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Clinical Study of Outcome of Close Management of Diaphyseal Fractures of Tibia in Adults

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SUMMARY

Time to fracture healing and factors that resulted in subsequent loss of alignment were evaluated in fifty patients with closed and Gustilo grade-I open fractures of tibial shaft after treatment by closed manipulation under intravenous analgesia and long leg plaster cast immobilization. Five patient were lost to follow-up. There were 34 male and 11 females with mean age of 32 years (range 16-70 years). Patients were followed up for the maximum of 27 weeks. 78% fractures were inflicted in motor bike accidents in young adult males. There were 32 closed and 13 open fractures. There were 12 transverse, 11 oblique, 5 spiral, 14 comminuted and 3 segmental fractures. 17 fractures subsequently developed displacement requiring wedging in 12 cases and remanipulation in 5 cases. Surgical treatment was carried out in seven cases; for persistent displacement in five and non-union in two cases. Average healing time with closed treatment was 17 weeks range 10-27 weeks. transverse and short oblique fractures healed faster. Factors which were responsible for loss of reduction included fracture tibia and fibula at same level, significant swelling, angulation >20°, shortening >2cm, contact <50%, difficulty with initial reduction and comminuted and long oblique fractures. Fracture geometry appeared to be a major factor but more than 1 factor were responsible in combination. It is concluded that closed management is a safe mode of treatment for closed, and grade-I open fractures of tibia. Marked initial displacement, difficulty with reduction, shortening >2cm, long oblique and comminuted fracture have greater tendency to displace and require closed observation. Segmental fractures are difficult to treat by closed method and should have primary internal fixation.

INTRODUCTION

Tibial shaft fractures impose a great impact on society because of their frequency and lack of universal consensus about treatment and demand an effective and safe method of treatment.[1]

Tibia, because of most weight bearing long bone, scanty blood supply with major portion being subcutaneous, thin soft tissue coverage and frequently involved in injuries, has always been a challenge to surgeons. Tibial fractures have been an issue of great importance with all their effect on the community in the form of delayed union, malunion, infection and joint stiffness.[2]

Controversy exists regarding treatment of tibial fractures because of wide range of options available. Closed as well as operative treatment are in current practice. The advantage of closed treatment is its simplicity, no fear of infection, low cost and minimal hospital stay but require prolonged immobilization of extremity with its problems. Nicoll[3], Sarmiento[4] and Harilaos[6] showed minimal functional deficit because of loss of reduction and residual deformity in such treatment. The proponents of surgery favour surgical intervention [dynamic compression plate (DCP), intramedullary (I/M) nail] because of difficulty of either reducing the fracture or maintaining the reduction in closed method. Secondly accurate reduction and stabilization by internal fixation helped in achieving early mobilization and bony union.[7,8] But it is associated with hazards of surgery

and anaesthesia including infection. Most of recent studies show 3-9% rate of infection.[9-11]

The problem of frequent displacements and loss of reduction is always a threat. Most of the studies have evaluated the conservative treatment in relation to delayed or nonunion but none has evaluated the factors which lead to loss of reduction which is then a cause of malunion or delayed union. This study was planned to evaluate the outcome of routinely applied POP cast after close reduction of close and grade I open fractures of tibial shaft to evaluate time to healing and factors which lead to loss of reduction or failure of closed treatment.

PATIENTS AND METHODS

We included 50 patients with closed and grade I open diaphyseal fractures of all kinds in adults only, which presented at accident and emergency department of Shaikh Zayed Hospital, Lahore between January 2000 & July 2000.

Patients were assessed regarding mode of injury details of fracture geometry, level of fracture, associated fracture of the fibula, degree of displacement, shortening and angulation, whether the fracture was closed or open and also associated injuries and any neurovascular compromise. All fractures, were manipulated under IV sedation in accident and emergency department. In open fractures wound was washed thoroughly with normal saline solution after IV antibiotics and tetanus prophylaxis. A window was subsequently made in POP and daily dressing till wound healing. Patients were only admitted when wound management or associated injuries demanded admissions in case of grade I open fracture antibiotics continued for 5 days. The criteria for satisfactory reduction was an angulation of $< 10°$ in AP plain, $< 5°$ lateromedial plain, $> 50\%$ cortical contact in both plains and shortening of < 1cm. Patients were followed up till bony union occurred or fracture demanded surgical intervention. Initially, weekly follow up during 1st month and then monthly follow up with clinical and radiological assessments. Wedging or remanipulation was carried out when displacement was found to be unacceptable; i.e. angulation $> 10°$ in AP plane and $> 5°$ in lateral plane and loss of cortical contact $> 50\%$. Weight bearing was started as early as possible whenever tolerated in transverse and short oblique fractures and in comminuted and long oblique fractures when they became stable usually 4-6 weeks. POP was removed when fracture was radiologically united and patient had been full weight bearing for at least 2 weeks. Knee and ankle range of motion were documented, any complication and patient acceptance was also documented.

Fractures which displaced despite repeated wedging or manipulation or which showed failure of union even after 6-9 months, were managed with surgical intervention.

RESULTS

We were able to complete the follow up in 45 patients (90%). Mean age was 32 years with a range of 16 to 70 years. 34 were males and 11 females. Road traffic accidents were responsible for 40 cases out of which 28 were bike riders, 12 cases were paediastrian hit by vehicles 5 cases occurred after slip and fall at or near home or during sports activity. In 29 cases injury involved right leg. Eight fractures were at upper 1/3rd level, 18 middle 1/3rd and 19 occurred at lower 1/3rd of tibial shaft.

Most common fracture pattern was comminuted fracture 14 (6 wedge butterfly, 8 gross comminution) followed by 12 transverse, 11 oblique, 5 spiral and 3 segmental fractures.

Both tibia fibula were fractured in 34 while only tibia was fractured in 11 cases. 13 cases were grade I open and 32 closed. Associated other injuries ranging from cut wound to other fractures were seen in 19 cases. Only one case had raised compartment pressure of 30mm of Hg.

Radiological assessment showed mean angulation of 12.4° (0-29°) in AP plane and 15.3° (2-35°) in lateromedial plane. On the whole 6 cases were totally displaced having no cortical contact. Out of remaining 39 cases mean cortical contact was 74.4% (35-100%) in AP and 78% (40-98%) in lateral planes. Shortening was seen in 31 cases which on the average was 11mm with a range of 0-24mm. Rotation was present in 7 cases out of which 5 were spiral fractures.

Post reduction AP angulation was 3.4° and lateral angulation 4.42° on the average. Cortical contact improved to 87.6% and 84.1% in AP and lateral planes. Average shortening left was 5mm.

Total 12 cases were admitted, 4 were admitted

primarily for wound management or associated injuries including the one with increased compartment pressure was also admitted and managed by elevation and observation which settled the condition. Average duration of stay of these cases was 10 days with range of 5-16 days. Other 8 cases were admitted during follow up for superficial wound infection 01 case, 7 for surgical intervention because either fracture was totally displaced despite repeated wedging or manipulation (5 cases) or nonunion (2 cases, both segmental). The details are shown in Table 1.

Rest of the 38 cases, healing was uneventful and average duration of union was 17 weeks with a range of 10-27 weeks. Transverse and short oblique fractures healed in relatively shorter period as compared to other fractures. The details are shown in Table 2.

A total of 17 cases showed loss of reduction during follow up which required repeat manipulation or wedging. Out of this 10 settled conservatively while 7 cases required surgery. The factors seemed to be responsible for displacement are shown in Table 3.

Table 1:

Type of Fracture	*No. of cases*	*G-I Open Fxs.*	*Wedging or remani-pulation*	*Average Duration for bony union (wks)*	*Surgery required*
Transverse	12	1	Nil	12	Nil
Oblique	11	3	5	12	2
Comminuted	14	6	7	20	3
Spiral	5	2	3	16	Nil
Segmental	3	1	2	27 wks 1-case	2
Total	45	13	17	17	7

Mean angulation at union was 2.5° and 3.9° in AP and lateral planes. Average shortening was 4mm with range (0-18mm). Knee ROM was >100° in 85% of the cases. Three cases had stiff knee with <30° ROM. These were immobilized for more than 20 weeks and delay in starting ROM. Two cases had equinus at ankle. One case had Sudeck's atrophy. There were no claw toes, or deep infection. One case had superficial infection of the wound, which settled with IV antibiotics.

DISCUSSION

Tibial shaft fractures in adults are notorious for their frequency of delayed union, nonunion, malunions and controversies regarding definitive and universally accepted treatment plan which over the years has shifted from cast application to compression plating and now IM nailing. Each mode of treatment has its merits and demerits. Personal preferences and experience of the person treating the tibial fractures also influence the indications and outcome of each method.[1,2] This study was conducted to evaluate the outcome, limitations and complications of closed management with POP cast of tibial shaft fractures in adults and to evaluate the factors which lead to loss of alignment.

Out of 50 cases included initially in study 5 were excluded because of loss of follow-up in the rest of 90% it was complete.

This study showed that tibial fractures are more common in males (75%) as compared to female with a ratio of 3:1. It affected the adults of all age group ranging from 16-70 years but mean age was 32 year with a peak range of 22-40 years. This mean age is comparable to others studies 28.8 year Wick et al 29.7 years Ibrahim et al, 31.4 years Nathan.[8,10,12]

Road traffic accidents (RTAs) were seen to be responsible in 88% of the cases while 12% occurred in domestic region including slip and falls and sports injuries. Out of these road side injuries 78% were due to bikes 78% of these bike injuries the victim was driver himself 22% passenger or paediastrian hit by bike. 92% of these bike victims were males showing that males are at greater risk for these injuries because of commonly involved in bike riding either related to job 64% or recreational 36%.[3] It is because in our society it is the commonest mode of transportation.

Domestic injuries mainly involved females who had slip and fall. This picture is quite opposite to most of western studies where sports injuries are the No.1 cause responsible for 41.5% of tibial shaft fractures while road traffic accident is responsible

Table 2:

Type of Fracture	Duration of Union (Weeks)						Displaced or Non united Fxs	Total
	10	12	14	16	18	20 or >		
Transverse	2	7	1	1	1	Nil	Nil	12
Oblique	Nil	1	5	2	Nil	Nil	2 displaced	11
Comminuted	Nil	Nil	1	5	4	1	3 displaced	14
Spiral	Nil	Nil	1	3	1	Nil	Nil	5
Segmental	-	-	-	-	-	1	2 non united	3
Total	2	8	8	12	6	2	7	45

Table 3: Factors responsible for loss of reduction.

Factors	No. of cases	No. of Displaced Cases	%age
1. Fx. Geometry			
Transverse	12	-	0
Spiral	5	2	40
Segmental	3	1	33
Oblique	11	6	55
Comminuted with wedge butterfly	8	5	64
Grossly comminuted	6	3	50
2. Marked Initial Swelling			
Treated with back slab	13	7	52
Treated with POP cast	9	5	58
3. Fx. of T/F at the same level	25	14	56
4. Marked initial displacement			
<50% contact in any plane	16	9	59
> 20° angulation in any plane	11	5	55
> 2cm shortening	4	3	75

B In all of the above cases more than 1 factor was present in combination.

for 35.6% of cases.[1,4] This reflects that road traffic accidents are much more common and responsible for such injuries in our society. This is also the reason of mostly males being the victims because they are more mobile and active for all out-door duties and activities while females are mostly restricted to indoors and domestic activities.

Lower 1/3rd of tibial shaft was most commonly affected 43% followed by middle 39.3% and upper 1/3rd 17.7%. This reflects the greater involvement of the area which is least covered and protected by tissues.

31.1% of the shaft fractures were comminuted, 24.5% transverse, 22% oblique, 12.5% spiral and 6.4% segmental fractures. Other studies showed spiral fracture more common as compared to other fractures followed by oblique, transverse and then comminuted fractures. This is because in the west, sports injuries are more common as compared to RTAs.[3,4,5] Fibula was intact in 24.5% of the cases. 71% fractures were close and 29% were grade-I open. Other associated injuries were seen in 42.2% of the cases which varied in severity from soft tissue trauma to bony fractures other than the involved leg. One case had raised compartment pressure of 30mm Hg. He was admitted and managed conservatively with elevation.

Close manipulation decreased the pre-reduction angulation of 12.4° to 3.4° in AP plane, and from 15.3° to 4.42° in lateral plane. Shortening was reduced from 11mm average to 5mm (total 6mm). Rotation was present in 15.5% of cases, out of which 71% were spiral. It persisted in one case despite repeated manipulation.

Twenty seven percent cases needed admission. 33% of these were admitted for management of

wounds or other associated injuries.

Follow-up showed that reduction was maintained in POP in 62.2% of the cases. Majority (42.8%) were transverse or short oblique fractures and 35.7% were having intact fibula which provided internal splintage. Loss of reduction (unacceptable) was seen in 37.8% and required wedging 68% or re-manipulation 32%. 70% of these displaced fractures were either comminuted or oblique. 58.8% of these displaced fractures settled with the intervension, while 41.2% required surgical intervention because of persistent displacement.

Regarding factors observed for displacement of fracture after initial reduction, fracture geometry seemed to be most affected as no displacement was seen in transverse fracture while fractures which had inherent instability were displaced mostly out of this, 8 were comminuted, 6 oblique, 2 spiral and 1 segmental fracture. Moreover, comminuted fractures which had wedge butterfly fragment (5 cases) had more tendency to be displaced than those who had gross comminution (3 cases). The 2nd most important factor seen was the severity of initial injury reflecting itself as degree of initial displacement, soft tissue injury and swelling of leg. 9 cases (total 16) had cortical contact of $<50\%$ which though, initially improved but deteriorated later same was true for fractures with angulation of $>20°$ (5 cases out of 11) and shortening of >2cm (3 cases out of total 4), found to be displaced.

Moreover, the amount of initial swelling also affected the initial reduction either because of initially needed back slab, 7 cases (later converted to complete POP cast) or initial POP cast 5 cases, which became loose when swelling settled, leading to loss of reduction. Another factor was the presence and level of associated fibular fracture. 34 cases had fracture of both tibia and fibula. Out of this, 25 had tibia-fibula fractured at the same level which lead to gross abnormal movements and instability, which persisted and lead to displacement in 14 out of 25. In 9 cases, the fracture of fibula was far away from tibial fracture and 11 had intact fibula which provided internal splintage and helped in maintaining reduction. However 2 cases in which fibula was intact showed delayed union >24 weeks due to persistence of gap at fracture site, despite early and full weight bearing.

Five cases out of 7 (2 oblique, 3 comm.) or non-union 2 out of 7 (both segmental) fractures required surgical intervention. 6 of these 7 were nailed and in 01 DCP + bone grafting was done. It was seen that in the cases of oblique fractures there was persistant displacement. Moreover they were also difficult to reduce initially.

In the rest of 38 cases (84%) average duration of bony union was 17 weeks with a range from 10-27 weeks. Bony union was achieved earlier in transverse and short oblique fracture (mean 12 weeks) as compared to other fractures. Comminuted and segmental fractures took the longest to heel (20 weeks for comminuted). Only 1 segmental fracture healed in 27 weeks. In the study of Sarmiento average union was achieved in 22 weeks with a range of 14-29 weeks[4]. Nicoll noted average time of duration of 3-4 months in simple closed fractures while, it increased to more than 5 months in comminuted or fractures which were difficult to reduce or had significant associated soft tissue injuries.[3] These results are comparable to the other studies i.e. Ellis showed bony union in average 10 weeks with rate of delayed union in minor severity. In moderate severity group it was (5 weeks and 11% incidence of delayed union major severity group which were mostly severely comm. segmental or G-III open fractures showed union in >23 weeks with 60% incidence of non-union.[7,9,10]

Non-union in our study was seen in 2 cases, both were segmental fractures, the third segmental fracture which healed but showed delayed union (27 weeks). This shows that segmental fractures are resistant to closed treatment and are best treated by surgery.

Mean angle at last follow up was 2.48° and 3.9° in AP and lateral planes respectively. Average shortening was 4mm. The knee range of motion was $\geq 100°$ in 85% of the cases, 3 cases had stiff knee with range of motion $<30°$. They were due to prolonged immobilization required for fracture healing (>20 weeks), 2 cases had equinus deformity at ankle. One case had Sudeck's atrophy. One had superficial infection in G-I open fracture which settled with IV antibiotics and dressings. There were no deep infections, no claw toes, VIC, no blisters or allergic phenomenon. Patient acceptance towards POP cast was excellent, immobilization was upto 14 weeks in 7 cases and >16 weeks in remaining cases, In hot weather, there was poor acceptance of close management and cast immobilization.

CONCLUSION

Road traffic accidents are responsible for most of the tibial shaft fractures in young bike-riders leaving physical disability and financial losses on our society. Improvement in traffic conditions and safety measures can decrease the prevalence of such injuries.

Long oblique, spiral, comminuted and segmental fractures; fracture of tibia and fibula at the same level, marked initial displacement and swelling are the major factors responsible for loss of reduction.

Wounds in grade-I open fractures do not affect the outcome, transverse and short oblique fractures give best response with earliest and increased incidence of bony union.

It is recommended that closed treatment of tibial shaft fractures is a safe, effective and non-invasive method. Long oblique, spiral and comminuted fractures should be closely monitored by serial radiogram as they have greatest tendency for loss of reduction. All the segmental fractures should be treated by surgery primarily.

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