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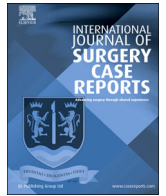
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Treatment of ununited femoral neck fractures in young adults using low-intensity pulsed ultrasound: Report of 2 cases

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ABSTRACT

INTRODUCTION: Delayed union and non-union of displaced femoral neck fractures remains a difficult clinical problem for orthopaedic surgeons. In the physiologically young patient, every effort should be made to preserve the native hip joint. We present two cases of ununited femoral neck fractures in young adults who were successfully treated with low-intensity pulsed ultrasound (LIPUS) and showed satisfactory results.

PRESENTATION OF CASE 1: A 41-year-old woman was involved in a motor vehicle crash and was diagnosed with displaced femoral neck fracture. Eleven months after internal fixation, a computed tomography (CT) scan revealed the presence of non-union of the femoral neck. LIPUS treatment was therefore initiated. After eight months, the fracture was completely consolidated.

PRESENTATION OF CASE 2: A 39-year-old man was involved in a cycling accident and was diagnosed with displaced femoral neck fracture. Thirteen weeks after internal fixation, a CT scan revealed delayed union of the femoral neck. LIPUS treatment was therefore initiated. After six months, the fracture was completely consolidated.

CONCLUSION: We suggest use of LIPUS as a possible treatment approach for delayed union and non-union of displaced femoral neck fractures in young patients before considering further surgical intervention.

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1. Introduction

Displaced femoral neck fractures remain a disturbing clinical problem for orthopaedic surgeons. In young patients, internal fixation aimed at preserving the femoral head is the standard treatment [1]. However, this treatment is associated with the risks of loss of fixation, non-union, and avascular necrosis. Despite increased intervention and advancement in orthopaedic technology, the rate of non-union of displaced femoral neck fractures in young patients remains 10%–30% [1–3]. Non-union is a challenging complication. There is increasing evidence that suggests that low-intensity pulsed ultrasound (LIPUS) significantly stimulates and promotes bone healing in the tibia, humerus, radius, scaphoid, and other non-unions [4–6]. However, there have been no studies on the use of LIPUS in the treatment of delayed union or non-union of displaced femoral neck fracture. In this report, we present two cases of ununited femoral neck fractures, one with non-union and another with delayed union, in young adults, who were successfully treated using LIPUS.

2. Case 1

A 41-year-old woman was involved in a motor vehicle crash. She was diagnosed with displaced left femoral neck fracture (Fig. 1A; AO/OTA classification: 31-B3; Garden classification: stage IV). Closed reduction and internal fixation were performed using the Hansson Pin Hook System (Stryker Trauma AG, Selzach, Switzerland) (Fig. 1B). Partial weight-bearing was permitted at post-operative week 4 and full weight-bearing at post-operative week 12. A computed tomography (CT) scan of the hip performed eleven months post-surgery revealed a fracture line and trabecular bridging only at the medial and anterior sites, which constitute two of the four cortices, thereby revealing the presence of non-union of the femoral neck (Fig. 2A). LIPUS treatment was therefore initiated using Sonic Accelerated Fracture Healing System (SAFHS; Smith & Nephew Inc., Piscataway, NJ, USA). The non-union site of the femoral neck was anteroposteriorly exposed to ultrasound for 20 minutes daily by the patient at home. Eight weeks later, a good callus formation was visible at the lateral and posterior sites (Fig. 2B). Eight months after the initiation of LIPUS treatment, the fracture was completely consolidated. LIPUS treatment was therefore terminated. At the latest follow-up (5 years post-surgery), the patient could walk without any complications.

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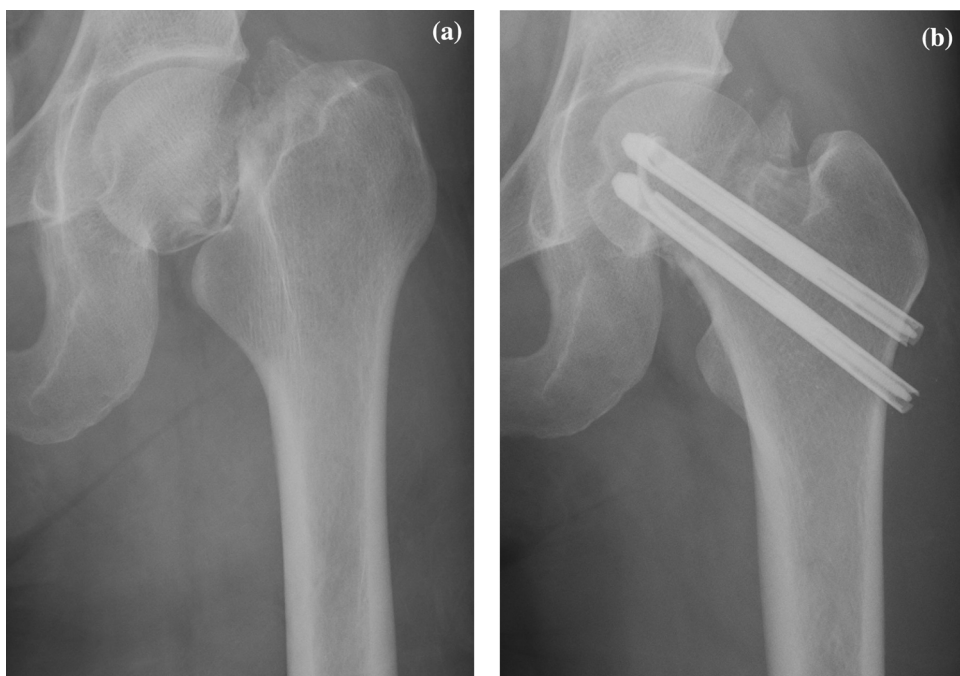


Fig. 1. Initial post-traumatic (a) and immediate postoperative (b) anteroposterior radiograph of the left hip.

3. Case 2

A 39-year-old man was involved in a cycling accident, during which he fell on his left side, while his toes were strapped on the

pedals. He was diagnosed with a displaced left femoral neck fracture (Fig. 3A; AO/OTA classification: 31-B2; Garden classification: stage III). Closed reduction and internal fixation were performed using the Hansson Pin Hook System (Fig. 3B). Partial weight-bearing

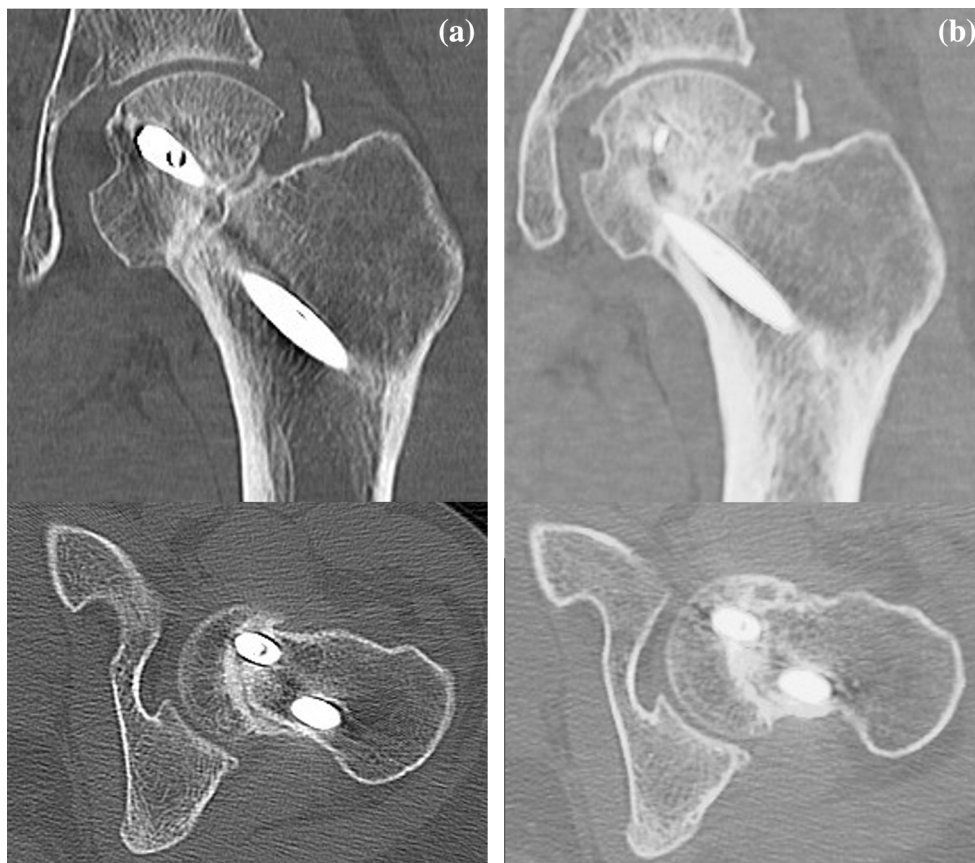


Fig. 2. (A) A CT scan taken 11 months post-surgery showing that trabecular bridging only at the medial and anterior sites, thereby suggesting the presence of non-union of the femoral neck. (B) A CT scan taken 13 months post-surgery (8 weeks after the initiation of LIPUS treatment) showing bony union of the fracture.

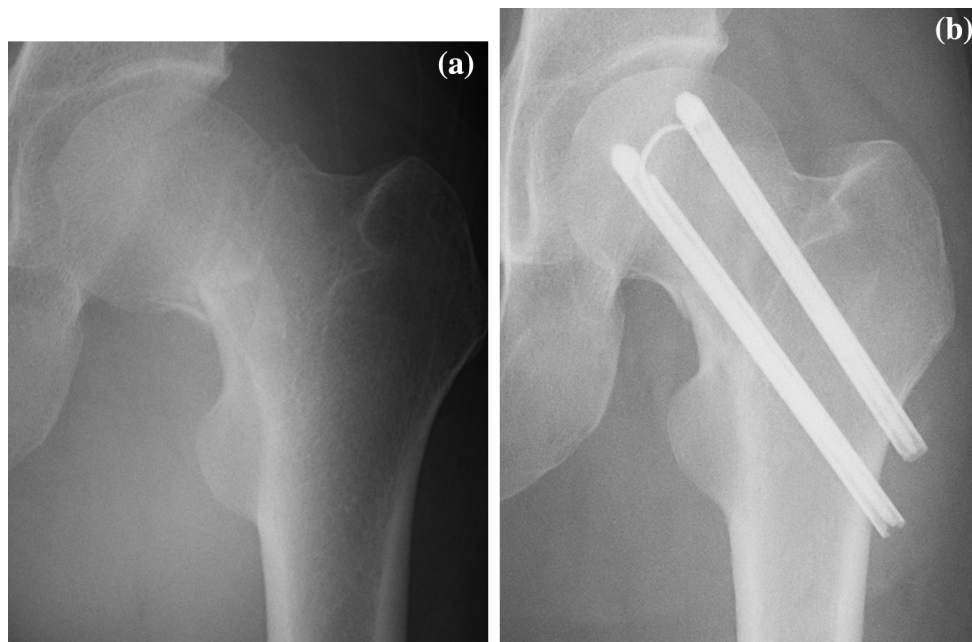


Fig. 3. Initial post-traumatic (A) and immediate postoperative (B) anteroposterior radiograph of the left hip.

was permitted at post-operative week 4 and full weight-bearing at post-operative week 13. Thirteen weeks after the surgery, a CT scan of the hip revealed a fracture line and no trabecular bridging at any of the sites (Fig. 4A), indicating delayed union of the femoral neck. Based on our experience with Case 1, we decided to initiate

LIPUS treatment using the SAFHS. Six months later, trabecular bridging was observed at the medial, lateral, anterior and posterior sites (Fig. 4B). LIPUS treatment was therefore terminated. At the latest follow-up (1 year and 3 months post-surgery), the fracture

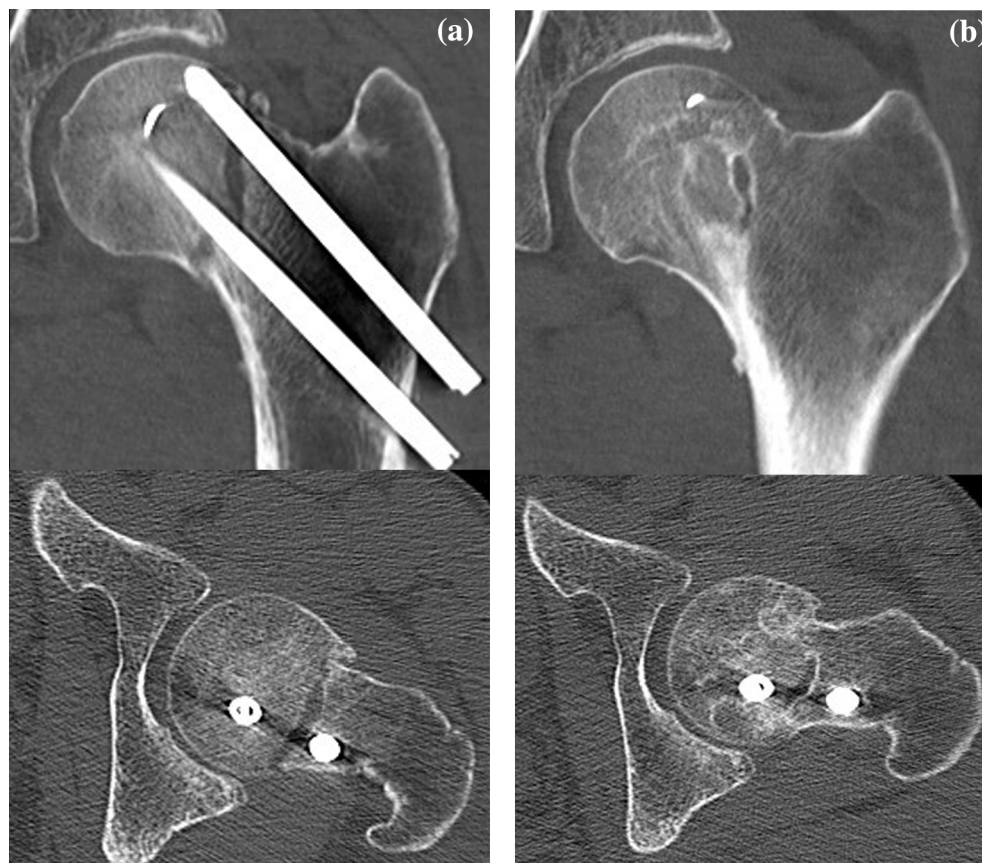


Fig. 4. (A) CT scan taken 13 weeks post-surgery showing the absence of trabecular bridging, which indicates delayed union of the femoral neck. (B) A CT scan taken 9 months post-surgery (6 months after the initiation of LIPUS treatment) showing bony union of the fracture.

was completely consolidated and the patient could walk without any complications.

4. Discussion

Extensive clinical research has demonstrated that LIPUS is effective in accelerating healing of delayed union and non-union of fractures, as well as healing of fresh upper and lower extremity fractures [4–10]. The United States Food and Drug Administration approved the use of LIPUS for accelerating healing of fresh fractures in 1994 and for the treatment of ununited fractures in 2000. Mayr et al. [4] reported 90% consolidation in 951 delayed unions and 85% in 366 non-unions in a retrospective study. World-wide clinical studies using LIPUS in 4,999 non-unions have demonstrated a healing rate of 88% [5]. In a nationwide, prospective study for LIPUS treatment on delayed union and non-union in Japan, a healing rate was 84% in long bone fractures in a lower extremity [9]. A level-I randomized sham controlled trial of 101 patients with delayed union of the tibia demonstrated significantly greater progress toward healing in those who received LIPUS treatment than in those who did not [10].

In the physiologically young patient, every effort should be made to preserve the native hip joint in the treatment of femoral neck non-union. For the treatment of femoral neck non-union with preservation of the femoral head, there are only a limited number of surgical options available to the orthopaedic surgeon including revision fixation with autogenous bone grafting, angulation osteotomy, and vascularized bone grafting. However, results have been variable and no one technique has proved entirely satisfactory [1,11–13]. In addition, second surgical intervention causes new or repeated soft tissue damage and comorbidity, leading to further loss of function. To the best of our knowledge, this is the first report of successful treatment of delayed union and non-union of displaced femoral neck fractures in young adults with the use of LIPUS. LIPUS is a safe, pain-free, noninvasive therapy that is performed daily at home by the patient. A review of literature found no report of associated complications such as irritation and allergy. LIPUS is a good alternative to surgical therapy in the treatment of challenging non-union, with lower cost and reduced risk of complications as well as having an excellent compliance [14,15].

5. Conclusion

We suggest the use of LIPUS as a possible treatment approach for delayed union and non-union of displaced femoral neck fractures in young patients before considering further surgical intervention.

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