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Case Report

Non-prosthetic implant-related femur fractures in post-polio patients

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ABSTRACT

The overall societal impact of poliomyelitis worldwide is decreasing, rendering it almost absent in most developed countries. However, even there, patients are still seen who contracted it in endemic areas or developed polio before vaccinations became widely available. Post-polio syndrome (PPS) causes skeletal and neurological changes that increase affected individuals' likelihood of fractures, including fractures requiring complex surgical treatment. The existence of previous internal fixation creates a particularly difficult challenge. We present here the surgical management of four post-polio patients who suffered non-prosthetic implant-related femoral fractures. Injuries occurred at earlier ages than implant-related fractures in non-polio patients and three of the four fractures occurred around plates, a phenomenon which is usually rare. The treatment of implant-related fractures in patients with post-polio syndrome poses significant technical challenges, often creating problematic functional sequelae for patients and high costs for healthcare systems.

Introduction

Poliomyelitis is a viral disease in which the usual portal of human bodily entry is through the mouth, most commonly through virus-containing cough droplets or contaminated feces. It mostly affects children. In some, the virus crosses the blood-brain barrier and infects neurons in the anterior horn of the spinal cord, leading to asymmetrical flaccid paralysis. Although polio has been eradicated in most developed countries, we still see imported cases and associated long-term sequelae [1,2]. Post-polio syndrome (PPS) is a late presentation of this disease often characterized by pain, fatigue, weakness, muscle atrophy, and reduced mobility in previously neurologically-impaired areas [3]. The condition can lead to an osteoporotic, deformed and hypovascularized skeletal structure [4]. Implant-related fractures (IRF) have been previously described as a complication of fracture fixation in post-polio syndrome patients, but not extensively studied [5]. We present here a retrospective review of four consecutive cases of non-prosthetic femoral IRF in PPS patients.

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Table 1
Characteristics of patients, injuries, treatments and results.

Case	Sex	Age[a]	ASA[b]	Time between fractures[c]	Initial injury		Current injury			Ambulation aid		Complications
					Fracture[d]	Treatment	Fracture[e]	Removal	Implant	Previous	End of follow-up	
1	Female	64	II	9 years	32A3	Non-locking plate	33CPP	Complete	Locking plate	None	Wheelchair	Nonunion
2	Male	65	II	25 years	32A2	Non-locking plate	32BPD	No	Locking plate	None	Crutches	
3	Female	53	II	7 months	32A1	Retrograde IMN	31CND	Complete	CMN	None	Crutches	
4	Female	63	III	18 months	33A2	Locking plate	32CPD	Partial	CMN	Walker	Wheelchair	

[a] American Society of Anesthesiologists Physical Status Classification.
[b] Years old.
[c] Period of time between fixation of initial and current injuries.
[d] As per AO/OTA classification system.
[e] As per Videla et al. classification system [6].

Case series

Between October 2018 and February 2020, four PPS patients with non-prosthetic, femoral IRF between 53 and 65 years old were surgically treated at a single, level I trauma center. Clinical and radiological features of each case are summarized in Table 1 and Fig. 1A–D. All had spinal PPS involvement and neurological repercussions involving the fractured limb. Two patients also had ipsilateral hemiparesis. All had relevant medical conditions and had an American Society of Anesthesiologists Physical Status Classification (ASA) score $\geq$ II. Previous fixation had occurred between seven months and 25 years before the current injury. Three patients had a plate and one an intramedullary nail. All IRF were classified according to the system proposed by Videla-Ces et al., being located distant from or adjacent to the implant [6]. All four affected femurs had significant metaphyseal deformities and a narrow medullary canal.

All the fractures occurred as secondary to low-energy trauma. For fixation of the IRF, cephalomedullary nails were used in two patients and locking plates in two. Case #4 (Fig. 1D) started immediate full weight-bearing after the procedure, while the remaining three had weight-bearing restrictions for a mean 8.3 weeks. Hospitalization was prolonged, averaging 16.5 days, with a mean delay from admission to the procedure of 6.5 days. All patients, except one, needed transfer to a public nursing care facility upon hospital discharge.

All fractures, but one, consolidated within 7.5 to 9.9 months. Case #1 (Fig. 1A) had nonunion, which we attributed to malreduction, resulting in inadequate medial support and varus collapse at the fracture site. A salvage procedure was performed that consisted of revision of the fixation using a nail and plate combination, with consolidation ultimately achieved 26.6 months after the initial surgery. No other postoperative complications were recorded. However, all four patients experienced an increased need for walking aids after the IRF fixation, two using a wheelchair.

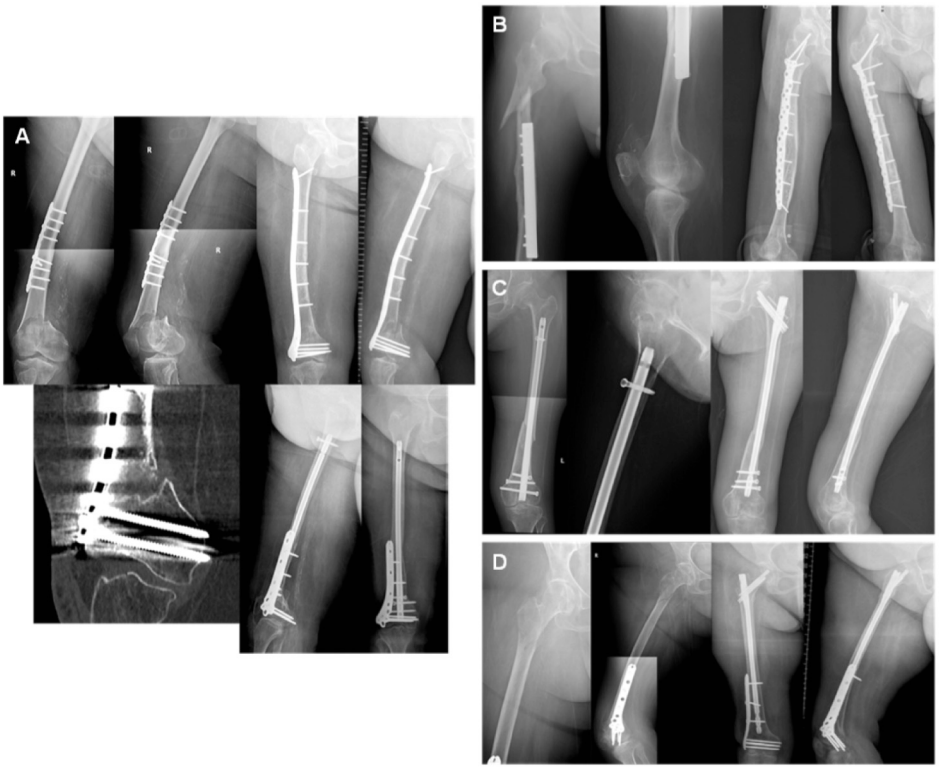

Fig. 1. Preoperative and postoperative imaging of all cases.
A. Case #1. Femoral shaft fracture treated with a non-locking lateral plate, resulting in varus malunion. Nine years later, the patient presented with a distal femur articular fracture, which we stabilized with a locked lateral plate contoured to the shaft deformity after removing the previous implant. Treatment failed, however, resulting in non-union, which we salvaged using a nail-plate combination.
B. Case #2. Subtrochanteric fracture proximal to 25-year-old plate fixation and recurvatum malunion. It was treated by removing the implants and stabilizing the bone with cerclages and a locked lateral periprosthetic plate.
C. Case #3. Femoral neck fracture following internal fixation of a distal diaphyseal fracture with a retrograde intramedullary nail, performed seven months earlier. A nail exchange was performed, this time using a cephalomedullary device and an additional anti-rotational screw in the femoral neck.
D. Case #4. Non-displaced subtrochanteric fracture proximal to lateral locking plate fixation of the distal femur performed 18 months earlier. Treatment consisted of partial removal of distal implants and cephalo-medullary nailing.

Discussion

Post-polio syndrome is a diminishing problem, many countries eradicating the virus due to worldwide vaccination campaigns initiated in 1988. However, it is estimated that 200,000 new cases could emerge annually in developing countries with persistent endemic transmission [1]. In developed countries, pre-vaccination patients with diverse degrees of neurological sequelae and imported cases also continue to require healthcare services [7].

Non-prosthetic IRFs occur at younger ages in PPS patients than in the general population. In our series of four PPS patients, ages ranged from 53 to 65 years, while our previously-reported sample on IRF after cephalomedullary nail fixation averaged 87.3 years old [8]. This earlier presentation among those with PPS likely relates to long-standing muscle atrophy that reduces stability and creates gait disturbances, consequentially both altering skeletal structure and increasing the risk of falls. A higher frequency of recurrent falls has been described in PPS patients, relative to those 55 years old and older in the general population [4].

Treatment of fractures in PPS-affected extremities continues to create surgical dilemmas. Different management options have been described that consider the special characteristics of PPS bones, which generally are osteoporotic, have narrow medullary canals, and often have prior deformities and/or issues with bone consolidation as sequelae from previous fractures or surgeries [1,4]. Intramedullary nailing is usually challenging because of the narrow canal and potential contractures around the hip and knee [7]. Locked plating has yielded good functional results in this population, given the potential to contour implants to the non-anatomical shapes of PPS bones. This is especially useful when dealing with IRFs around intramedullary implants. However, the irregular and small diameter of affected femurs may lead to difficulties with implant sizing [1,8–10]. Previous incisions may limit approach options and minimally-invasive techniques are advised to preserve osseous blood supply [9]. The presence of previous implants posed additional problems in our series, with three of our four patients requiring the removal of previous implants, a procedure which often was complex since latency periods in our patients ranged up to 25 years.

The mechanical performance of any construct is impaired by the extremely poor quality of PPS bone. This is particularly concerning given the creation of elevated stress forces at the terminal ends of implants. Extramedullary implants cause less force dissipation at their terminal ends than intramedullary implants. In our PPS patient series, three of the four fractures occurred around a plate, a phenomenon that is otherwise uncommon. This phenomenon may be attributable to both the extreme bone fragility these patients have and the preferential use of plates in these patients, due to difficulties using nails. Primary whole-bone fixation can be considered for femoral fractures in PPS patients, as is standard practice for IRF [1,8]. However, this suggestion is merely speculative and could be extremely demanding, from a technical perspective, in many cases. This option thereby requires considerable further investigation.

For PPS IRF patients, it is difficult to restore pre-injury function after fracture fixation [10]. Even optimal surgical management can lead to high reoperation rates, ranging from 7 to 16 %, such procedures including operations for implant removal, nonunion, malunion, and IRF [1,5,9]. On the other hand, non-operative treatment of PPS fractures typically results in excessive immobilization periods, thereby worsening patients' overall prognosis [7]. We believe that, even in patients presenting with severe functional impairment, any femoral fracture in which surgical fixation is indicated and technically feasible should undergo it, taking into account the severe impact on quality of life that long-lasting pain would cause. Also consequent to these patients' fragility are high health resource consumption during hospitalization and stays in nursing facilities.

In conclusion, fractures in PPS-affected femurs are challenging to treat, and even more so when they are IRF. In addition to inherent difficulties, there typically is the need for surgeons to remove implants or the existence of consolidation issues or deformities, both caused by and beyond those caused by polio. In addition, IRF in PPS patients may affect younger patients, leading to life-altering functional sequelae and increased healthcare costs spanning many years.

Ethical approval

This study has been performed under the guidance of the WMA Declaration of Helsinki on Ethical Principles for Medical Research Involving Humans Subjects.

Consent to participate and publish

All patients gave informed consent to participate in this study and all the collected data were de-identified.

Authors' contributions

All authors contributed to the study conception and design and writing. All authors read and approved the final manuscript.

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Declaration of competing interest

The authors have financial conflicts of interest to declare with Smith & Nephew, Zimmer-Biomet, Stryker and MBA Surgical Empowerment.

Data availability

The data that support the findings of this study are available from the corresponding author, José Vicente Andrés Peiró, upon reasonable request.

References

[1] J. Mingo-Robinet, J.A. Alonso, M. Moreno-Barrero, L. González-García, V. Garcia-Virto, H.J. Aguado, Aspectos técnicos y complicaciones en el tratamiento de las fracturas de los miembros inferiores con secuelas de poliomielitis, Rev. Eesp. Cir. Traumatol. Ortop. 62 (2018) 257–266, https://doi.org/10.1016/j.recot.2018.01.011.

[2] P. Checa Betegón, J. Valle Cruz, J. García Coiradas, A. Rodríguez González, A. González Pérez, E. Torrecilla Cifuentes, et al., Fractures in patients with poliomyelitis: past or current challenge? Injury 51 (2020) S48–S54, https://doi.org/10.1016/j.injury.2020.02.029.

[3] J.K. Lo, L.R. Robinson, Postpolio syndrome and the late effects of poliomyelitis. Part 1. Pathogenesis, biomechanical considerations, diagnosis, and investigations: postpolio syndrome, part 1, Muscle Nerve 58 (2018) 751–759, https://doi.org/10.1002/mus.26168.

[4] H.B. Çevik, Management of femoral fractures in aging adult polio population: a retrospective review of 13 cases, South Clin. Istanb Eurasia (2020), https://doi.org/10.14744/scie.2019.95967.

[5] Y.N. Gellman, A. Khoury, M. Liebergall, R. Mosheiff, Y.A. Weil, Outcome of femoral fractures in poliomyelitis patients, Int. Orthop. 43 (2019) 2607–2612, https://doi.org/10.1007/s00264-019-04285-2.

[6] M. Videla-Cés, J.-M. Sales-Pérez, R. Sánchez-Navés, E. Romero-Pijoan, S. Videla, Peri-implant Femoral Fractures Study Group, Proposal for the classification of peri-implant femoral fractures: retrospective cohort study, Injury 50 (2019) 758–763, https://doi.org/10.1016/j.injury.2018.10.042.

[7] S.P. Garceau, E.N. Igbokwe, Y. Warschawski, M.E. Neufeld, O.A. Safir, J.P. Wade, et al., Management options and outcomes for patients with femoral fractures with post-polio syndrome of the lower extremity: a critical analysis review, JBJS Rev. 8 (2020) e0146, https://doi.org/10.2106/JBJS.RVW.19.00146.

[8] I. Vilar-Sastre, S. Corró, J. Tomàs-Hernández, J. Teixidor-Serra, J. Selga-Marsà, C.-A. Piedra-Calle, et al., Fractures after cephalomedullary nailing of the femur: systematization of surgical fixation based on the analysis of a single-center retrospective cohort, Int. Orthop. 46 (2022) 2357–2364, https://doi.org/10.1007/s00264-022-05490-2.

[9] Khalil A. El-Sayed, Locked plating for femoral fractures in polio patients, Arch. Orthop. Trauma Surg. 130 (2010) 1299–1304, https://doi.org/10.1007/s00402-010-1126-z.

[10] W. Wang, H. Shi, D. Chen, Y. Chen, J. Wang, S. Wang, et al., Distal femoral fractures in post-poliomyelitis patients treated with locking compression plates: LCP for femoral fractures in post-polio, Orthop. Surg. 5 (2013) 118–123, https://doi.org/10.1111/os.12035.