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Atypical Vancouver B1 Periprosthetic Fractures: The Unsolved Problem

Giovanni Vicenti[1], Giuseppe Solarino[1], Guglielmo Ottaviani[1], Massimiliano Carrozzo[1], Filippo Simone[1], Giacomo Zavattini[1], Domenico Zaccari[1], Claudio Buono[1], Davide Bizzoca[1], Giuseppe Maccagnano[2], and Biagio Moretti[1]

Abstract

Atypical femoral fractures (AFF) are stress or insufficiency fractures induced by low energy trauma or no trauma, frequently correlated with prolonged bisphosphonate therapy. The diagnosis follows major and minor criteria, originally described by the Task Force of the American Society for Bone and Mineral Research in 2010 and updated in 2014. However, the definition of AFFs in the report excluded periprosthetic fractures. When atypical fractures occur close to a prosthetic implant the situation become critical, the surgical treatment is often demolitive and supported by medical treatment. Moreover, acute ORIF as a first line treatment is frequently burdened by a high failure rate , and often a stem revision is required as second line treatment. The healing process is long and difficult with poor functional results and impairing outcomes. We present a case treated at our institution of a 78 year old woman with a history of a femoral atypical periprosthetic fracture, complicated by multiple surgical revisions. Its arduous management reflects all the difficulties that these type of fractures could present to the surgeon, while its good final result may teach us how to approach them in a correct way.

Keywords

periprosthetic fractures, femur fractures, vancouver classification, osteoporosis, atypical femur fracture, open reduction and internal fixation, revision stem

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Introduction

Total hip arthroplasty (THA) represents one of the most common and successful orthopedic procedures. As a result of the ageing of the population the number of implanted arthroplasties is globally increasing and consequently the number of periprosthetic fracture (PPF) is rising too. The incidence of PPF after primary THA has been reported at less than 1%[1,2] and is considered the third most common reason for revision.[3,4] This complication has a significant impact on a patient's clinical outcome with high morbidity and mortality. Atypical femoral fractures (AFF) are stress or insufficiency fractures induced by low energy trauma or no trauma. These fractures are frequently correlated with

[1]School of Medicine, University of Bari "Aldo Moro"- AOU Policlinico Consorziale, Bari, Italy
[2]Department of Basic Medical Sciences, Neuroscience and Sense Organs, Foggia University Hospital, Foggia, Italy

Corresponding Author:
Giovanni Vicenti, School of Medicine, University of Bari "Aldo Moro"- AOU Policlinico Consorziale, Piazza Giulio Cesare 11, Bari 70124, Italy.
Email: dott.gvicenti@gmail.com

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prolonged bisphosphonate (BP) therapy. The diagnosis follows major and minor criteria, which were originally described by the Task Force of the American Society for Bone and Mineral Research (ASBMR) in 2010 and updated in 2014[5] (Table 1). However, the definition of AFFs in the report excluded periprosthetic fractures. When atypical fractures occur close to a prosthetic implant the situation become critical, the surgical treatment is often demolitive and supported by medical treatment. The healing process is long and difficult with poor functional results and impairing outcomes. It also has a significant economic impact, due to the complex nature of the surgery and prolonged rehabilitation requiring lengthy hospital stays.[6]

Clinical Case

A 78-year-old woman with right cementless THA implanted following a femoral neck fracture in 2012, fell in August 2015. Radiographs revealed a periprosthetic non-comminuted transverse fracture with medial cortical thickening just distal to the tip of the stem (Figure 1). The patient also reported aggravating tight pain over the past 3 months. The patient comorbidities were heart disease, diabetes mellitus type 2 and osteoporosis, treated with Alendronic acid (70 mg/week) and cholecalciferol for 3 years. The patient underwent open reduction and internal fixation (ORIF) with NCB periprosthetic femur plate system (Zimmer Biomet, Warsaw), cerclages and medial cortical strut allograft (Figure 2). Intraoperatively the stem was found to be stable. Alendronic acid was suspended and substituted with Teriparatide. After the surgery, the patient was allowed to early active and passive mobilization with partial weight bearing with walker. However, only after 4 days she sustained a hardware failure (Figure 3). The patient underwent a new surgical open reduction and internal fixation with a longer plate augmented with a longer cortical strut on the medial side (Figure 4). Wheelchair use and non-weight bearing were advised for 30 days. After 6 months of partial weight bearing the patient returned to our hospital for the onset of right tight pain. Radiographic evaluation revealed breakage of the locking plate and a refracture at the same place (Figure 5). Implant instability and bone stock deficiency were found during surgery. The prosthesis was then replaced with an Arcos Modular Femoral Revision Stem Interlocking 20 mm × 250 mm (Zimmer Biomet, Warsaw) distally locked with 3 cortical screws. The ceramic head was replaced too with a 36 mm Biolox Delta (Figure 6). She was allowed to protected weight bearing walking for 6 weeks and then full weight bearing. At 6 month follow up the fracture was considered clinically healed but radiographic union was still incomplete. However, the patient was able to walk with a walker without pain.

Discussion

We reported a complex case of BP related femoral fracture around a well fixed cementless stem. The 2013 ASBMR diagnostic criteria for AFF require the

Table 1. 2010 American Society for Bone and Mineral Research Task Force Case Definition of Atypical Femoral Fracturess.

Specifically excluded are fractures of the femoral neck, intertrochanteric fractures with spiral subtrochanteric extension, pathological fractures associated with primary or metastatic bone tumors and peri-prosthetic fractures.

Major features	Minor features
• Located anywhere along the femur from just distal to the lesser trochanter to just proximal to the supracondylar flare	• Localized periosteal reaction of the lateral cortex
• Associated with no trauma or minimal trauma, as in a fall from a standing height or less	• Generalized increase in cortical thickness of the diaphysis
• Transverse or short oblique configuration	
• Non-comminuted	• Prodromal symptoms such as dull or aching pain in the groin or thigh
• Complete fractures extend through both cortices and may be associated with a medial spike; incomplete fractures involve only the lateral cortex	• Bilateral fractures and symptoms • Delayed healing • Comorbid conditions (e.g., vitamin D deficiency, rheumatoid arthritis, hypophosphatasia) • Use of pharmaceutical agents (e.g., BPs, glucocorticoids, proton pump inhibitors)

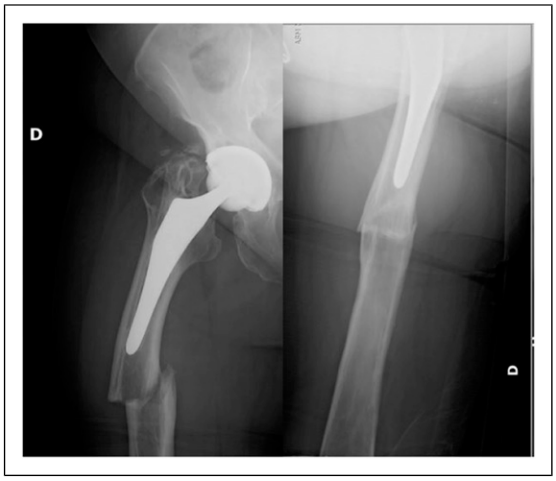

Figure 1. Transverse vancouver B1 periprosthetic fracture with cortical thickening.

Figure 2. Open reduction and internal fixation with NCB periprosthetic femur plate system (Zimmer Biomet, Warsaw), cerclages and medial cortical strut allograft.

Figure 3. Hardware failure 4 days after the surgery.

Figure 4. Reduction and fixation with a longer plate and a longer cortical strut on the medial side.

presence of at least 4 of the 5 major criteria[5] as summarized in Table 1. This case fulfill all the 5 major criteria and 1 of the minor. This fracture challenges the current definition of AFF that excludes PPF. A review of the literature identified 13 articles reporting 25 cases as summarized in Table 2. AFF are known to be related to many comorbidities like metastatic lesions, osteomalacia or dysmetabolic conditions as primary hyperparathyroidism.[7] Many authors proposed correlation between insufficiency femoral fractures and long term antiresorptive therapy.[8-10] BPs related fractures can be favored by a combination of suppressed bone turnover and repetitive stress, resulting in fatigue failure. The site of maximal stress occurs in the subtrochanteric area as described by Pauwels.[11] Atypical periprosthetic fractures (APPFs) are probably induced by the above elements plus patient and implant related factors such as femoral stem loosening, varus

Figure 5. Refracture at the same level after 6 months of partial weight bearing.

Figure 6. Revision surgery with arcos modular femoral revision stem interlocking 20 mm × 250 mm (Zimmer Biomet, Warsaw) distally locked with 3 cortical screws.

alignment, stem-tip impingement and osteolysis.[12] Moreover PPFs are described to occur more frequently after application of cementless THAs.[13] Robinson et al. reported on 10 cases of APPFs, they reported an overall incidence of complications of 25%, a mortality of 10% and an average time to union at 8 months.[14] Proposed treatment of these injuries is both medical and surgical depending on fracture pattern. Incomplete fractures were treated conservatively by discontinuing BPs, starting Teriparatide and limiting weight bearing. Sayed-Noor and colleagues proposed prophylactic ORIF if conservative treatment shows no improvement after 6 months in order to prevent the dangerous complications of APPFs.[15] Surgical treatment of femoral PPF is based on the Vancouver classification. It considers fracture location, stability of the implant and bone stock. Fractures which occur around a stable stem or close to the tip are classified as type B1 and the most common treatment is ORIF with plates, screws and/or cerclages and cortical strut allograft on the medial side when comminution is present. However, atypical transverse fractures must be considered unstable frequently lead to plate failure. For this reason, intramedullary nailing was proposed as treatment of choice. Regarding APPFs revision with a long stem implant may provide biomechanical stability similar to femoral nailing plus the advantage of faster recovery. Moreover, ORIF of these fractures is frequently biomechanically insufficient leading to high rate of failure. That is why we suggest a more invasive management of APPFs with long revision stems in order to prevent patient morbidity.

Table 2. Reviewed articles.

Author(s)	Year	Age	Sex	BP's (Years of use)	Comorbidities (Other drugs)	Prodromal symptom	Cortical thickening	AO classification	Treatment	Outcomes
Sayed-Noor[15]	2009	78	F	ALN (9)	None	+	+	32-A3	CONS (6 mths no improvement) then ORIF	5 months under observation
Curtin[16]	2011	52	F	ALN (5)	RA (GCs)	+	-	INCOMPLETE	CONS + Teriparatide	6 months under observation
		85	F	RIS (N/S)	RA (GCs)	+	+	INCOMPLETE	CONS + Teriparatide	6 months under observation
		79	F	ALN (>9)	RA (GCs)	+	+	INCOMPLETE	CONS	6 months healed
Schaeffer[17]	2012	79	F	ALN (10) then IBAN	N/S	+	+	32-A3	CONS then ORIF + stem revision	5 months under observation
Cross[18]	2012	81	F	ALN (>12)	None	+	+	INCOMPLETE	CONS + Teriparatide	6 months under observation
Chen[19]	2012	81	F	ALN (4) then IBAN (4 months)	N/S	+	+	32-A3	CONS then ORIF	2 months under observation
Reb[20]	2013	74	F	N/S (10)	None	+	+	INCOMPLETE	Stem revision	6 months healed
Bhattcharyya[21]	2014	72	F	ALN (10)	Parkinson disease, RA (GCs)	+	+	32-A3	CONS	3 months under observation
Lee[22]	2015	43	F	RIS (5,5)	N/S	+	+	32-A3	ORIF then ORIF + Teriparatide	30 months healed
		74	F	RIS (6)	N/S	+	+	32-A3	ORIF + Teriparatide	7 months under observation
		86	F	ALN (9,3)	N/S	–	+	32-A3	ORIF	8 months under observation
Wakayama[23]	2015	68	F	RIS (7)	RA (GCs)	+	+	32-A3	ORIF + Teriparatide	4 months under observation
Niikura[22]	2015	69	F	ALN (7)	Dermatomyositis, Interstitial pneumoniae (GCs, immunosuppressants)	+	+	32-A3	ORIF	24 months healed
Woo[24]	2016	82	F	ALN (3)	None	–	+	N/S	ORIF + Teriparatide then stem revision + ORIF	12 months healed
Bottai[25]	2017	77	F	ALN (>10)	N/S (GCs, chloroquine, Vit. D)	–	–	32-A3	ORIF then ORIF + Teriparatide	6 months under observation
Kurinomaru[26]	2019	81	F	ALN (N/S)	None	+	+	32-A3	ORIF + Teriparatide	4 months healed

(continued)

Table 2. (continued)

Author(s)	Year	Age	Sex	BP's (Years of use)	Comorbidities (Other drugs)	Prodromal symptom	Cortical thickening	AO classification	Treatment	Outcomes
Miura[27]	2019	81	F	ALN (>5)	N/S	+	+	N/S	CONS then ORIF + Teriparatide	24 months healed
		85	F	ALN (>5)	N/S	–	+	N/S	ORIF + Teriparatide	3 months under observation
Toro[28]	2020	84	F	N/S (7)	None	+	+	32-A3	ORIF then ORIF	6 months healed
		81	F	N/S (6)	None	+	+	32-A3	ORIF	6 months healed
		85	F	N/S (10)	None	+	+	Incomplete	ORIF	12 months healed
Wan[29]	2020	85	F	ALN (2)	None	–	N/S	32-B	ORIF + Teriparatide then ORIF then stem revision + ORIF	12 months healed

BPs: bisphosphonate; F: female; ALN: alendronate; RIS: risedronate; N/S: not specified; RA: rheumatoid arthritis; GCs: glucocorticoids; CONS: conservative; ORIF: open reduction internal fixation.

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ORCID iDs

Giovanni Vicenti https://orcid.org/0000-0002-7412-7990
Giuseppe Maccagnano https://orcid.org/0000-0002-8596-2422

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