were over the age of 70 at the time of surgery with the exception of a 58-year-old woman with rheumatoid arthritis. There were 14 women and one man. The average age at operation was 81.9 years (range, 57–92). Twelve patients were ambulators prior to surgery, and three patients were considered nonambulators. Fractures that were undisplaced or impacted were treated with plaster fixation and were excluded from this study. All other supracondylar and intercondylar fractures were treated surgically. Eight fractures were of the T-intercondylar type, extending into the knee joint. The other nine were extra-articular supracondylar fractures. Three were displaced, and six were displaced and comminuted.

Five patients (33%) had previous surgery on the involved side. Two had a previous total knee replacement, two had a previous total hip arthroplasty, and one had a previous hip screw for an intertrochanteric hip fracture.

SURGICAL TECHNIQUE

The operation is done with the patient supine on a routine operating table that can accommodate image intensification. No tourniquet is used. A lateral incision is made over the distal third of the femur curving anteriorly in the distal portion to end 1 cm lateral to the tibial tubercle. The fascia lata is incised, the intermuscular septum is isolated, and the vastus lateralis is retracted anteriorly in its distal third. At the lateral epicondyle, the retinaculum and synovium are incised and the knee joint is entered for management of the intercondylar fracture (Fig. 1). The intercondylar fracture is cleaned, irrigated, and reduced under direct vision and held with one or two 6.5-mm cancellous lag screws. A guide pin is then placed transversely across the reconstituted condylar portion about 1 cm proximal to the intercondylar notch. Fluoroscopic control establishes correct position and depth of the guide pin, which is then measured. A dynamic compression screw of sufficient length to reach the medial femoral cortex is then placed over the guide pin. The proximal end of the distal portion of the fracture is then exposed, and with a curette all cancellous bone is removed from the condyles and saved for later bone graft.

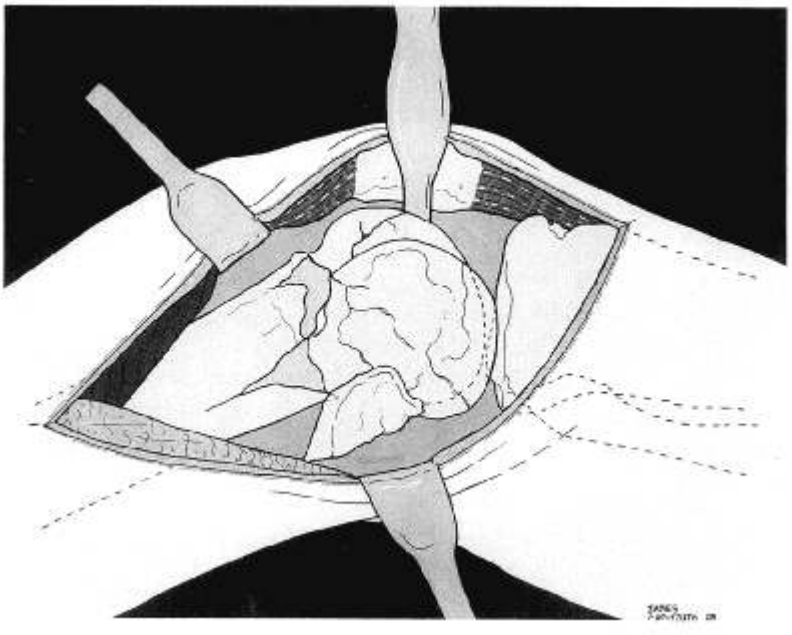

FIG. 1. Diagram of exposure of fracture.

The transfixation screws are then seen within the empty shell. A 95° supracondylar plate of sufficient length to allow at least four holes in the proximal fragment is then placed over the dynamic compression screw and held with a plate-compressing screw. Methyl methacrylate in a doughy state fills the distal fragment and surrounds all exposed portions of the screws present within. Care is taken to exclude cement from the fracture surfaces.

Next, the proximal tube is approached. Any remaining cancellous bone from the medullary canal is removed and saved. A cement restrictor is placed to a level in the proximal femoral canal above the proposed upper end of the plate. All major comminuted fragments are replaced and held loosely with either cortical position screws or circlage wire. The canal is filled with relatively liquid acrylic cement, again taking care to exclude cement from all fracture surfaces. The cement is allowed to fully harden, and reduction is accomplished. The side plate is rotated into position along the proximal shaft, and the A-O compression device is used to obtain maximal compression at the fracture site. The cement in both fragments prevents overcompression and provides absolute rigid fixation. Two 4.5-mm cortical screws are placed through the distal two holes, without overdrilling, into the cement-filled distal fragment for additional fixation. All of the proximal screw holes are filled, after drilling and tapping, with 4.5-mm cortical screws of proper length. The compression device is then removed. The final step of the operation is placement of the copious cancellous bone graft about the fracture site (Fig. 2).

A suction drain is placed down to the fracture site. The wound is irrigated, all bleeding is controlled, and the wound is closed in layers. Final radiographs are taken in the operating room. A compression dressing is applied. The patient is placed in a continuous passive motion machine on the day of surgery beginning with 0° of extension to 15° of flexion. On the 2nd day, all drains are removed, and the patient is out of bed into a chair. Partial weight bearing to tolerance with external support is started on the 3rd postoperative day.

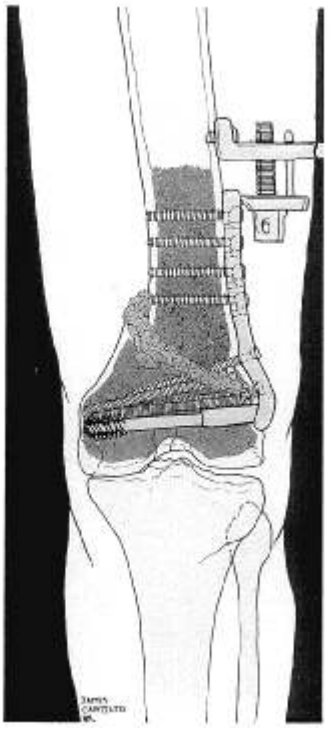

FIG. 2. Diagram of compression fixation with bone graft.

FOLLOW-UP OBSERVATION

Of the initial group of 15 patients, two died in the immediate postoperative period, and one died from unrelated causes 6 months postoperatively. All of the remaining 12 patients (14 cases) were contacted and were available for physical examination and radiographs. The average length of follow-up time was 2.1 years (range, 15–43 months). Of those surviving patients who were ambulatory prefracture, all save one had remained ambulatory at follow-up study. Both patients with bilateral fractures remained ambulatory at follow-up study. Most used some type of external support (cane or walker) while ambulating. Two patients reported mild pain in the area of the supracondylar plate. The other 10 patients were pain free. The average range of knee motion was 100.4°. One patient had a 15° flexion contracture. All of the other knees came to full extension. Radiographs at follow-up examination showed fracture healing in all cases with no evidence of either nonunion or malunion. Incorporation of bone graft was evident in most cases (Fig. 3). All three femur fractures that occurred above the plate were well healed with abundant callus formation after open reduction and internal fixation with a DC plate.

Overall results were evaluated using a modification of the criteria of Neer et al. (Table 1) (9). All patients were graded on a 90-point scale since the category of work was eliminated because it did not

FIG. 3. Five-month postoperative follow-up x-ray film of left supracondylar fracture in a 79-year-old patient with bilateral fractures.

apply to our patient population. All scores were then converted to a 100-point scale.

Using these criteria, excellent or satisfactory results were obtained in 11 of 14 cases (79%). This included excellent results in seven and satisfactory results in four. Three cases were considered unsatisfactory (21%). Two of the three unsatisfactory results occurred in patients who sustained femoral shaft fractures above the plate, which were subsequently successfully treated. The third unsatisfactory result occurred in the patient with a previous ipsilateral total knee replacement. Secure fracture fixation in this patient required 2 cm of femoral shortening that resulted in ligamentous laxity, thus requiring a knee brace for stability in ambulation. There were no failures.

COMPLICATIONS

There were two deaths in the immediate postoperative period. Both occurred in patients over 90 years old (Table 2). One patient died from mesenteric artery thrombrosis 3 days postoperatively. The other death was in a 92-year-old patient with multiple medical problems who died 5 days postoperatively as a result of bilobar pneumonia.

Three patients sustained femur fractures above the supracondylar plate. One fracture occurred 3 months postoperatively in a patient who was otherwise doing well and fell at home on her knee. The other two fractures occurred in the 1st postoperative month. One patient who had a previous 135° hip screw device twisted her leg in a bed rail, sustaining a spiral midshaft femur fracture between the two plates (Fig. 4). The third patient, who had had a previous total knee replacement, had a fracture above her plate from undetermined causes while at home. The first two patients were treated for their femur fractures with open reduction and internal fixation with a dynamic compression plate (Fig. 5). The third patient sought treatment elsewhere and was unavailable for follow-up observation.

DISCUSSION

Prior to the advent of modern techniques of internal fixation, nonoperative treatment for all supracondylar femur fractures was recommended (9,16). The large study of Neer et al. in 1967 demonstrated that treatment with traction and/or plaster resulted in satisfactory results in most cases. Attempts at internal fixation resulted in many complications (infection, nonunion, stiffness) and an overall poor outcome. Patients with displaced T-intercondylar fractures, however, did poorly with both nonoperative and operative treatment (9).

Despite this pessimistic view, succeeding authors have advocated internal fixation using a variety of devices and techniques (2–10,12–15,17). Most authors have used either A-O blade plates or, most recently, A-O condylar screws and side plates. Satisfactory results have been obtained in 80–90% of patients, and knee motion is generally excellent. Poor results were generally attributed to inadequate fracture fixation. Schatzker and Lambert in 1979 underscored this problem (13). They showed that when the principles of rigid internal fixation were strictly adhered to results were good in 75% of patients, while only 21% of patients had satisfactory results when these principles were violated. Common errors leading to poor fixation remain inadequate reduction, failure to compress fracture fragments, failure to use bone graft, improper use of methyl methacrylate, and technical difficulties encountered with the use of the blade plate. It is likely

TABLE 1. *Criteria for evaluation of results*[a]

Functional (60 units)	Unit value	Anatomic (30 units)	Unit value
Pain (20 units)		Gross anatomy (15 units)	
no pain	20	thickening only	15
intermittent or in bad weather	16	5° angulation or 0.5 cm short	12
with fatigue	12	10° angulation or rotation, 2.0 cm short	9
restricting function	8	15° angulation or rotation, 3.0 cm short	6
constant or at night	4–0	union but with greater deformity	3
Function (20 units)		nonunion or chronic infection	0
as before injury	20	Roentgenogram (15 units)	
mild restriction	16	near normal	15
restricted; stairs sideways	12	5° angulation or 0.5 cm displacement	12
cane or severe restriction	8	10° angulation or 1.0 cm displacement	9
crutches or brace	4–0	15° angulation or 2.0 cm displacement	6
Motion (20 units)		union but with greater deformity; spreading of condyles; osteoarthritis	3
normal or 135°	20	nonunion or chronic infection	0
100°	16		
80°	12		
60°	8		
40°	4		
20° or less	0		

[a] Excellent, above 85 units; satisfactory, 70 units; unsatisfactory, 55 units; failure, below 55 units (based on converting numbers to a 100-point scale).

that many of these problems were present in the poor results from internal fixation in the early studies.

The elderly patient with a fracture in osteoporotic bone continues to be a problem because of the difficulty in obtaining rigid fixation (Fig. 6). Indeed, most such series show a high complication rate in these patients (9). Both the poor holding power of the osteoporotic bone and the extensive comminution frequently present have frustrated attempts to achieve rigid internal fixation. Implant loosening has been common, and many authors have used postoperative cast bracing to prevent overt failure of the device (13). In the series of Schatzker and

TABLE 2. *Patient data*

Patient	Age, yr	Prefracture ambulatory status	Fracture type	Postoperative ambulatory status	Range of motion	Pain	Complications	Length of follow-up time, yr	Postoperative Neer score
1 (R)	79	Independent	T-intercondylar	Independent	105°	None	None	3.7	95
(L)			Supracondylar comminuted		105°	None	None	3.7	95
2	77	Cane	Supracondylar comminuted	Nonambulatory	85°	None	Fracture above plate	2.8	68
3	85	Nonambulatory	Supracondylar comminuted	Nonambulatory	95°	None	None	2.0	91
4	79	Independent	Supracondylar comminuted	Walker	70°	Moderate	Fracture above plate	2.0	60
5	84	Nonambulatory	T-intercondylar	—	—	—	None	Died 6 mo postoperatively	—
6	92	Cane	Supracondylar	—	—	—	Death	—	—
7	81	Independent	T-intercondylar	Cane	120°	Mild	None	2.2	80
8	91	Independent	Supracondylar	Independent	90°	None	None	2.2	95
9	91	Nonambulatory	Supracondylar comminuted	Nonambulatory	70°	None	None	1.75	80
10	57	Independent	Supracondylar comminuted	Independent with knee brace	90°	None	Knee instability	1.6	67
11 (R)	90	Independent	T-intercondylar	Walker	135°	None	Fracture above plate	1.3	87
(L)			T-intercondylar		120°	None	None	1.3	80
12	72	Independent	T-intercondylar	Cane	90°	None	None	1.3	78
13	90	Independent	Supracondylar	—	—	—	Death	—	78
14	80	Independent	Supracondylar	Cane	120°	None	None	2.2	91
15	80	Independent	T-intercondylar	Independent	110°	None	None	1.4	95

FIG. 4. X-ray film of a 90-year-old patient with previous 135° hip screw device who, on the 3rd postoperative day, caught her right leg in the bed rail and sustained a fracture at the upper end of the supracondylar plate.

FIG. 6. Preoperative x-ray film in the patient whose final result is seen in Fig. 5.

Lambert, the goal of rigid anatomic fixation could only be achieved in three of 12 elderly patients with osteoporotic bone. Complications of loose and broken blade plates were seen in these patients (13).

FIG. 5. X-ray film of surgery performed to correct the fracture seen in Fig. 4.

Because of the technical difficulties, he suggested that nonoperative treatment may ultimately be best, as some cases were clearly beyond the surgeon's ability (13).

More recently, intramedullary devices have been advocated specifically for elderly patients with osteoporotic bone (6,7,15,17). The most well known of these is the Zickel supracondylar rod. These devices function as internal splints and are not appliances that offer rigid fracture fixation. Although union is usually achieved, significant shortening may occur, and most patients require adjunctive cast or brace treatment and a prolonged period of non–weight bearing postoperatively. The use of these devices is generally limited to extra-articular or nondisplaced intra-articular fractures (6).

Benum in 1977 approached the problem of fracture fixation in the elderly osteoporotic patient by using the ASIF supracondylar blade plate in conjunction with intramedullary methyl methacrylate (1). All of his cases were extra-articular supracondylar fractures, and bone graft was not used. Benum reported no cases of implant failure, and he reported union in 13 of 14 cases. There was no radiologic evidence of callus formation, however, and he depended on disappearance of the fracture lines

to determine the presence of union. He also did not report the range of postoperative knee motion.

The technique employed in our series is, in effect, a modification of the technique of Benum but offers several advantages. With our technique, it was possible to achieve all of the principles of anatomic reduction and rigid internal fixation in all 17 cases. We successfully avoided all of the common causes of inadequate fixation as described by Schatzker and Lambert. The use of methyl methacrylate provided excellent anchorage for A-O cortical screws. We thus obtained rigid fracture fixation and developed axial compression without risking implant failure in otherwise soft osteoporotic bone. Because of the rigidity of the fixation, external support was not required. In addition, it was possible to begin early range of motion as well as partial weight bearing. The use of bone graft, conveniently obtained from the femoral metaphysis, was helpful in encouraging early osseous union and restoring bone mass to the comminuted fracture site (Fig. 3).

Femoral shaft fractures at the proximal end of the plate were a problem in three of 14 cases. In two of the three cases, other significant factors were present. In one case the patient fell on her knee, causing fracture. In the other case, a supracondylar plate was placed adjacent to a side plate from a previous hip screw, resulting in a stress riser at the site. The potential problem of femoral shaft fracture was anticipated, and an additional anterior spanning plate was used to improve torque control. However, the anterior plate size as well as its fixation were inadequate, and fracture occurred between the two side plates (3).

CONCLUSION

Elderly patients with supracondylar femur fractures benefit greatly from treatment, which provides early mobilization and early weight bearing. However, as with younger patients, rigid anatomic fixation is required to prevent implant failure and nonunion. Our technique is applicable to all osteoporotic patients with either supracondylar or intercondylar femur fractures. The use of methyl methacrylate provides excellent fixation of hardware and permits the use of standard A-O principles. The objectives of achieving early mobilization and weight bearing, avoiding casts and braces, and providing radiographic evidence of osseous union are satisfactorily met.

REFERENCES

1. Benum P: The use of bone cement as an adjunct to internal fixation of supracondylar fractures of osteoporotic femurs. *Acta Orthop Scand* 48:52–56, 1977
2. Brown A, D'Arcy JD: Internal fixation for supracondylar fractures of the femur in the elderly patient. *J Bone Joint Surg* 53B:420, 1971
3. Giles JB, Delee JC, Heckman JD, Keever JE: Intercondylar fractures of the femur treated with a supracondylar plate and lag screw. *J Bone Joint Surg* 64:864–870, 1982
4. Hall MF: Two-plane fixation of acute supracondylar and intercondylar fractures of the femur. *South Med J* 71:1474, 1978
5. Healy WL, Brooker AF: Distal femoral fractures: comparison of open and closed methods of treatment. *Clin Orthop* 174:166, 1983
6. Joseph FR: Evaluation of the Zickel supracondylar fixation. *Clin Orthop* 192:190, 1982
7. Kolmert L, Egund N, Pearson BM: Internal fixation of supracondylar and bicondylar fractures using a new semielastic device. *Clin Orthop* 181:204, 1983
8. Mize RD, Bucholz RW, Grogan DP: Surgical treatment of displaced, comminuted fractures of the distal end of the femur. *J Bone Joint Surg* 64:871–879, 1982
9. Neer CS III, Grantham SA, Shelton ML: Supracondylar fracture of the adult femur. A study of one hundred and ten cases. *J Bone Joint Surg* 49:591–613, 1967
10. Olerud S: Operative treatments of supracondylar–condylar fractures of femur. *J Bone Joint Surg* 54A:1015, 1972
11. Pritchett JW: Supracondylar fractures of the femur. *Clin Orthop* 184:173, 1984
12. Riggins RS, Garrick JG, Lipscomb PR: Supracondylar fractures of the femur. A survey of treatment. *Clin Orthop* 82:32, 1972
13. Schatzker J, Lambert DC: Supracondylar fractures of the femur. *Clin Orthop* 138:77, 1979
14. Seinsheimmer F: Fractures of the distal femur. *Clin Orthop* 153:169, 1980
15. Shelbourne KD, Brueckman FR: Rush-pin fixation of supracondylar and intercondylar fractures of the femur. *J Bone Joint Surg* 64A:161, 1982
16. Stewart MJ, Sisk TD, Wallace SL: Fractures of the distal third of the femur. *J Bone Joint Surg* 48A:784, 1966
17. Zickel RE, Fietti VG Jr, Lawsing JF III, Cochran GVB: A new intramedullary fixation device for the distal third of the femur. *Clin Orthop* 125:185, 1977
18. Zickel RE: Fractures of the adult femur excluding the femoral head and neck: a review and evaluation of current therapy. *Clin Orthop* 147:93, 1980