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Management of Subtrochanteric and Proximal Femoral Shaft Fractures with the Hybrid LRS Proximal Femur Construct: Case Series of Seven Patients

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Running title: HYBRID LRS PROXIMAL FEMUR

Abstract: ***This retrospective single-centre case series evaluated the clinical and radiological outcomes of a hybrid limb reconstruction system proximal femur construct used for complex subtrochanteric and proximal femoral shaft fractures in situations where conventional internal fixation was unsuitable, including open fractures and chronic infection. Seven patients treated between July 2019 and April 2025 were reviewed. Outcomes included fracture union, time to union, complications, reoperations, and ASAMI bone and functional scores. Five patients achieved union, with a mean union time of 18 months. Two patients developed persistent non-union. Four patients achieved good or excellent ASAMI outcomes, while three had fair or poor results. Reoperation was required in five patients. The hybrid construct may provide a salvage or alternative fixation option in selected complex proximal femoral cases where infection or soft tissue compromise limits internal fixation. Larger comparative studies are needed to define its role.***

Keywords: subtrochanteric fracture; proximal femoral shaft fracture; external fixation; limb reconstruction system; hybrid LRS

1. Introduction

Proximal femur fractures present a complex challenge in their management due to the unique anatomical, biomechanical and biological characteristics. This group encompasses fractures of the femoral head, femoral neck, intertrochanteric as well as subtrochanteric fractures. In this case series, we present seven cases of subtrochanteric and proximal femoral shaft fractures treated with hybrid LRS proximal femur construct.This study aimed to evaluate the clinical and radiological outcomes of hybrid LRS proximal femur fixation in complex proximal femoral fractures unsuitable for standard internal fixation.

2. Methodology

This retrospective, single-center case series study was conducted at a level II trauma centre, commenced after the institutional board review approval was obtained. All patients with subtrochanteric and proximal femoral shaft fractures from July 2019 until April 2025 were reviewed. Inclusion criteria included skeletally mature patients treated with hybrid LRS proximal femur construct including open fractures, closed fractures with severe soft tissue damage, and patients with infected internal fixation. Patients with incomplete medical and radiological records were excluded. All consecutive eligible patients were included except one patient who was lost to follow-up.

Figure 1: Hybrid LRS proximal femur construct

A retrospective medical record review was conducted, and collected data included patient demographics, indications for hybrid LRS, operative data, and radiological and clinical outcomes. The functional ASAMI score and ASAMI bone scores were used to quantify the clinical and radiological outcomes, respectively. This scoring system was selected due to its comprehensiveness that assesses both radiological union as well as the functional status particularly in patients treated with external fixation. The results were explained using descriptive statistics.

Figure 2: Hybrid LRS proximal femur with Schanz screws

The Hybrid LRS proximal femur construct involves a monorail connected to an Italian femoral arch by a hybrid connector (Figure 1). Four 6.0mm HA-coated Schanz screws are connected to the femoral arch and inserted into the proximal femoral segment. Four to seven 6.0mm HA-coated Schanz screws can be inserted into the distal segment through two standard clamps mounted on the monorail (Figure 2). Further compression of the fracture ends is possible using the compression-distraction unit (CDU). Radiograph of the hybrid LRS proximal femur construct is shown in Figure 3.

The surgery was done with the patient lying supine on the radiolucent surgical table. The fracture site was debrided and reduced through open reduction. Two standard clamps were mounted on the monorail. Schanz screws were inserted at the distal fragment through the clamps ensuring parallel pin placement. The Italian femoral arch was connected to the proximal end of the monorail using a hybrid clamp. Schanz screws were inserted to the proximal fragment using free-hand drilling (multiplanar pin insertion). Then, the pins were connected to the femoral arch using the pin fixation bolts, rancho tubes, and/or posts. Intra-operative imaging was used to ensure good reduction, and correct pin placement.

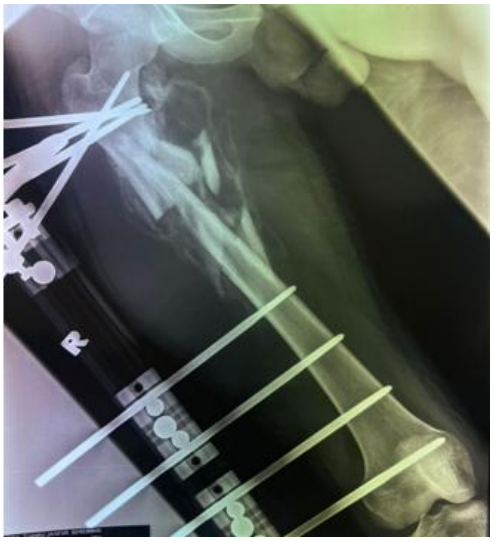

Figure 3: Radiograph of hybrid LRS proximal femur

Full weight bearing was allowed post-operatively, and all patients were referred to the physiotherapists for ROM exercises and ambulation training. Pin site care was done following the standard protocol.

3. Results

From the record review, seven patients were identified. Patient demographics, indication for hybrid LRS proximal femur application, clinical and functional outcomes were summarised in Table 1.

Table 1: Patient demographics, indication, time to union, time on frame, functional ASAMI score, ASAMI bone score, complications, and re-operation

Case Number	1	2	3	4	5	6	7
Gender	Male	Male	Male	Male	Female	Male	Male
Age at surgery	22	16	40	18	33	38	61
Indication	Open fracture	Open fracture	Open fracture	Closed fracture	Chronic OM	Chronic OM	Chronic OM
Time to union (months)	10	28	Non-union	16	24	10	Non-union
Time on frame (months)	10	28	42	16	24	32	17
Functional ASAMI score	Good	Good	Poor	Good	Good	Fair	Poor
ASAMI bone score	Good	Good	Poor	Excellent	Good	Fair	Poor
Complications	Nil	Re-fracture	Re-fracture	Nil	Pin site infection	Joint stiffness	Pin site infection
Re-operation	No	Yes	Yes	No	Yes	Yes	Yes
Abbreviations: OM (Osteomyelitis); ASAMI (Association of the Study of the Methods of Ilizarov)							

The patients' ages ranged from 16 to 61 years, with an average age of approximately 32.6 years. The majority of patients are males (six out of seven). Hybrid LRS proximal femur was applied due to open fractures (3 cases), chronic osteomyelitis (3 cases) and closed fracture (1 case). We labelled the three cases with chronic osteomyelitis to the presence of confirmed infection following internal fixation. We wanted to differentiate the cases with the acute open and closed fractures.

Case Number 4 had closed subtrochanteric fracture with infected Morel-Lavalle lesion, thus external fixation was chosen to manage the fracture and infection. The average duration of follow-up was 25.2 months, ranging from 16 to 42 months.

Figure 4: Radiographs of Case Number 1 showing consolidated fracture site

Two patients did not achieve union at the fracture site. For the five patients where union was achieved, the average time to union was approximately 18 months, with a range from 10 to 28 months. The average time on frame is approximately 24.6 months, with 5 out of 7 patients requiring re-operation during the follow-up. For the patient in Case Number 6, the fracture was united at 10 months. However, he had significant limb shortening that required bone lengthening and the frame was only removed after 32 months once the distraction site had consolidated.

4. Discussions

Subtrochanteric fractures involve fractures at the region extending from the lesser trochanter to 5cm distal to it [1]. Cephalomedullary devices are considered the gold standard for the treatment of these fractures because of their biomechanical superiority of its load-sharing properties, minimal soft tissue disruption, and a shorter lever arm resisting bending moments.

However, in the fractures with severe soft tissue damage or in the presence of active infection, external fixation may be required as a temporary or even definitive stabilization. While simple monolateral external fixation may suffice for temporary stabilization, a more robust construct - such as circular ring fixator (Ilizarov) or monorail external fixator (LRS) - is needed for longer durations.

For infected non-unions and segmental bone defects, the Ilizarov circular ring fixator has historically been the standard treatment, utilizing distraction osteogenesis to bridge gaps and eradicate infection [2],[3]. However, circular frames around the proximal femur are highly cumbersome, poorly tolerated by patients, and severely impede personal hygiene and mobility [4],[5]. The monorail external fixator (LRS) is a much more patient-friendly and easily applied alternative. However, malalignment of the fracture such as valgus or varus axis deviation may happen with the monorail fixator especially in cases requiring bone transport [5].

The hybrid LRS proximal femur construct used in our series overcomes this limitation by enabling multiplanar pin placement, which maximizes proximal fixation rigidity without the full bulk of a traditional circular frame.

The results of this case series are encouraging. From the literature, non-union rates for subtrochanteric femur fractures range from 2.3% to 23%. Whereas for open fracture, the non-union rate may rise up to more than 50% [6]. Our patient population mainly are open fractures and chronic osteomyelitis. Only two out of seven patients (approximately 28%) in our series had non-union at the end of the follow-up, a rate comparable to those reported in the literature. Data on the time to union for open or infected subtrochanteric fractures are scarce. The average time of union in subtrochanteric fractures treated with an intramedullary nail is generally 17 to 26 weeks [7]. The average time to union in our cohort is 18 months (about 78 weeks). This is expected given that our cohort consists of open fractures or infected fractures.

We utilized the ASAMI scoring system to document the functional and radiological outcomes. This standardized system is commonly used to evaluate and report bone reconstruction cases, particularly those involving Ilizarov and monorail external fixators. The ASAMI scoring system divides the patient outcomes into the Bone Score and Functional Score [2],[3],[5]. The ASAMI Bone Score evaluates outcomes based on four primary criteria: fracture union, absence of infection, deformity of less than 7 degrees, and limb-length discrepancy (LLD) less than 2.5cm.

The ASAMI Functional Score assesses the patient's physical recovery and quality of life after the reconstruction is complete and the frame is removed [3],[5]. The details of the categories are listed in Table 2. Four of the patients achieved 'Good' and 'Excellent' outcomes in both categories while the other three patients had 'Fair' and 'Poor' outcomes. The main factor contributing to poor outcomes was the fracture non-union.

Table 2: ASAMI Bone and Functional Scores

	Bone Score	Functional Score
Excellent	Union achieved with three other criteria (no infection, deformity <7°, LLD <2.5cm)	The patient is active, no limp, minimum joint stiffness (loss of <15° of knee extension/ankle dorsiflexion), no RSD, no significant pain
Good	Union achieved with two out of three other criteria	Active with one or two of the followings: limp, stiffness, RSD, mild pain
Fair	Union achieved with only one of the three other criteria	Active with three or all of the followings: limp, stiffness, RSD, significant pain
Poor	Non-union, re-fracture, or union combined with none of the other three criteria	Inactive (inability to return to work/daily activities)
Abbreviations: LLD (limb-length discrepancy); RSD (reflex sympathetic dystrophy)		

Like other external fixation methods, the hybrid LRS proximal femur construct deals with the common complications such as pin track infections, pin loosening, joint stiffness and contractures. Reported incidence rates of pin track infections vary from 33% up to 100% [8]. Superficial infections can be treated by rigorous pin site care and oral antibiotics, but deeper infections may lead to pin loosening, necessitating surgical debridement and revision or removal of the implants.

5. Conclusion

The hybrid LRS proximal femur construct may serve as a useful salvage or alternative fixation option for selected complex proximal femoral fractures, particularly when infection, open injury, or soft tissue compromise limits conventional internal fixation. However, the small heterogeneous sample and retrospective design limit generalizability. Larger comparative studies are needed before broader clinical recommendations can be made.

Declaration of conflicting interests
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