ORIGINAL ARTICLE

Floating knee injuries: postoperative complications and outcome

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Abstract

Objective: To evaluatepost-operative complications and functional outcome of floating knee injuries using Karlstrom's criteria.

Methods: The prospective randomised study was conducted at Allied Hospital, Faisalabad, Pakistan, from November 2013 to October2014, and comprised patients of either gender. The injuries were classified using Fraser classification. Femur fractures were treated with intramedullary nails, dynamic hip screws, dynamic condylar screws, dynamic compression plates, buttress plates or external fixators. Tibia fractures were treated with buttress plates, dynamic compression plates, intramedullary nails, inter-fragmentary screws or external fixators.Patients were monitored at 1, 2, 3 and 6 months postoperatively. Final outcome was measured by Karlstrom's criteria.

Results: Of the 65 patients, 50(77%) were males and 15(23%) were females. According to Fraser classification, there were 46(70.8%)type I, 3(4.6%) type IIa, 7(10.8%) type IIb, and 9(13.8%) type IIc injuries. Most injuries were sustained during motor bike accidents 59(90.8%) involving right limb 38(58.5%) more than the left 27(41.5%), and 22(33.8%) had associated bony injuries and 4(6.2%) had visceral injuries. Non-union occurred in 16(12.3%) fractures, amputation in 5(7.7%), stiffness in 21(32.3%), soft tissue complications requiring reconstruction in 5(7.7%), infection in femur 11(16.9%), and infection in tibia 13(20%). Outcome was Excellent in 16(24.6%), Good 26(40%), Satisfactory 16(24.6%) and Poor 7(10.8%).

Conclusion: A better functional outcome without sequelae/complications depends on the choice of implants according to Fraser classification, comminution at fracture site, intra- or extra-articular nature and whether the fracture is open or closed.

Keywords: Floating knee, Fraser, Complications, Outcome, Karlstrom. (JPMA 65: S-195 (Suppl. 3); 2015)

Introduction

Simultaneous fracture of the femoral and tibial shafts of the same limb have been termed floating knee.[1,2] This may include a combination of diaphyseal, metaphyseal, and intra-articular fractures also.[3-5] The force which is required to fracture the femur and tibia at the same time is immense and, hence, these patients have associated other bony and visceral injuries. Although the exact incidence of the floating knee is not known, but it is an uncommon injury.[6] The largest series reported in the literature is of 222 patients over 11 years.[7,8] The reported mortality rate ranged from 5% to 15%, reflecting the seriousness of associated injuries in the floating knee.[7,9,10]

In the earlier 20th century, treatment constituted of a conservative approach, provided by means of skeletal traction and plastered apparatus.[1,2] This treatment involving prolonged periods of bed-rest became a challenge for the surgeons as the complications led to poor clinical outcome.[2,11] The 21st century emerged with an increasing knowledge of the clinical evolution of fractures and their complications, advanced stabilisation and permanent fixation techniques combined with less traumatic approaches produced significantly superior results compared to conservative treatments.[1,12,13] Thus, a better quality pre-hospital healthcare and standardised assessment of patients with multiple injuries have led to the survival of patients presenting with severe injuries, thus establishing a new therapeutic challenge for the treating personnel: the rehabilitation of the involved limb.[1]

Surgical stabilisation of both fractures and early mobilisation of the patient and extremity produce best clinical outcomes.[14] Although treatment planning for each fracture in the extremity should be considered individually to achieve the optimal result, the effect of that decision must be considered in the light of the overall injury status of the entire extremity. Collateral ligament and meniscal injuries may also be associated with this fracture complex. Complications, such as compartment syndrome, loss of knee motion, failure to diagnose knee ligament injury, and the need for amputation, are not uncommon. Better results and fewer complications are observed when both fractures are diaphyseal than when one or both are intra-articular.[2,4] A thorough secondary survey is mandatory in a trauma patient because of

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concealed injuries. The deformed limb can be a major distracting factor and it is not unusual to miss the other injuries. The lack of a standardised assessment of joints surrounding fractures has been described as one of the causes of poor late outcomes. In this context, knee joint deserves stronger attention because a variable amount of the trauma energy is absorbed by the capsule-ligamentous complex of the knee joint.[1,15]

Delayed union, non-union, malunion and stiffness of the knee are more common in patients with floating-knee injuries than in patients with isolated femoral or tibial fractures.

For patients in general, multiple factors such as advanced age, cigarette smoking in terms of pack-yearsat the time of injury, a high Injury Severity Score (ISS), and the presence of open and comminuted fractures adversely affect the bony union time and the re-operation rate.[2,16]

The incidence of infection and incidence of osteomyelitis are relatively high in floating-knee injuries, especially in patients with open or type II fracture patterns.[13,17] Strategies that have made the eradication of infections possible in most of the instances include meticulous debridement, continuous suction and irrigation drainage, and the management of dead space with polymethyl methacrylate (PMMA) beads impregnated with antibiotics.[17]

Using the criteria of Karlstrom and Olerud (Table-1), most authors have described Excellent to Good results in as many as 65% of surgically treated patients compared with conservative treatment[16,18] where success rates decreased to 29%. The complication rate is associated with fracture type (open fracture), Fraser type IIc, tibial plateau and distal tibia.[19]

In children, Good to Excellent results have been reported with both conservative and surgical methods. Fixation of 1 or 2 fractures in children aged 9 years or below offers superior results and minimises the incidence of long-term dysfunction of the extremity.[20,21]

Regarding intra-articular (type II) injuries, Good or Excellent results are reported in 24% patients.[10] The difficulty in achieving satisfactory function after type II injuries may be the result of severe injuries to the soft tissue, damage to the knee joint, and/or the complexities of achieving stable reconstruction.

◆ Apart from knee involvement and open type III femoral fractures, other factors that contribute to the functional outcomes after floating knee injuries are: severity of soft tissue trauma in the tibia, fixation time after injury in the tibia, Arbeitsgemeinschaft für Osteosynthesefragen (AO) fracture grade in the femur and tibia, and fixation time after injury in the femur and severity of open femoral fractures.[18]

Isolated fractures in stable patients can be treated acutely. By contrast, temporary stabilisation of the fractures with external fixation is indicated for unstable patients or those in extremis, according to the concepts of damage-control orthopaedics. When the patient's physiological state is stabilised, conversion to internal fixation is desirable.[22]

Intra-articular fractures of the knee joint, severe soft tissues injuries, fracture comminution and open fractures are associated with more complication and less desirable functional outcomes as compared to extra-articular fractures[18] (Figure-1).

The current study was planned to review the results of treatment of floating knee injuries performed at our institution in terms of complications and functional outcome and to calculate the distribution of fracture type within patient age groups.

Patients and Methods

The prospective randomised study was conducted at Allied Hospital, Faisalabad, Pakistan, from November 2013 to October 2014, and comprised patients of either gender. Patients were enrolled through the emergency department and those who refused the treatment or were lost to follow-up were excluded.

Data collected included demographics, aetiologies, fracture types, complications and functional outcome. Patients were categorised based on fracture extension to the knee joint using Fraser's classification (Table-2, Figure-2).

Complications included non-union of either the femoral or tibial fractures, infection of either the femoral or tibial fracture sites, secondary soft tissue defects due to infection of fracture sites or skin necrosis and which needed skin grafting or flap surgery, amputation, knee stiffness, and mortality. Aetiology, fracture type and complications were categorised.

Patients having closed fractures or open type I or II fractures were treated according to fracture site. Femoral fractures around the cervicotrochanteric area were fixed under traction with dynamic hip screws (DHS), dynamic compression screws (DCS), or cannulated screws. Some femoral shaft fractures in paediatric age group were fixed by open reduction and internal fixation (ORIF) with K-nails. Some femoral diaphyseal fractures were fixed with intramedullary interlocking nails by performing open reduction with the patient in the decubitus position or by

closed reduction under traction. Some femoral shaft fractures were fixed by ORIF with dynamic compression plates (DCPs). Femoral fractures in the supra-intercondylar area had ORIF with condylar buttress plates or DCS. Tibial fractures around the tibial plateau, proximal tibia or distal tibial areas were fixed by ORIF with buttress plates or DCPs. Some tibial shaft fractures were managed in plaster of Paris (POP) cast. Some tibialdiaphyseal fractures were fixed with interlocking nails by open or closed reduction. Some tibial shaft fractures were fixed by open reduction with DCPs. For type III open fractures, temporary external skeletal fixators (knee spanning and knee sparing) were applied. Internal fixation with plates or nails was done after wound condition had been stabilised. Rehabilitation involving quadricep strengthening and continuous passive motion of knee joints began on the second postoperative day, continuing to the day of hospital discharge.

Two patients under 10 years of age were managed conservatively with Hip Spica Cast extending from the toes to sub-costal margin.

After discharge, the patients were advised to perform quadriceps strengthening exercises and to flex their knees. Partial/touch-down weight-bearing was advised 8 to 12 weeks post-operatively when evidence of callus bridging was visible on plain radiographs. Full weight-bearing was allowed when radiographs confirmed consolidation of the fracture site.

Patients were monitored at 1, 2, 3 and 6 months post-operatively. Anteroposterior (AP) and lateral radiographs were taken during each visit. Knee stiffness was defined as a ROM <90°. Union was defined as solid if cross-trabeculation was observed on AP and lateral radiographs. Non-union was defined as failure of fracture union at consecutive 3-month follow-up. Infection was defined as visible purulent discharge from wound.

Cases with a limited ROM in the knee joints received manipulation with or without anaesthesia. Patients received manipulation either through physiotherapy without any anaesthesia or manipulation was done under sedation and full relaxation.

Patients with non-union of femoral or tibial fractures had cancellous autobone graft and revision surgery if the implants were loose or broken. Union was achieved in all patients. Patients with infection of the fracture site had debridement surgery and empirical intravenous (IV) antibiotic therapy followed by IV and oral antibiotics after culture and sensitivity. Skin grafting and flaps were done to cover the skin defects. Muscle flap surgery was performed if there were soft tissue defects caused by trauma and infection. Amputation due to severe infection (above-knee [AK] in 1 case) or gangrenous extremity due to crush injury or infection was performed in 4 cases (below knee [BK]).

Data was analysed using SPSS22 and final outcome was measured by Karlstrom's criteria (Table-1).

Results

The study group comprised 65 patients; 50(77%) males

Table-1: Karlstrom criteria.

Criterion	Excellent	Good	Acceptable	Poor
Subjective complaint From thigh or leg	0	Intermittent slight symptoms	More severe symptoms Impairing function	Considerable functional impairment; pain at rest
Subjective symptoms from knee or ankle joint	0	Same as above	Same as above	Same as above
Walking ability	Unimpaired	Same as above	Walking distance restricted	Use cane, crutch or other support
Work and sports	Same as before accident	Given up sport; work same as before accident	Changes to less strenuous work	Permanent disability
Angulation, rotational deformity or both	0	<10°	10-20°	>20°
Shortening	0	<1 cm	1-0 cm	>3 cm
Restricted joint mobility (hip, knee, ankle)	0	<10° at ankle ; <20° at hip, knee or both	10-20° at ankle; 20-40° at hip, knee or both	>20° at ankle; >40° at hip, knee or both

Excellent: No complaints or limitations secondary to the injury to the extremity.
Good: Occasional minor pain in the extremity or a decreased ability to participate in athletic activities.
Fair: Intermittent moderate pain in the extremity but the patient is able to perform all activities of daily living and most recreational activities.
Poor: Constant pain in the extremity and an inability to perform activities of daily living because of the injury to the extremity.

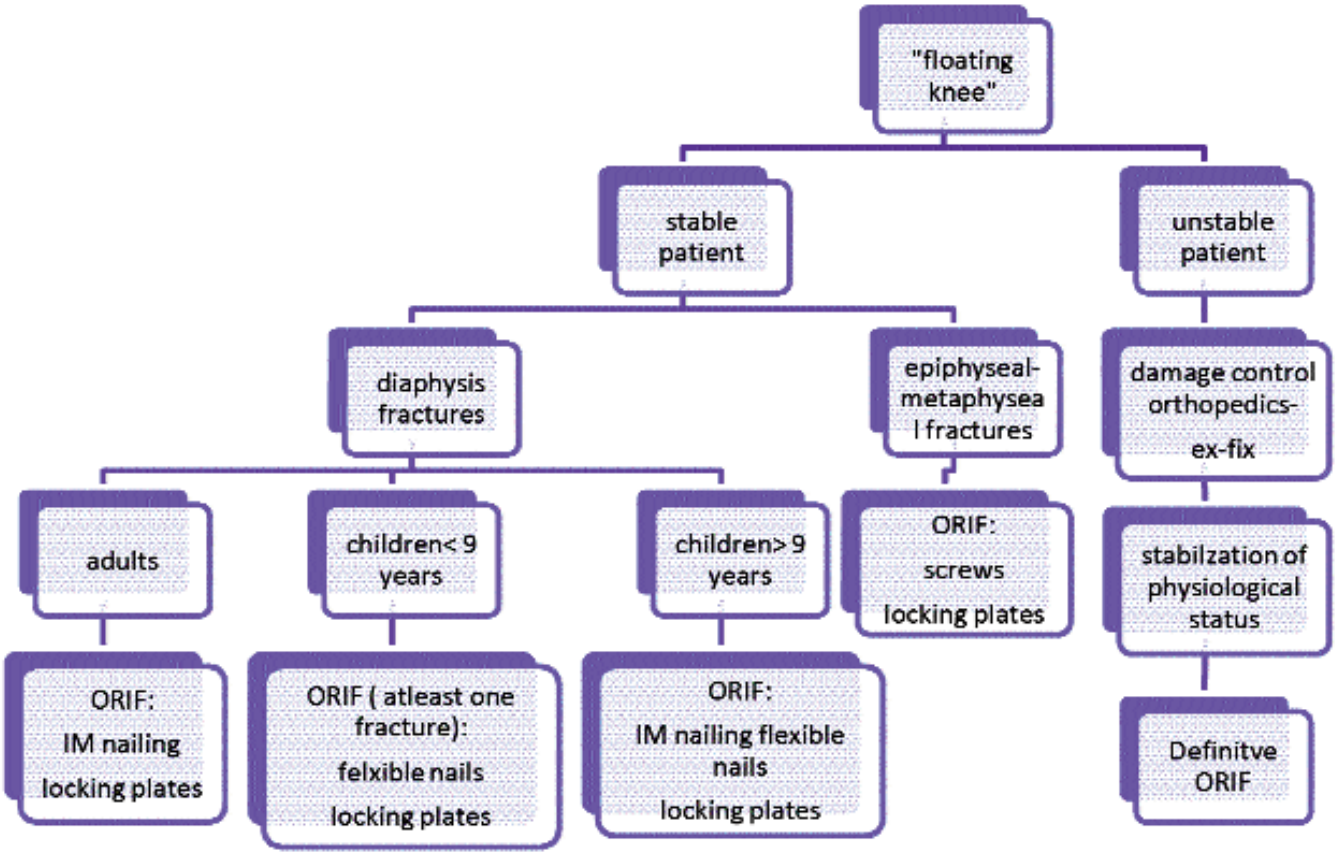

Figure-1: Management of floating knee injuries.

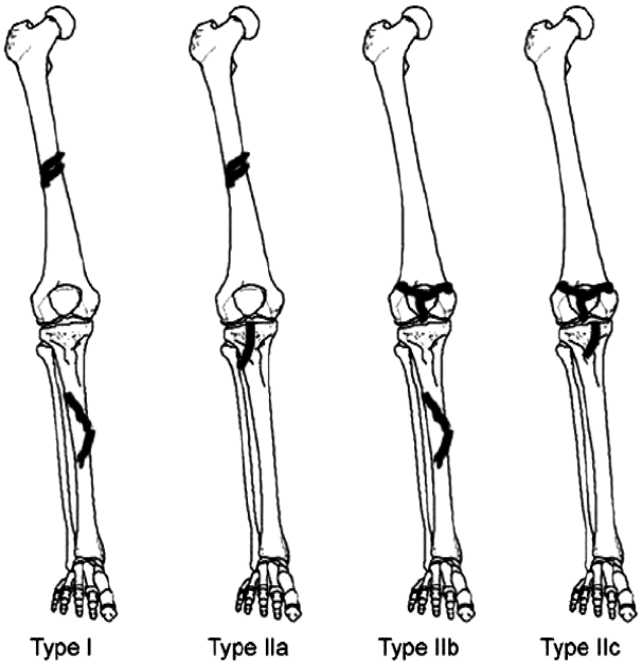

Figure-2: Frazer classification.

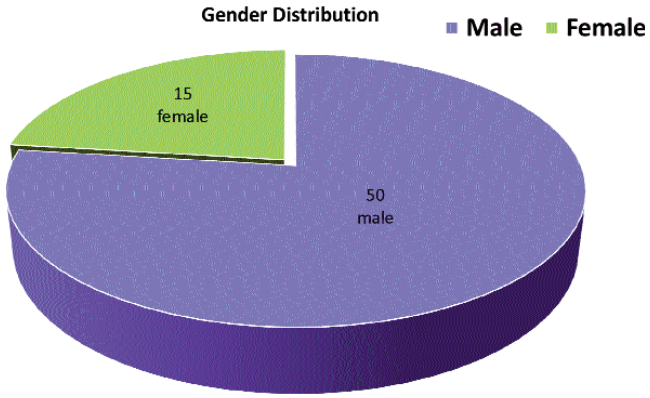

Figure-3: Gender Distribution.

Table-2: Fraser classification.

Type I:	Both fractures involve the shaft without articular involvement of the knee
Type II:	Articular involvement of the knee
Type IIa:	Femoral shaft and tibial plateau fractures.
Type IIb:	Fractures of the distal femur and the shaft of the tibia
Type IIc:	Fractures of the distal femur and tibial plateau

Table-3: Gustilo and Anderson classification.

Gustilo Type	I	II	IIIA	IIIB	IIIC
Energy	Low energy	Moderate	High	High	High
Wound Size	< 1 cm	> 1cm	>10cm	>10cm	>10cm
Soft Tissue	Minimal	Moderate	Extensive	Extensive	Extensive
Contamination	Clean	Moderate contamination	Extensive	Extensive	Extensive
Fracture Pattern	Simple fx pattern with minimal comminution	Moderate comminution	Severe comminution or segmental fractures	Severe comminution or segmental fractures	Severe comminution or segmental fractures
Periosteal Stripping	No	No	Yes	Yes	Yes
Skin Coverage	Local coverage	Local coverage	Local coverage including	Requires free tissue flap or rotational flap coverage	Typically requires flap coverage
Neurovascular Injury	Normal	Normal	Normal	Normal	Exposed fracture with arterial damage that requires repair

Table-4: Age Distribution.

Age Categories	Fraser Classification				Total
	type I	type II a	type II b	type II c	
1-10	2	0	0	0	2
11-20	19	0	2	0	21
21-30	11	1	2	4	18
31-40	11	2	2	3	18
41-50	3	0	1	2	6
Total	46	3	7	9	65

Table-5: Surgical complications.

Complication			
Infection	Femur	Yes	11
	Tibia	Yes	13
Non-union		Yes	16
Secondary soft tissue procedure		Graft	2
		Flap	3
Amputation		Yes	5
Stiffness		Yes	21
Mortality		None	0
Total			71

and 15(23%) females (Figure-3).

The overall mean age was 27.80±11.27 years (range: 5-50 years) and 57(88%) patients were between 11 and 40 years of age. Mean duration of hospital stay was 18.4±9.2 days. Most of the injuries were sustained during motor bike accident either with a car 24(36.9%) or another motorbike 20(30.8%). Associated injuries mostly included accompanying fractures of other bones 22(33.8%) followed by visceral Injuries 4(6.2%). Floating knee fractures were common in the right limb 38(58.5%) than the left limb 27(41.5%). Floating knee fracture was of Fraser classification type I in 46(70.8%) cases. Non-union of femur fracture occurred in 7(10.8%) cases and in tibia 9(13.8 %). Amputation had to be done in 1(1.5%) case in femur and in 4(6.2%) cases in tibia. Infection complicated 11(16.9%) and 13(20%) cases in femur and tibia respectively. Knee stiffness complicated 21(32.3 %) cases.

Table-6: Recommendations for fixation of floating knee injuries.

Injury type	Description	Recommendations	Femoral technique	Tibial technique
I	Femoral or tibialdiaphyseal fractures	Protect tibial fractures during femoral stabilization; consider temporary two-pin fixator	Retrograde nails are often preferred; antegrade nails are used for high femoral fractures; reconstruction nails are used for subtrochanteric fractures	Intramedullary nails preferred; consider external fixator for severe fractures
IIA and	Diaphyseal femoral and intra-articular tibial fractures	Stabilize femur first; stabilize proximal tibia fractures through approach used for retrograde nailing	Same as type I	Cannulated screws; open reduction internal fixation (plates and screws); external fixation in severe patterns
IIB	Intra-articular femoral and diaphysealtibial fractures	Stabilize femur first	Angled plate and retrograde nails	Same as for type I
IIC	Femoral and tibial intra-articular fractures	Consider spanning external fixator	Depends on pattern	Depends on pattern

Landy DW, Johnson KD. "Floating knee" Injuries; ipsilateral fractures of femur and tibia. JAAOS, Vol 9, No 4, July/August 2001.

There was no mortality in the study population. Soft tissue procedures were done in 5(7.7%) cases. Majority of the femur and tibia fractures were shaft fractures 47(72.3%) in both instances. Femur fractures were closed in majority of cases 51(78.5 %) and tibia fractures were of closed type in 29(44.6%) cases and of Gustilo and Anderson type II (Table-3) in 22(33.8%) cases. Outcome was Excellent in 16(24.6 %), Good in 26 (40.0 %), Acceptable in 16 (24.6 %) and Poor in 7 (10.8 %).Distribution of each fracture type within each patient age group was worked out separately (Table-4).

There were 71 complications in the study cases (Table-5). There was no significant association between infection in femur fracture and Fraser classification (p=0.39) and outcome (p=0.748). Infection in femur fracture was significantly associated with type of femur fracture (p=0.000) and amputation (p=0.026). There was no significant association between infection in tibia fracture and Fraser classification (p=0.519), soft tissue procedures (p=0.096), outcome (p=0.412), type of tibia fracture (p=0.081) and amputation (p>0.05). Infection in femur and tibia fracture were both significantly associated with non-union of fracture in femur and tibia respectively (p=0.000 each). Fraser classification had no effect on complications and outcome (p>0.05).

Discussion

The term 'floating knee' is used when the knee joint is isolated partially or completely due to a fracture of the femur and tibia.[23] Survivors of high-speed traffic accidents often have injuries to several parenchymal organs as well as multiple fractures.[19] A careful evaluation of these injuries and resuscitation of the patient must precede the definitive management of specific fractures[7] as described by Fraser classification (Table-2, Figure-2).

Our study showed that floating knee injury occurs most frequently between ages 11 and 40 years and predominately in men. Most such injuries are caused by motorcycle crashes1. These findings differ from those reported by Dwyer et al.[9] This is due to the fact that motorcycles are a major means of conveyance in Pakistan.

Hee et al. suggested a pre-operative scoring system that considered age, smoking status at time of injury, ISS, open fractures, segmental fractures and comminution to affect the prognosis of the final outcome of these fractures. The associated injuries played a major role in the initial outcome of patients with regard to a delay in initial surgery, prolonged duration of surgery, anaesthetic exposure and a delay in rehabilitation.[16]

Paul et al. reported that 62% patients had major concomitant trauma to the head, trunk or the other extremities.[24] In our study, 40% of the patients had associated injuries to head, trunk or other extremities owing to the more protective equipment available now than at the time when Paul et al. conducted their study.

Arslan H. et al. concluded that the cases with Poor outcomes were those with open knee injury, and those with Fair outcomes were those with angulation. It was concluded that knee ligament injuries do not affect the outcome of floating knee trauma in children, though they do in adults, but that open knee injuries do affect the outcome, and operative treatment of the femoral fracture is the treatment of choice for all ages.[25] These findings support our study results.

Kao et al. summarised that these types of injuries are usually associated with high complication rate and mortality as is evident in our study too, which are independent of the treatment regimen. There are various treatment modalities which an orthopaedic surgeon typically employs, especially aggressive and early stabilisation of both femoral and tibial fractures.[19]

This shows that the poor prognostic factors are related to the type of fracture (open or closed, intra-articular fractures, severe comminution and associated injuries). Physiotherapy and early mobilisation are required to reduce the complication rate and obtain good functional results.

There are different methods of treatment for the floating knee, with variable clinical outcome. Landy et al. gave recommendation regarding management options, techniques and which fracture to be stabilised first (Table-6).[4]

Conclusion

Floating knee injuries are a group of complex injuries that require a thorough assessment for classification and surgical planning with careful rehabilitation and to minimise the complications and achieve good final outcome.

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