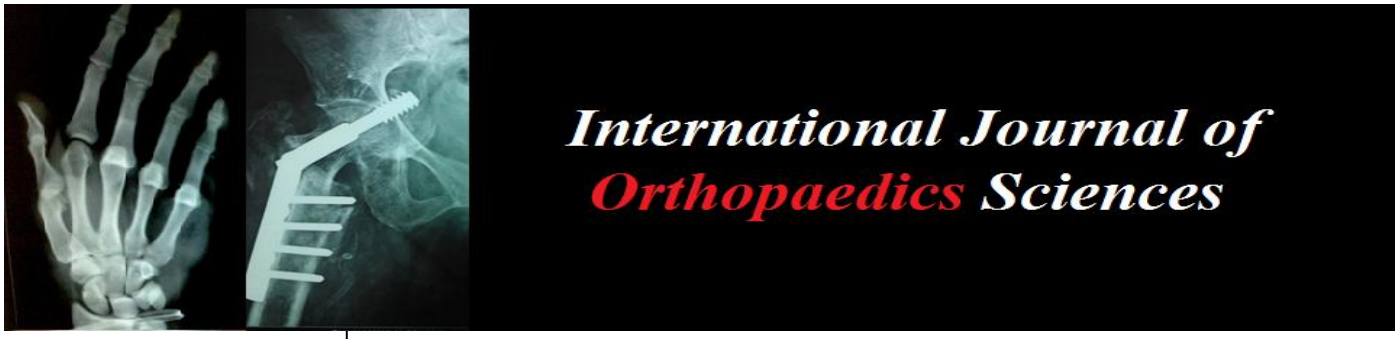

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Dr. Raju KP
MS Ortho, Associate Professor, Orthopaedics BGS Global Institute of Medical Sciences, Bangalore, Karnataka, India

Dr. Madhuchandra P
MS Ortho, Assistant Professor, Orthopaedics BGS Global Institute of Medical Sciences Bangalore, Karnataka, India

Dr. Pawankumar KM
DNB Ortho, Assistant Professor, Orthopaedics BGS Global Institute of Medical Sciences, Bangalore, Karnataka, India

Dr. Shrinidhi IS
D. Ortho. DNB Ortho, Senior Resident, Orthopaedics BGS Global Institute of Medical Sciences, Bangalore, Karnataka, India

Correspondence
Dr. Madhuchandra P
MS Ortho, Assistant Professor, Orthopaedics BGS Global Institute of Medical Sciences Bangalore, Karnataka, India

Functional outcome of type a and type c supracondylar fractures of femur treated by retrograde intramedullary nailing technique

Dr. Raju KP, Dr. Madhuchandra P, Dr. Pawankumar KM and Dr. Shrinidhi IS

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Abstract
Background: Distal femoral fractures historically have been difficult to treat. Because of the proximity to the knee joint, regaining full knee motion and function is difficult. Controversy remains regarding the optimum device among various fixation devices available for distal femoral fixation. Retrograde nailing has shown to be the optimal device for this fracture. Hence this study was conducted to analyze the functional outcome Muller's type A and C distal femoral fractures treated with retrograde intramedullary nailing.
Materials and methods: The study was conducted in a tertiary referral institute between January 2010 to December 2015. This study was conducted in a retrospective and prospective manner. Retrograde nailing was performed on a total of 43 patients presenting with supracondylar and intra condylar fractures of distal femur. Cases were followed up till December 2016. 3 of our patient lost to follow up. Outcome was assessed by using Neer's scoring system.
Results: All patients were followed up for an average of 15 months. There were 30 type A and 10 type C AO fractures. All the fractures eventually healed with an average time to union of 15 weeks. Using Neer's scoring system there were 22(55%) excellent, 12(30%) good, 4(10%) fair and 2(5%) poor results.
Conclusion: Retrograde nailing makes biological osteosynthesis of distal femoral fractures with less Periosteal stripping, less blood loss, lesser need for none grafting, decreased operative time and very low late varus collapse rates.

Keywords: Retrograde nailing, Distal femur fractures, Neer's scoring

1. Introduction
Distal femoral fractures account for 7% of all femoral fractures [1]. Supracondylar and intra condylar fractures of the femur are very difficult to manage. These fractures invariably present with lot of comminution, many a times with open injuries and bone loss. Many a times they will be floating injuries with associated proximal tibial fractures. Since these fractures involve or close to knee joint, regaining complete knee range of movement is also difficult. Distal femoral fractures are also associated with high incidences of infection, non union and malunion and hence produce significant disability [2]. These fractures are commonly seen in high energy injuries and also in elderly population. Its always a great challenge for the treating orthopaedic surgeon to manage these fractures. Many factors come in to play when it comes to plan the treatment of these fractures, such as fracture type, associated injuries, age and soft tissue injuries [3]. Prior to 1970s most of the supracondylar fractures were treated non operatively. As per literature, results of non operative treatment were only better than surgical treatment during these days [4, 5]. After the arrival of AO group, results of surgical treatment drastically improved owing to improved techniques [6-8]. Till late 90s osteosynthesis with plate fixation was the choice. Although early mobilization was an advantage, iatrogenic soft tissue trauma, periosteal stripping and stress on implant lead to non unions, implant failures, infections and pseudoarthrosis. Rigid fixation is difficult to achieve in elderly osteoporotic individuals. To counter these disadvantages, retrograde supracondylar nailing technique was developed in 90s [9].

Supracondylar nailing gives biomechanical advantages over plates because of its intramedullary location with more load sharing and also soft tissue stripping and periosteal injury is less. We have analyzed the functional outcome of retrograde nailing in Muller's type A and type C [10] supracondylar fractures of distal femur through this study.

2. Materials and methods

The study was conducted in a tertiary referral institute between January 2010 to December 2015. This study was conducted in a retrospective and prospective manner. Retrograde nailing was performed on a total of 43 patients presenting with supracondylar and intra condylar fractures of distal femur. Cases were followed up till December 2016. 3 of our patient lost to follow up.

Muller's type A and type C fractures, up to Gustilo and Anderson [11] type III B were included in the study. Muller's type B fractures, Gustilo and Anderson's type IIIC fractures, fractures presenting 12 hours after injury, fractures in pediatric age in group in whom growth plates were still open, pathological fractures and those who lost to follow-up were excluded from the study.

Once the patients were admitted, they were carefully examined and all associated fractures and co morbidities were recorded. All details were recorded in the case sheets. Radiographic evaluation was done and fracture pattern were classified and planned for surgery as per requirement. Computed tomographic scans were obtained whenever articular involvement was there. Limb was immobilized till the surgery. After thorough pre op evaluation, patients were taken up for surgery. In case of compound fractures, patients were taken up for surgery within 3 hours of hospitalization, emergency wound debridement, irrigation and definitive fixation was done. Multiple surgeons have performed the surgeries in our study. The average interval between the injury and surgery varied from several hours to twelve days (mean 4 days). Any delay in surgery was attributable to polytrauma or medical condition of the patients. All fractures were fixed by retrograde intramedullary nailing; appropriate nail length was assessed clinically and radiographically. Knee was positioned in 50-70 degree of flexion in order to get a proper entry point. Standard midline patellar tendon splitting approach(Figure 1) was used in all cases and in type C fractures joint was visualized and articular fragments were reduced first and fixed with 2 6.5mm Cannulated screws, one anteriorly and one posteriorly with of 14mm apart, so that they should not hinder while passing the nail. Wound was closed in two layers and compression dressing was applied. Static quadriceps exercises were started from day 1, and knee range of motion exercises were started from day 3, after change of dressing in all cases. Non weight bearing walking with walker support and gait training with parallel bar technique was started from day 5. All patients were discharged from the hospital after suture removal on day 14.

Fig 1: Midline patellar tendon splitting approach

Patients were followed up regularly afterwards on 6th, 12th and 20th weeks. After that patients were followed up every 3 months till fracture union. At each follow up, patients were assessed for knee range of motion, fracture union by clinical and radiological methods. All data was recorded in case sheets. Neer's criteria were used for evaluation of results (Table 1). In retrospective group, data was gathered from hospital data and case sheets and clinically assessed by recalling the patients for follow up. Out of 43 patients, 3 patients were lost to follow up due to reasons unknown. We have analyzed the functional outcome of 40 patients.

Table 1: Neer's criteria for evaluation of results

Functional (70 units)	Unit value	Anatomical (30 units)	Unit value
Pain (20 units)			
5. No pain	20		
4. intermittent or bad	16		
3. with fatigue	12		
2. restrict function	8		
1-0. constant or at night	4-0		
Function (20 units)			
5. as before injury	20		
4. mild restriction	16		
3. restricted stairs sideways	12		
2. cane or severe restriction	8		
1-0. crutches or brace	4-0		
Motion (20 units)			
5. normal or 135 degree	20		
4. 100 degree	16		
3. 80 degree	12		
2. 60 degree	8		
1. 40 degree	4		
0. 20 degree	0		
Work (10 units)			
5. as before injury	10		
4. regular but with handicap	8		
		Gross anatomy (15 units)	
		0. Non union or chronic infection	0
		1. Union but with greater deformity	3
		2. 15 degree angulation or rotation, 3cm short	6
		3. 10 degree angulation or rotation, 2cm short	9
		4. 5 degree angulation or rotation or 0.5cm short	12
		5. Thickening only	15
		Roentgenogram (15 units)	
		0. Non union	0
		1. Union but with greater deformity, arthritis	3
		2. 15 degree angulation or 2cm displacement	6
		3. 10 degree angulation or 1cm displacement	9
		4. 5 degree angulation or 0.5 cm displacement	12
		5. Near normal	15

3. after work	6		
2. light work	4		
1-0. no work	2-0		

3. Results and analysis:

The study included a total of 40 patients of supracondylar fractures of femur, conducted in a tertiary referral institute between January 2010 to December 2015. Following observations were made from our study.

Average age of the patients is 42 years with a range from 24 to 60 years. Majority of the patients were in the age group of 30-50 years. Male patients were aged between 24 to 54 years with an average of 40 years. Female patients were aged between 40 to 60 years with an average of 51 years (Table-2). Out of the 40 patients, there were 32 male patients accounting for 80% of the patients and 8 female patients making up for the remaining 20% of the patients.

Table 2: Showing age distribution of patients.

Age group (in years)	No. of patients	Percentage
20-30	6	15
30-40	14	35
40-50	8	20
50-60	12	30

Right side was involved more commonly, in 26 patients among all accounting for 65% of all fractures and left side was involved in rest of the 14(35%) patients. None of our patients had bilateral fractures.

Majority of the fractures were caused due to high energy trauma such as road traffic accidents. 32 cases were due to road traffic accidents accounting for 80% of the total cases. Remaining 20% were a result of trivial trauma such as simple falls.

12 fractures were compound fractures, accounting for 30%. Of these, 8 were Gustilo type II (67%) and 4 were Gustilo type III (33%). Based on Muller's classification system, extra articular i.e., type A fractures constituted 75% (30 patients) and 25% (10) were intra articular C1 and C2 fractures (Table -3).

Table 3: Type of fractures based on Muller's classification system.

Subtype	No. of patients	Percentage
A1	12	30
A2	12	30
A3	06	15
C1	08	20
C2	02	05

In 8 cases (20%), the duration of surgery was less than 1 hour, in 24 cases (60%) the duration of surgery was 1 to 1.5 hours and in 8 cases it was 1.5 to 2 hours. Operative time averaged 67 minutes for all fractures, 60 min for extra articular fractures and 86 min for intra articular fractures. It was observed that the operative time was more during the initial learning curve and came down with experience.

In 32 (80%) cases, blood was less than 500ml and in 6 (15%) it was between 500 to 1000ml. And in 2 cases it was more than 1000ml. Average blood loss was 210ml for fractures in which closed reduction was achieved and 890 ml for the fractures that required open reduction. Two patients needed blood transfusion.

Out of 43 patients, 3 patients were lost to follow up and all the remaining cases were followed up for an average of 14.6 months (ranging from 5 to 24 months). All the fractures united eventually. Average time to fracture union was 15.5 weeks (ranging from 12 to 20 weeks). There were no delayed unions. There were no non unions. There were 4 cases of malunion. Two of the patients required bone grafting. In other words, there were no fracture union related complications.

Average range of motion was 103 degrees. The final range of motion attained in type A fractures averaged 19 degrees when compared with type C fractures, which was 79 degrees. The average range of motion attained in closed fractures was 110 degree and that in open fractures was 102 degrees. The average range of movement where closed reduction was obtained was 115 degrees and 75 degrees in cases which required open reduction. Average range of motion in patients younger than 50 years was 120 degrees where as it was 92 degrees in patients aged more than 50 years.

We had our share of complications which included anterior knee pain in 8 patients, shortening (1-2cm) in 6 patients and one patient had nail breakage due to early weight bearing ambulation. There were no superficial or deep infections in our study. There were no cases of heterotropic ossification.

We used Neer's 100-point rating scale to evaluate the functional results. It emphasizes on pain, restriction of activity, range of motion, work capacity as compared to pre injury functional status, gross anatomical malalignment and radiological evaluation for union and alignment. Neer's score was assigned for each patient. Using this rating scale, there were 22(55%) excellent results (Fig 2), 12(30%) god results, 4(10%) fair result and 2(5%) poor result (Table 4). On further critical analysis, it was found that type A fractures had 94% good to excellent results with an average range of motion of 119 degrees as compared to type C fractures, which had 60% good to excellent results with an average range of motion of 79 degrees. It was observed that 93% of the closed fractures had a good to excellent results with an average range of motion of 110 degrees and 67% of open fractures had good to excellent results with an average range of motion of 102 degrees.

2A: Pre operative x ray

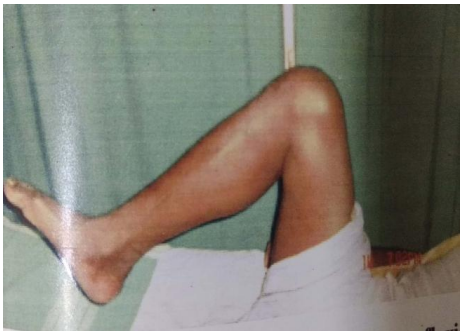
2B: Immediate post op x ray

2C: 6 Weeks post op x ray

2D: 12 Weeks post op x ray

2E: Active knee extension

2F: Active knee flexion



2G: Sitting cross legged

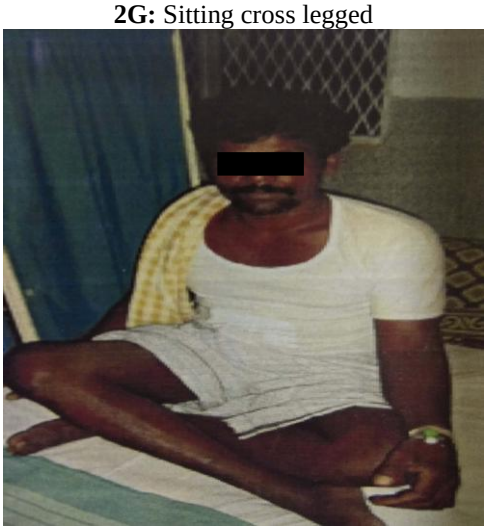


Fig 2: Case example of good outcome

Table 4: Functional rating as per Neer's scoring system.

Functional result as per Neer's score	No. of patients	Percentage
Excellent	22	55
Good	12	30
Fair	04	10
Poor	O2	05

4. Discussion

There has been no uniform reporting of the results of treatment of supracondylar fractures. It is difficult to compare the results of different studies because of the differing demographic characteristics, differing fracture patterns and differences in the classification and functional rating systems used [12]. Till late 90s open reduction and internal fixation with extra medullary implants was the standard treatment of choice for all supracondylar fractures. This had many drawbacks such as infection, iatrogenic soft tissue injury,

periosteal stripping, non unions and implant failures. After the advent of retrograde supracondylar nailing technique, many of these complications have been avoided. Being a load sharing device, it allows for secondary callus formation, provides 3 point fixation for the fracture, thus not allowing the fracture to displace and also the reamed products contribute to fracture healing. Hence we have conducted this study to analyze the functional outcome of supracondylar fractures treated by retrograde Intramedullary nailing technique and compared with the results of different studies in the existing literature.

The concept of retrograde intramedullary nailing in distal femur fractures was developed in an attempt to overcome the limitations of antegrade nailing in polytrauma patients and to ensure the advantages of minimally invasive technique over standard plate fixation systems [13]. Biomechanical analysis of various retrograde nailing systems compared with the plate systems have shown a lower torsional and axial stiffness, but similar bending stiffness, particularly for physiological and critical modes of varus loading [14].

Henry *et al* [15], in 1991 reported that by virtue of its intramedullary position, the retrograde nails have a biomechanical advantage over laterally placed conventional plating systems. Despite the proven higher stiffness of plate systems compared with intramedullary devices, the latter systems provide the advantage of indirect fracture reduction away from the comminuted metaphyseal region, thus bone grafts can be avoided.

Retrograde nailing and plate osteosynthesis have problem with respect to the control of axial reconstruction. The correct choice of nail entry and insertion is mandatory to achieve the physiological rotation and mechanical alignment. The actual point of entry has been variously described by clinical experience of various authors [16, 17]. Our experience indicates that a variation exists in the mediolateral location of the entry portals, which is most likely caused by the normal variability in the bony femoral anatomy. In the vast majority of femurs, the optimal entry point is located in the expected safe position, anterior to attachment of posterior cruciate ligament. Surgeon has the option, based on the individual clinical situation, to choose a different method of fixation or to proceed with retrograde nailing using a sub optimal entry portal location [18].

Our study when compared with the other series, showed the comparable results regarding fracture union rates, functional outcome and complication rates (Table 5 and Table 6).

Table 5: Showing the comparison of our study results with other series [21-24] regarding blood loss, operative time and fracture union.

Series	Blood loss	Opeartive time	Follow-up	Union rate	Remarks
Seifert *et al*	-	-	12-37 months Average-33weeks	9-17 weeks Average-12.6 weeks	All fractures healed; 1 open reduction
Gellman *et al*	50-1700 ml Average -373ml	60-315 min Average -154 min	4-36 months Average- 18 months	2-4 months Average – 3 months	All healed; one bone grafting
Lucas SM *et al*	Average – 224 ml	156 min	Minimum of 5 months	-	All healed;16 polytrauma, I open reduction
Bel JC *et al*	Average - 250 ml	Average – 150 min	Minimum of 12 months	Average- 12 weeks	All healed.
Our study	Average -340 ml	Average- 67 min 60 min for type A 86 min for type C	5-24 months Average- 14.6 months	12-20 weeks Average – 15.5 weeks	All fractures healed; 8 open reduction.

Table 6: Comparing functional outcome of our study with other series [21-24] using Neer's functional rating system.

Series	Functional results	Complications
Seifert *et al*	Leung score: A:16% fair,16% good & 16% excellent C:18% fair, 63%good & 19% excellent No difference between type A & C	1 DVT, 2 shortening, 1 insufficient fracture reposition, 1 spiral fracture and 2 retropatellar chondral lesions.
Gellman *et al*	Sanders's score: 4 excellent, 15 good, 2 fair & 2 poor A:3 excellent,16 good & 1 poor C:1 excellent, 9 good, 2 fair & 1 poor. Average flexion- 106 degree(55-140)	1 malunion 6 shortening 3 nail impingement 1 missed locking bolt 2 needed arthrolysis
Lucas SM *et al*	Average ROM – 100 degree Average flexion- 104 degree Average extensor lag 4 degree A: ROM 92 degree, lag 6 and flexion 98 degree C: ROM 103 degree, lag 3 & flexion 106 degree	4 knee pain 1 malunion 1 shortening 1 bent nail 1 broken nail 6 needed arthrolysis
Bel JC *et al*	Average ROM: 110 degrees(60-120 degree)	3 malunions 1 shortening
Our study	Neer's scoring: Overall: 55% excellent, 30% good, 10% fair & 5% poor. Type A: 67% excellent, 27% good & 6% fair Type C: 20% excellent, 40% good, 20% fair & 20% poor	8 knee pains 6 shortening 4 malunions 1 nail breakage.

All the fractures in our study healed in an average of 15.5 weeks. Two of our patients required bone graft due to delayed signs of union. Both of them were compound fractures. Studies with lateral fixation devices report similar rates of union, but 25-40% of patients required bone grafting [19]. Data from our study suggests that retrograde nailing leads to rapid fracture healing without need for bone grafting in spite of comminution and bone loss. This can be attributed to

biological fixation, decreaed soft tissue injury, no periosteal stripping and production of reamed products which serve as bone graft.

The operative time and blood loss during surgery become important issues in the treatment of multiply injured patients. The advent of supracondylar nailing has remarkably reduced the blood loss during surgery and operative time needed for the surgery. Both operative time and blood loss are substantial when internal fixation is done using lateral fixation devices because of extensive soft tissue dissection [20]. Our study also reiterated the same.

Numerous rating scales have been used to determine the functional outcomes after surgical treatment of supracondylar fractures of femur. Neer, Leung, Sanders, Karlstrom and Olerud are some of the rating systems in vogue. We used Neer's scoring system because it emphasizes on important patient outcome variables such as pain, functions as related to activities of daily living, range of motions, return to work, anatomic alignment and radiographic evaluation of union and mechanical alignment. However, no rating scale is validated to be superior to other.

Range of motion in our study was on par with previously reported series. Extra articular fractures had better knee range motions than the intra articular ones. Open fractures did not alter the functional results. Younger patients attained better results than elderly population. This is because younger patients adhered to strict and vigorous physiotherapy than the elderly. Fractures which underwent open reduction had lower results; this could be due to intra articular fracture pattern and operative insult to extensor mechanism.

Eight of our patients had anterior knee pain. Pain could not be attributed to any local cause. All of them had relief with simple analgesics. Four of our cases had malunion. A total of 6 patients had shortening ranging between 1to 2cm.one patient in our study had nail breakage near the fracture. This was due to early weight bearing and fracture united by conservative means. There were no cases of sepsis of knee joint and there were no incidences of superficial or deep infections.

Limitations: True common confounding variables in the present study that were not evaluated properly are associated injuries and pre existing arthritic conditions, both of which can lower the score. We acknowledge these limitations in our study.

5. Conclusion

Retrograde intramedullary nailing in distal femoral fractures makes biological osteosynthesis possible in these difficult and complex fractures with less operative time, minimal soft tissue stripping, minimal blood loss, decreased need for bone grafting, reasonably rigid fixation in osteoporotic bones and with added biomechanical advantages. It provides predictably reproducible good functional results with low morbidity and good healing rates as well as satisfactory articular mobility in Muller's type A & C fractures. This safe, effective and reliable technique should find a place in the armamentarium of every orthopaedic surgeon dealing with distal femoral fractures. A word of caution is that this technique requires expertise and details of technique should be known to surgeon to avoid complications. However, long term clinical outcome studies and Meta analytical studies are awaited to know the results of retrograde nailing technique for distal femoral fractures.

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7. References

1. O' Brien PJ, Meek RN, Blachut PA, Broekhuyse HM. Fractures of the distal femur: Rockwood and Green's fractures in adults. 5th ed, Lippincott Williams and Wilkins, 2001; 2.
2. Whittle AP, Wood II GW. Campbell's operative orthopaedics, Chapter 51, In: Fractures of lower extremity, 10th ed, Mosby Inc 2003, 3.
3. Palcide RJ, Lonner JH. Fractures of the distal femur. Current opinion in orthopaedics 1999; 10(1):2-9.
4. Stewart MJ, Sisk TD, Wallace SL. Fractures of the distal third of femur. J Bone Joint Surg. 1966; 48A:784-807.
5. Neer CS, Grantham SA, Shelton ML. Supracondylar fracture of the adult femur. J Bone Joint Surg 1967; 49A:591-613.
6. Schatzker J, Lambert DC. Supracondylar fractures of the femur. Clin Orthop. 1979; 138:77-83.
7. Thomas TL, Meggit BF. A comparative study of methods for treating fractures of the distal femur. J Bone Joint Surg. 1981; 63B(1):3-6.
8. Siliski JM, Mahring M, Hofer HP. Supracondyalar-intercondylar fracture of the femur. Bone Joint Surg. 1989; 71:95-104.
9. Helfet DL, Lorich DG. Retrograde intramedullary nailing of supracondyalar femoral fractures. Clin Orthop. 1988; 350:80-84.
10. Muller ME, Allgower M, Schneider R. Manual of internal fixation, 3rd ed. Berlin, Springer-Verlag. 1991, 140-141.
11. Gustilo RB, Mendoza RM, Williams DN. Problems in management of type III open fractures. J Trauma. 1984; 24:742-746.
12. Laros GS. Supracondylar fractures of the femur. Editorial comment and comparative results. Clin Orthop. 1979; 138:9-12.
13. Moed BR, Watson JT. Retrograde nailing of femoral shaft. J Am Acad Orthop Sugeons. 1999; 7:209-216.
14. David SM, Harrow MF, Peindl RD. Comparative biomechanical analysis of supracondylar femur fracture fixation; locked intramedullary nail versus 95 degree angle blade plate. J Orthop Trauma. 1997; 11:344-350.
15. Henry SL, Green SA, Tragar S, Seligson D. Management of the supracondylar fractures of femur with GSH intramedullary nail: A preliminary report. Contemporary Orthopaedics. 1991; 22:630.
16. Herscovici D, Whiteman KW. Retrograde nailing of the femur using an intercondylar approach. Clin Orthop. 1996; 332:98-104.
17. Patterson BM, Routt ML, Bennrschke SK, Hansan ST. Retrograde nailing of femoral shaft fractures. J Trauma. 1995; 38:38-43.
18. Carmack DB, Moed BR, Kingston C, Zmurko M, Watson JT, Richardson M. Identification of optimal intercondylar starting point for retrograde femoral nailing: An anatomical study. J Trauma. 2003; 55(4):692-695.
19. Giles JB, DeLee JC, Heckmann JD, Keever JE. Supracondylar – intercondylar fractures treated with a supracondylar plate and lag screw. J Bone Joint Surg. 1982; 64A:864-870.
20. Pritchett JW. Supracondylar fractures of the femur. Clin Orthop. 1984; 184:173-177.
21. Seifert J, Stengal D, Matthes G, Hinz P, Ekkernkamp A,

Ostermann PAW *et al*. Retrograde fixation of distal femoral fractures: Results using a new nail system. J Orthop Trauma. 2003; 17(7):488-495.
22. Gellman RE, Paiement GD, Green HD, Coughlin RR. Treatment of supracondylar femoral fractures with a retrograde intramedullary nail. Clin Orthop. 1996; 332:90-97.
23. Lucas SE, Seligson D, Henry SL. Intramedullary supracondylar nailing of femoral fractures: A preliminary report of the GSH Supracondylar nail. Clin Orthop 1993; 296:200-206.
24. Bel JC, Chardon C, Boissier F, Moyen B, Herzberg G. Centromedullary retrograde locking nailing for supra and intercondylar fractures of the femur in multiple trauma patients: A series of 33 cases. J Bone Joint Srg. 2001; 83-B(Supplement I):42.