Lu and Maruo Holledge. Trauma Cases Rev 2017, 3:048
DOI: 10.23937/2469-5777/1510048
Volume 3 | Issue 1

Trauma Cases and Reviews

ISSN: 2469-5777

Case Report: Open Access

Surgical Management of an Atypical Femoral Non-Union Fracture with Bone Morphogenic Protein Supplementation

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Abstract

This is a case report of a surgical treatment of the non-union of an atypical femoral fracture (AFF), associated with prolonged bisphosphonate use. The case is one of a sub-trochanteric non-union and implant failure, after an index procedure of a trochanteric entry-point-locked cephalomedullary nailing. The non-union fracture healed successfully by exchange of nail and autologous iliac crest bone graft and a bone morphogenic protein-7 (osteogenic protein-1, OP-1) supplementation.

This case describes one of the surgical treatment options for treating non-union with implant failure in AFF treatments. The case suggests that the surgical management of bisphosphonate-related AFFs should be different from standard fracture treatment: for example involving a thicker and longer intramedullary (IM) nail, an autologous iliac crest bone graft, and use of bone morphogenic proteins.

Keywords

Atypical femoral fractures, Hip fractures/surgery, Bisphosphonate, Non-union, OP-1

Introduction

The overall incidence of non-union or delayed union of subtrochanteric fractures, and subsequent failure of fixation, regardless of type, varies from 7% to 20% [1]. This case report provides one of the surgical treatment options for treating non-union with implant failure, for patients with AFF associated with bisphosphonate use. The optimizations of the mechanical environment (revision of fixation), along with the enhancement of the multidimensional biological pathways of bone healing, was used as the framework for a single stage surgical revision for atrophic non-union with implant failure in the AFF case.

Case Report

An 87-year-old female had a left upper frontal thigh pain with a sudden onset of pain in her hip. She had been unable to bear weight for 18 months previously, but with no history of falls or injuries. She has a co-morbidity including diabetes mellitus, and was on medications. She had been on a bisphosphonate (alendronate) for the previous ten years. Her initial radiographs were performed in a different hospital (with no radiographs available). She was diagnosed as AFF based on an ASBMR task force 2013 revised case definition of AFF [2].

The index IM nail insertion was performed in the first hospital. A piriformis entry-point-locked cephalomedullary nailing was used (Figure 1), and the patient was allowed weight bearing as tolerated, at six weeks after surgery. She reported that there was no pain on mobilization with the assistance of a four-wheel frame walker, post surgery. However, twelve months after surgery, she developed upper thigh pain and difficulty in walking. The radiographs showed an atrophic non-union fracture with the breakage of an IM nail at the level of the non-union fracture site. However, we noted that there was no breakage in the distal locking screws. This differed from the usual patterns of IM failure (Figure 1). Twelve months after initial management, revision surgery was performed with the removal of the broken implants, and re-insertion of a longer and thicker nail, plus an autologous iliac crest bone graft, and OP-1 supplementation at the fracture site. The patient was allowed weight bearing as tolerated, immediately after surgery. At nine months post revision surgery, complete healing was achieved (Figure 2).

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Citation: Lu J, Maruo Holledge M (2017) Surgical Management of an Atypical Femoral Non-Union Fracture with Bone Morphogenic Protein Supplementation. Trauma Cases Rev 3:048. doi.org/10.23937/2469-5777/1510048

Received: June 30, 2016: **Accepted:** February 20, 2017: **Published:** February 23, 2017

Figure 1: 12 months post index IM nailing the radiographs showed subtrochanteric fracture of the proximal femur with small oblique fracture line and cortices thicken on AP and lateral views. Breakages IM nail at the non-union site with intact distal locking screws were clearly demonstrated on AP view.

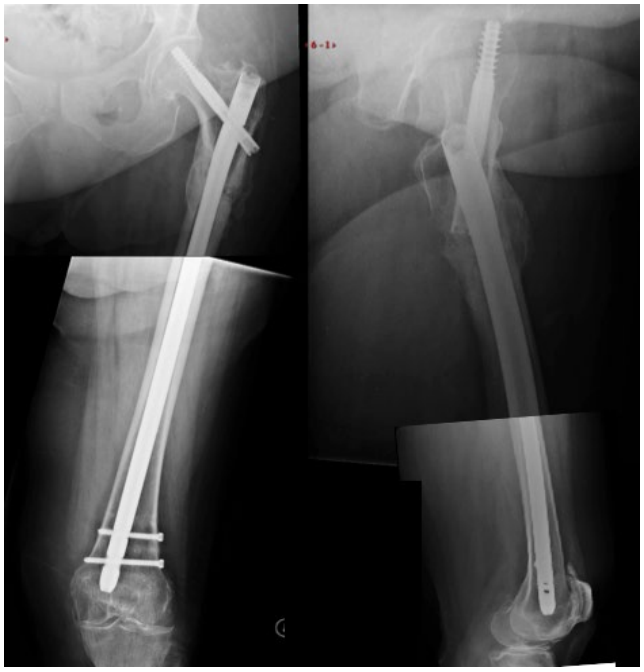

Figure 2: Twelve months after initial index surgery, removal of broken implants, re-insertion of longer and thicker long Gamma nail with autologous iliac crest bone graft and supplement of the OP-1 were performed. Nine months post revision surgery, radiographs showed complete healing of the fracture with pain-free on full weight bearing.

Discussion

A growing number of case reports and epidemiological data suggest an association between bisphosphonate use and atypical subtrochanteric and femoral shaft fractures, and moreover that longer treatment is associated with higher risk [2]. Bisphosphonate-associated AFFs are rare compared with osteoporotic fractures [2]. For that reason, treatment options for AFFs are largely still under discussion.

There is strong supportive evidence that AFFs, as stress or insufficiency fractures, differ from osteoporosis fractures, as in our case, in which the patient didn't have a history of falls or injuries [2]. AFFs have radiographic features that are characteristically transverse or slightly oblique in nature, and occur in the lateral cortex, or tension side, of the subtrochanteric region of the femur, where diffuse cortical thickening and fractures can be observed on radiographs. The most dependable radiographic characteristics for identifying AFFs are focal lateral cortical thickening and a transverse fracture line [3]. Complete fractures tend to have a characteristic radiographic appearance, as in our case (Figure 1).

Within the femur, the subtrochanteric region experiences larger compressive and tensile forces than the other regions of this long bone. These forces can reach several times that of body weight [4]. In the presence of bisphosphonates, bone remodelling is suppressed and increased micro-damage accumulation leads to deterioration in the micro-architecture of the bone [5]. This remodelling suppression of bone material properties can lead to increased AFFs, as well as influencing recovery [6]. The bisphosphonate-related suppression of bone remodelling may slow healing and prolong the path to recovery. The inhibitory effect of bisphosphonates on osteoclastic remodelling decreases intra-membranous fracture healing, and may lead to increased rates of delayed union (or non-union).

The number of fractures prevented by bisphosphonate use far exceeds those potentially related to bisphosphonate therapy [7]. However, the increasing number of delayed or non-union AFFs is an important concern for either index or revision surgery. Clinical literatures have raised concern about the appropriate length of bisphosphonates treatment [7]. It is known that bisphosphonates, particularly alendronate, have long-term biologic effects [8]. Even when the drug is discontinued, the physiologic effects persist for at least a further five years [8]. Anti-fracture efficacy is limited in postmenopausal osteoporosis beyond five years [8]. Bisphosphonate treatment should include a drug holiday after five years administration. Also following the diagnosis of a complete or impending AFF, discontinuation of bisphosphonates should be recommended to help promote a more favorable healing environment [9].

A multi-disciplinary approach, incorporating both medical and surgical teams, should be used for bisphosphonate-associated fractures. Augmented fracture fix-

ation by supplementation of a biological agent may be a reasonable approach, for initial and revision surgery. We suggest that the preferred treatment method could include surgical stabilizations, with supplementary bone-healing treatments such as autologous iliac crest bone graft, and or bone morphogenic protein such as OP-1, in order to get simultaneous optimization of the mechanical and biological environment. Over the past decade, many studies have reported the use of OP-1 for non-union treatment [10], but as far as we know this is the first report of OP-1 usage for a non-union AFF case. Although further studies are needed to confirm efficacy for AFFs, management of non-union AFF with implant failure, with exchange intramedullary nail and autogenous bone graft in addition to the supplement of OP-1, is an option during the surgical decision-making process.

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