



Outcome of femoral fractures in poliomyelitis patients

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Abstract

Background and purpose As patients who were afflicted with poliomyelitis during the outbreaks in the past are aging, lower extremity osteoporotic fractures are becoming more frequent. Fixation in deformed, porotic bone, coupled with muscle weakness and imbalance creates a unique challenge when treating these fractures as does their reduced rehabilitation potential. The aim of this study was to investigate the outcome of femoral fractures in surviving poliomyelitis patients.

Patients and methods Sixty-five patients with 74 femoral fractures were treated between 1990 and 2014. Clinical outcome was assessed using the Parkland and Palmer mobility score, and quality-of-life was assessed using the SF-12® score.

Results Some 84% of the fractures were a result of low-energy mechanisms and occurred in the polio-affected limbs, but nonaffected limbs were also injured owing to low-energy mechanisms in all cases. Fifty-seven fractures were treated operatively. There were nine re-operations (16%), including implant removals, nonunion, peri-implant fractures, and malunion. Some 60% of the patients did not regain their previous ambulatory capacity. Post-operative weight-bearing status did not correlate with the final functional outcome.

Conclusions Polio patients with femoral fractures have a guarded prognosis for regaining their pre-injury ambulatory capacity. A higher re-operation rate than that with “normal” osteoporotic fractures is expected.

Keywords Poliomyelitis · Osteoporotic fractures · Femoral fractures

Introduction

Many polio-surviving patients from the 1940s and 1950s are still alive. These individuals are of special interest as they have reached their sixth and seventh decades and are thus prone to osteoporotic fractures. The exact pathophysiological mechanism for fractures in this population is unknown, but increased osteopenia and altered muscle mass and balance are believed to be contributing factors toward such fractures [1], as well as for a high incidence of falls [2].

Proximal femoral fractures are among the most common osteoporotic fractures seen in orthopaedic practice [3], and distal femoral fractures are increasing in frequency in the geriatric population [4]. The general rule regarding these fractures is early fixation and aggressive rehabilitation in an

attempt to promote return to function. However, there are major differences between “normal” geriatric patients and polio survivors with respect to bony anatomy, including valgus oriented hips, increased version, and a narrow medullary canal [5]. Rehabilitation can be also impaired by deficient muscle mass, impaired gait, and severely decreased bone mass. Therefore, modifications of conventional surgical techniques might be required in this patient group, and there may well be less predictable outcomes.

The aim of the present study was to determine the surgical and functional outcome among polio survivors suffering from osteoporotic femoral fractures.

Patients and methods

A retrospective, Institutional Review Board (IRB) approved cohort study was performed in an academic Level I trauma centre. The cohort consisted of patients with a history of poliomyelitis with at least one affected lower extremity who presented with femoral fractures between the years 1990 and 2014. A total of 65 patients with 74 fractures met our inclusion criteria. Patients with pathological fractures were excluded from the study.

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The patients' medical records were reviewed, and demographic information including age, sex, and the type of femoral fracture was noted. Fixation methods including non-operative treatment and surgical osteosynthesis methods were also noted. Peri-operative complications were reviewed. Lastly, post-operative ambulatory status at the last follow-up appointment was evaluated and documented. A phone survey was conducted among surviving patients, which included the Parker and Palmer mobility score, as well as the modified Short-Form 12 questionnaire (SF-12) for general mental and physical quality of life.

All relationships were statistically analyzed using either Students' *t*, ANOVA, or chi-square tests using SPSS version 19 (IBM, USA). Significance was defined as a *P* value of less than 0.05.

Results

The female-to-male ratio was 1.47:1. Average age on admission was 60.2 years (range 10–85 years). Median hospital stay was eight days (range 0–58 days). In the vast majority of patients, the fracture mechanism was low-energy trauma (Table 1).

The most prevalent fractures consisted of proximal femoral fracture ($n = 39$), followed by distal femoral fractures ($n = 24$) and midshaft femoral fractures ($n = 11$). The polio-affected limb was involved in the majority of cases (62 out of 74 fractures). It should be noted though that all contralateral fractures were the result of low-energy mechanisms. The complete epidemiological details are presented in Table 1. Of the 65 patients, 27 died during the follow-up period and seven were not available for phone interview, leaving 31 patients who were available for the administration of post-operative outcome scores.

Table 1 Patient demographics and fracture characteristics of 65 patients with 74 fractures

	Number (percent)
Gender	
Male	30 (40.5%)
Female	44 (59.5%)
Average age \pm SD	60.2 \pm 13.5
Mechanism of injury	
Simple fall	61 (82.4%)
Sudden movement	5 (6.8%)
High-energy trauma	6 (8.1%)
N/A	2 (2.7%)
RT/LT ratio	33:41
Plegic extremity	62 (83.8%)
Fracture type	
Proximal (OTA31)	39 (52.7%)
Shaft (OTA32)	11 (14.9%)
Distal (OTA33)	24 (32.4%)

Operative treatment

Fifty-seven out of 74 fractures (86%) were fixed operatively in our institution, whereas 16 were treated non-operatively usually using a splint/cast and one was treated with excisional arthroplasty. The latter groups consisted of nonwalkers/wheelchair-bound patients, that is, mainly nonambulatory individuals.

Among the 39 proximal fractures, the major modality of treatment consisted of internal fixation. Six patients were treated with a Compression Hip Screw (Smith & Nephew, Memphis TN), and three subtrochanteric fractures with a 90 D-degrees Dynamic Condylar Screw. In the later years of the study period (after 2001), nine patients were treated with a Percutaneous Compression Plate (PCCP, Orthofix, Verona, Italy; Fig. 1). Cannulated cancellous screws were used in eight patients and cephalomedullary nails in seven. Three proximal femoral fractures with a displaced femoral neck fracture required hemiarthroplasty (using a posterior approach, one Austin Moore implant and two cemented bipolar hip hemiarthroplasties). Two cases of proximal femoral fractures were treated nonoperatively owing to associated severe medical comorbidities, and one case was treated with excisional arthroplasty owing to an initial nonambulatory status. The data regarding proximal femoral fractures are detailed in Table 2.

The majority of the distal femoral fractures were treated nonoperatively ($n = 12$): nine distal fractures were plated, and two distal fractures were treated with retrograde intramedullary nails. One case involving the lateral condyle alone was fixed with screws alone.

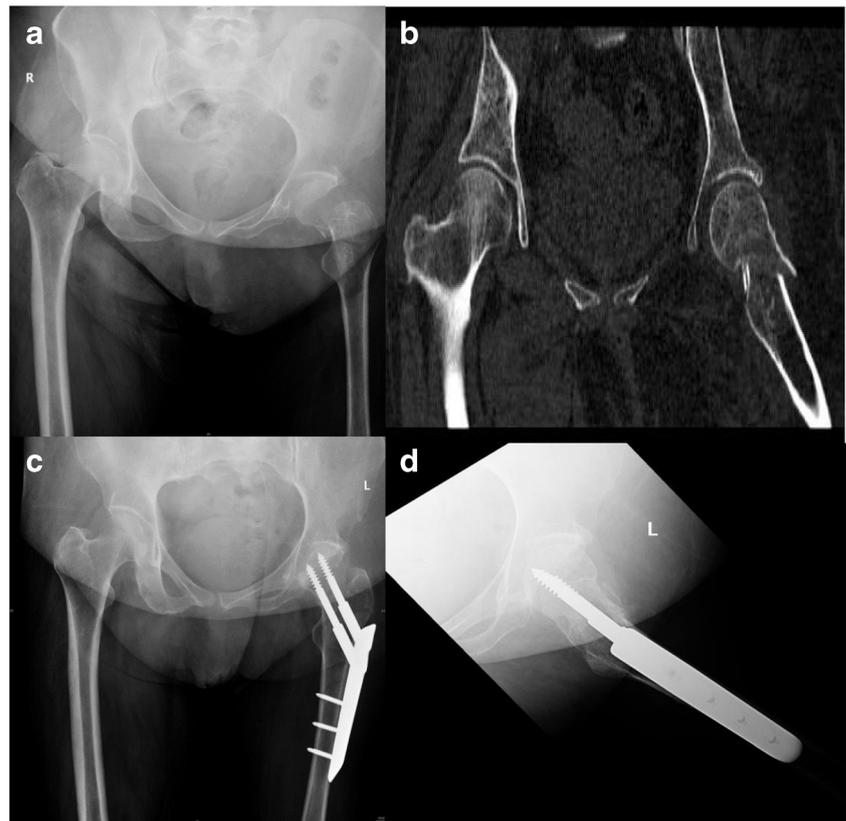
Out of 11 femoral shaft fractures, seven were treated with antegrade intramedullary nails, one was treated with a retrograde femoral nail, one was plated, and two were treated non-operatively (one nonambulatory patient and one nondisplaced fracture).

Functional outcome

Pre-injury status: 56 of the patients had physical independent gait prior to sustaining a femoral fracture. Forty-five walked without the use of orthotics, whereas 11 required walking aids. There was no significant difference between walking status prior to injury and either the mechanism of the injury or the fracture type. Strict post-operative instructions were given to all study participants, and a detailed discharge letter containing these instructions was provided.

Post-treatment status: 52 cases were instructed not to bear weight on the fractured limb during the six immediate post-operative weeks, and 19 were instructed to bear either partial ($n = 7$) or full weight ($n = 12$) on the injured limb (three fracture cases did not specify whether they should bear weight). There was a significant difference between the instructions to

Fig. 1 A 63-year-old female polio patient with residual left limb weakness presented with right hip pain after falling: on X-ray, a basicervical hip fracture was detected (**a**). A CT scan was then done to further assess osteopenia and valgus deformity (**b**). The fracture was then reduced and fixed using the Gottfried PCCP system (**c, d**). The patient recovered her ambulatory capacity



bear weight based upon fracture site ($p < 0.01$): proximal femoral fracture patients were instructed to either bear weight ($n = 17$) or not ($n = 22$) (one patient was unavailable), and distal femoral fracture patients were almost always instructed not to bear weight ($n = 23$, as compared to one patient alone). Different constructs (plating or nailing) did not affect the decision regarding immediate weight-bearing.

Out of the 57 operative patients, 26 were subsequently transferred to inpatient rehabilitation facilities and 30 were discharged home. Of the ambulatory patients, only 22 returned to their pre-fracture ambulatory status by their final follow-up (39.3%), with 46 patients achieving some walking capacity (82.1%). Multivariate analysis failed to demonstrate a correlation among fracture type, mechanism of injury, and affected limb involvement. Inpatient rehabilitation following surgery or immediate weight-bearing status was also not correlated with the final ambulatory capacity. This was consistent with proximal, shaft, or distal fractures.

Functional outcome scores

Of the patients who were available for follow-up ($n = 31$), 25 were instructed not to bear weight on the affected limb, which led to a lower Parkland and Palmer mobility score 3.83 ± 2.82 as compared with 5 ± 2.97 in the weight-bearing group ($n = 6$). Multivariate analysis failed to demonstrate a correlation among fracture types, mechanism of injury, and affected limb involvement. Subanalyses showed that almost all of the weight-bearing group exhibited proximal femoral fractures with an average mobility score of 5.6 ± 2.88 , which was higher than in the non-weight-bearing group, but still did not reach statistical significance ($p = 0.11$). Pre-existing selection bias of non-ambulatory patients prior to fracture which were treated mainly non-operatively in midshaft and distal fracture did not allow statistical analyses of that subpopulation.

When assessing HRQoL using SF-12, the scores did not differ significantly between the groups (71.36 ± 14.29 in the

Table 2 Functional scores stratified based on fracture location

	Parkland and Palmer mobility score	SF-12 score	PCS score	MCS score
Proximal	4.29 ± 2.57	71.13 ± 13.31	63.07 ± 10.79	79.18 ± 19.66
Shaft	4.17 ± 2.64	71.76 ± 17.39	67.22 ± 16.77	76.3 ± 20.86
Distal	3.73 ± 3.55	70.59 ± 14.82	63.17 ± 14.79	77.59 ± 19.56

Table 3 Functional scores based on weight-bearing instructions

	Parkland and Palmer mobility score	SF-12 score	PCS score	MCS score
WB	5.6 ± 2.88	68.55 ± 12.14	59.78 ± 5.85	77.33 ± 19.47
NWB	3.83 ± 2.82*	71.56 ± 14.52	64.58 ± 13.73	78.35 ± 19.56

* $p = 0.11$

NWB group and 66.3 ± 12.1 in the WB group, $p = \text{NS}$). Additionally, no significant difference was found between the groups in the Physical and Mental Component Scale scores (PCS and MCS). The full listing is detailed in Table 3.

Complications

Although all operative fractures apart from that in one patient (who died prior to adequate follow-up) healed, the overall reoperation rate was 16% (9/56 cases). Two cases of nonunions of proximal shaft fractures were successfully treated with exchange nailing. Two cases of screw fixation had subsequent subtrochanteric fractures below their fixation and were treated by nailing. One case of an intertrochanteric fracture had a varus collapse and cutout and was revised, but the patient died within a few months owing to other causes. In three cases (two DCSs and one screw fixation), hardware was removed because of implant prominence and one case had a delayed derotation osteotomy for a long-standing malunion (Fig. 2).

Discussion

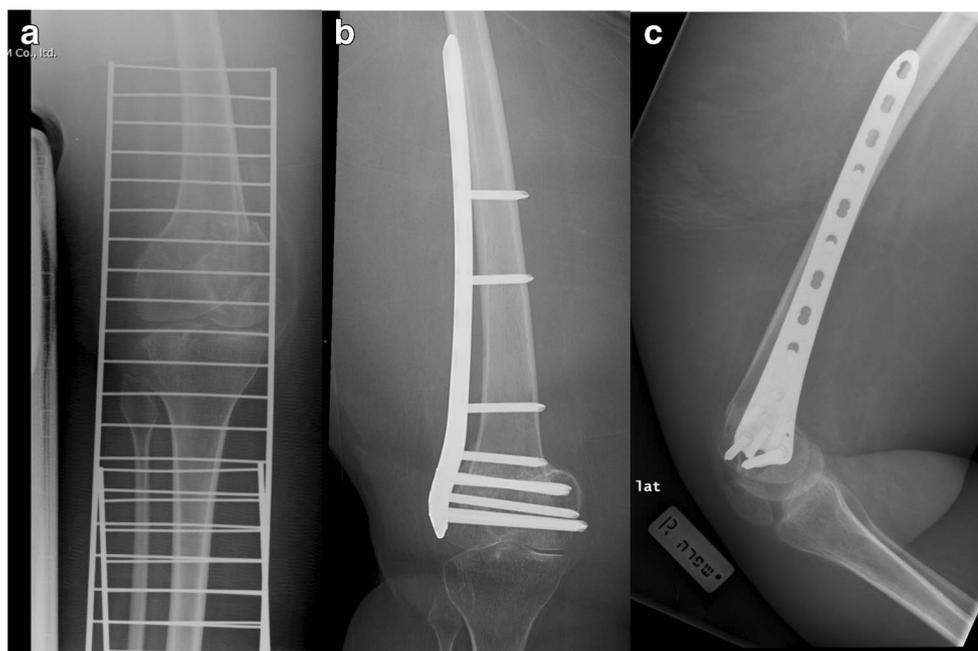
Our study describes the outcome of osteoporotic femoral fractures in the polio population. We observed a significant complication rate and compromised rehabilitation potential, regardless of the treatment and post-operative care. Although recent studies regarding polio patients are scarce, owing to the infrequency of infection and almost total eradication, we decided to investigate this population because of the challenges it presents to the orthopaedic surgeon, especially as children of the last full-blown epidemics in the Western world are reaching the age of osteoporotic fractures.

Surgical treatment of fractures in the polio population has been previously described [6]. The most recent articles by Khalil et al. [7] showed good results when a locked plate was used in femoral fractures. Wang et al. [8] also showed good results in distal femoral fractures that were treated with LCP plates. In our department, many patients were treated in the early and mid-1990s, especially for distal fractures, a time in which modern retrograde nails and locking plates were not yet

Fig. 2 A 47-year-old male polio patient with bilateral lower limb weakness presented with right hip pain after falling: on X-ray, an intertrochanteric hip fracture was detected and fixated with a DHS (a). On follow-up, the fracture has healed in valgus malalignment (b) requiring derotational osteotomy while maintaining the DHS's blade in the head (c). Post-operative imaging showed full healing with better positioning (d, e). However, functional improvement was not observed and actually the patient deteriorated



Fig. 3 A 64-year-old female patient with a distal femoral fracture (a) fixed with a 4.5-mm locked distal femoral plate. The patient developed progressive knee arthritis and did not return to her preinjury function. Note the mismatch between the standard plate and the patient femur (b, c)



available, and in many cases, non-operative treatment was preferred as opposed to using old, nonlocking implants with expectation of failure. Several of our more recent patients were successfully treated with modern-locking plates, which appear to overcome some of the obstacles in polio-patient surgery, namely poor bone quality and mismatch between the implant and the deformed bone, resulting in a nonperfect fit between the anatomical plate and the bone.

Similar to the general population, femoral osteoporotic fractures in our study were more common in female patients. Despite the heterogeneity of our fracture types, the average age for fractures in our population was younger than expected. This might be due to the osteoporotic tendency of the polio population, especially in the affected extremities.

It could also be that unaffected extremities in polio patients are more porotic owing to overall reduced mobility and are more susceptible to osteoporotic fractures with more complicated course and therefore were also included in this study (Fig. 1).

Complications included nonunions, peri-implant fractures, malunion, cutout, and prominent hardware, which together led to a re-operation rate of 16%. Given the technical difficulties encountered during surgery on these patients, which were due to osteoporotic bone and hardware mismatch (Fig. 3), this complication rate is reasonable. It should be noted that at the time of the study, older implant types were used in at least one-half of the patients. A recent study reports much higher complication rates with “normal” geriatric patients treated with third-generation cephalomedullary implants [9]. This result might be biased owing to a relatively high number of nonoperative patients.

The rehabilitation of polio patients is extremely difficult as evident from our study. Nearly 60% of pre-operative

ambulators lost some or all of their ambulatory capacity. Although this number is similar to the rate found in geriatric hip fractures [10], it should be noted that the average age of the patient group presented in this study was much younger than the typical hip fracture population. Postoperative weight-bearing or staying in an inpatient rehabilitation facility did not significantly change this grim result, in contrast with what we believe to be true when dealing with hip fracture surgery [11].

This study was limited by the rarity of the disease today, its retrospective nature, and the heterogeneity of fractures. Other study limitations were changes in surgical practice over the years and lack of clinical follow-up in many of the patients owing to the long study period and a substantially higher mortality rate, especially in those sustaining femoral hip fractures. However, it does provide some insight regarding these hard-to-treat fractures and patients, and the potential goals that should be sought when treating femoral fractures in polio patients.

Authors' contributions YNG and YAW designed the study, supported data collection, performed data analyses, and wrote and revised the manuscript. AK, ML, and RM designed the study, operated the patients, and critically reviewed the manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval An IRB (institutional Review Board) approval was obtained for this study according to the 1964 Helsinki Declaration.

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