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EDITORIAL

- 902 Clinical implications of reconsideration of enthesitis/enthesopathy/enthesial erosion, as tendon attachment-localized avulsions and stress fracture equivalents

Rothschild BM

- 908 Evidence-based orthobiologic practice: Current evidence review and future directions

Jeyaraman M, Jeyaraman N, Ramasubramanian S, Balaji S, Muthu S

REVIEW

- 918 Application prospects of urine-derived stem cells in neurological and musculoskeletal diseases

Yang HS, Zheng YX, Bai X, He XY, Wang TH

MINIREVIEWS

- 932 Orthopedic revolution: The emerging role of nanotechnology

Ruan WJ, Xu SS, Xu DH, Li ZP

ORIGINAL ARTICLE**Retrospective Cohort Study**

- 939 Impact of computed tomography/magnetic resonance imaging registration on rehabilitation after percutaneous endoscopic decompression for lumbar stenosis: Retrospective study

Guo XB, Chen JW, Liu JY, Jin JT

SCIENTOMETRICS

- 950 Research trends in exercise therapy for the treatment of pain in postmenopausal osteoporosis over the past decade: A bibliometric analysis

Dai ZQ, Gong XY, Zhang R, Jin MQ, Lu W, Wen W, Chen J, Lu FJ, Yang YF, Wang L, He XJ

CASE REPORT

- 965 Simple and effective method for treating severe adult skeletal class II malocclusion: A case report

Xie LL, Chu DY, Wu XF

- 973 Treatment of a femoral neck fracture combined with ipsilateral femoral head and intertrochanteric fractures: A case report

Yu X, Li YZ, Lu HJ, Liu BL

- 981 Atypical cervical spondylotic radiculopathy resulting in a hypertensive emergency during cervical extension: A case report and review of literature

Cui HC, Chang ZQ, Zhao SK

- 991** Extracorporeal shock wave therapy in treating ischial non-union following Bernese periacetabular osteotomy: A case report

Yan J, Zhu JY, Zhao FF, Xiao J, Li H, Wang MX, Guo J, Cui L, Xing GY

LETTER TO THE EDITOR

- 997** Conversion hip arthroplasty for failed nailing of intertrochanteric fracture: Reflections on some important aspects

Yang FC

ABOUT COVER

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Extracorporeal shock wave therapy in treating ischial non-union following Bernese periacetabular osteotomy: A case report

Jun Yan, Jun-Yu Zhu, Fei-Fei Zhao, Jian Xiao, Hao Li, Ming-Xin Wang, Jing Guo, Liang Cui, Geng-Yan Xing

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Abstract

BACKGROUND

Extracorporeal shock wave therapy (ESWT) is increasingly being recognized as an advantageous alternative for treating non-union due to its efficacy and minimal associated complications. Non-union following Bernese periacetabular osteotomy (PAO) is particularly challenging, with a reported 55% delayed union and 8% non-union. Herein, we highlight a unique case of ischial non-union post-PAO treated successfully with a structured ESWT regimen.

CASE SUMMARY

A 50-year-old patient, diagnosed with left ischial non-union following the PAO, underwent six cycles of ESWT treatment across ten months. Each cycle, spaced four weeks apart, consisted of five consecutive ESWT sessions without anesthesia. Regular X-ray follow-ups showed progressive disappearance of the fracture line and fracture union. The patient ultimately achieved a satisfactory asymptomatic recovery and bone union.

CONCLUSION

The results from this case suggest that this ESWT regimen can be a promising non-invasive treatment strategy for non-union following PAO.

Key Words: Ischial non-union; Extracorporeal shock wave therapy; Non-union; Bernese periacetabular osteotomy; Case report

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Core Tip: Non-union following periacetabular osteotomy is a postoperative complication that is challenging to resolve through conservative treatment alone and typically necessitates surgical intervention for effective management. A personalized extracorporeal shock wave therapy regimen can help us address this challenge effectively.

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INTRODUCTION

Despite advancements in osteotomy techniques for acetabular dysplasia, non-union or delayed union remains a common postoperative complication, with an incidence rate of 8%[1]. Surgical treatments, while effective, are costly, uncertain, and often accompanied by complications, such as infection or neurovascular injury[2]. This necessitates the exploration of noninvasive alternatives. One such promising modality is extracorporeal shock wave therapy (ESWT), which has demonstrated clinical efficacy comparable to surgery for bone nonunions without the associated complications[3-6].

Treatment of deep-seated nonunions like the ischium, however, presents unique challenges. Achieving accurate energy delivery to the fracture site for successful bone healing is difficult due to the deep location of the ischium and its coverage by surrounding musculature[7]. This underscores the need for an optimized, short-term, and effective treatment regimen tailored to patients' individual characteristics.

To our knowledge, no studies have yet proposed a standardized protocol for ESWT regarding the timing of treatment of femoral non-union. Furthermore, few studies have explored multiple treatments or cyclical regimens[6,8]. This case report aims to bridge this gap by presenting a unique case of successful non-union management of the left ischial ramus post-internal fixation with acetabular osteotomy screws, utilizing a cyclical ESWT regimen. This case report illuminates a potential pathway for the nonsurgical management of deep tissue non-union, contributing significant clinical value to the field.

CASE PRESENTATION

Chief complaints

A 50-year-old female patient was experiencing pain in her left hip and a limited range of motion when walking and squatting.

History of present illness

When known, the age, sex, body mass index, injury location, surgical procedure, past medical history, duration, and clinical description were recorded (Table 1). The patient underwent a left pelvic osteotomy procedure with corrective screw fixation on May 13, 2019, due to bilateral acetabular dysplasia (Figure 1A and B). The procedure involved an open approach, osteotomy, rotational correction, and screw fixation. In the year following her operation, she attended The Fourth Medical Center of our hospital every three months for X-ray examinations. These showed a clear fracture of the left ischial branch and gradual formation of surrounding sclerotic bone. However, the X-rays from the last three months did not show any notable evidence of callus formation (Figure 1C). Following a consultation at The Third Medical Center of our hospital, she was diagnosed with a non-union of the left ischium, prompting her to seek ESWT at the Third Medical Center's treatment room.

History of past illness

There is no history of past illness.

Personal and family history

The patient was healthy prior to her diagnosis of acetabular dysplasia before the operation. She had no notable personal

Table 1 Clinical characteristics of ischial non-union case 1

Case	Age in year	Sex	Body mass index in kg/m ²	Location	Surgical procedure	Past medical history	Duration of non-union	Clinical description
1	50	Female	23.81	Left hip	Periacetabular osteotomy	(-)	> 13 months	Non-union, pain, restricted mobility

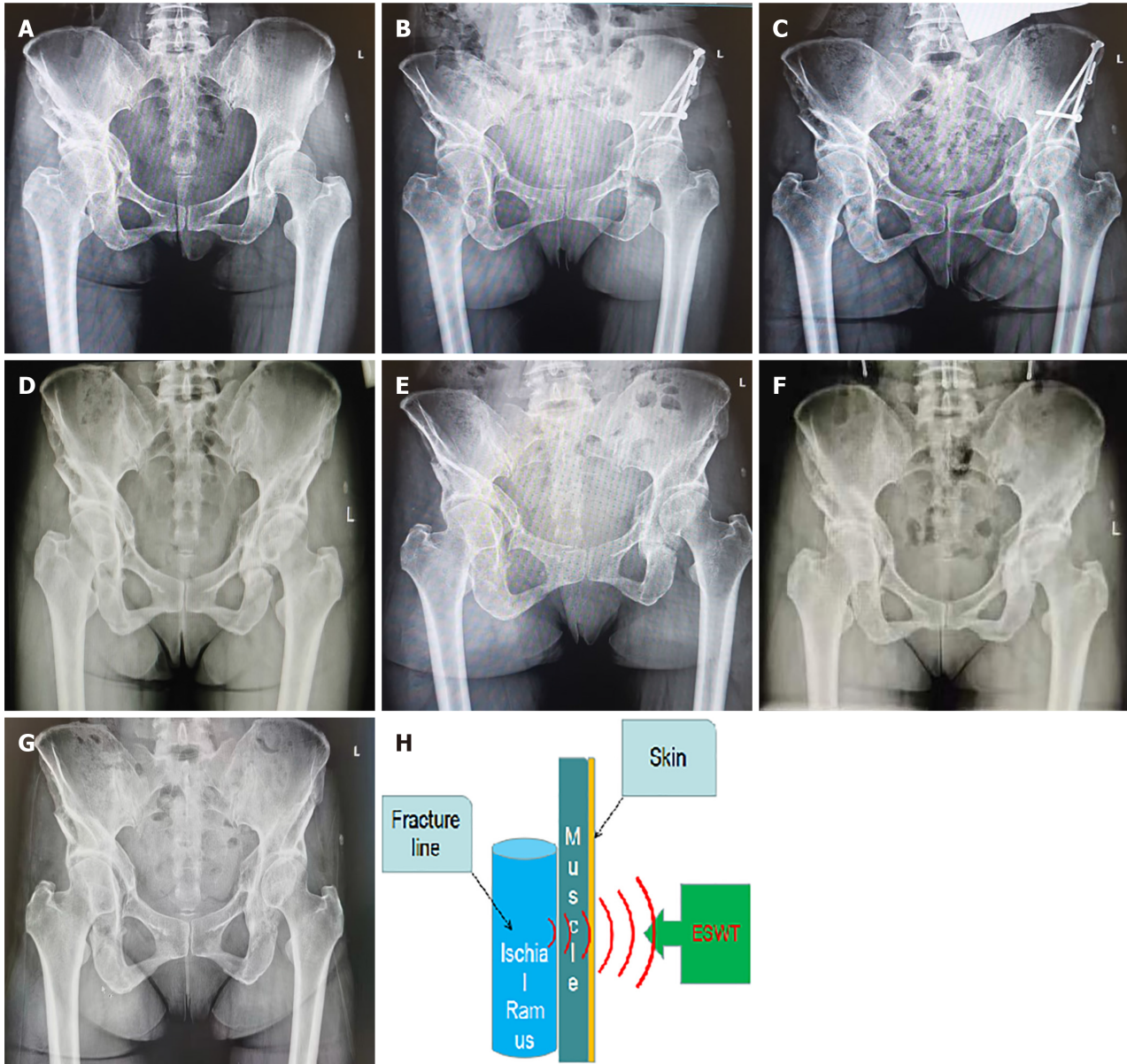


Figure 1 Schematic representation of pre-periacetabular osteotomy and post-periacetabular osteotomy, pre-extracorporeal shock wave therapy and post-extracorporeal shock wave therapy, and the extracorporeal shock wave therapy healing process. A: Pre-periacetabular osteotomy (PAO); B: Post-PAO; C: Pre-extracorporeal shock wave therapy (ESWT); D: Two months (2 cycles) post-ESWT; E: Four months (4 cycles) post-ESWT; F: Six months (6 cycles) post-ESWT; G: Sixteen months post-ESWT; H: Schematic of ESWT-induced healing. ESWT: Extracorporeal shock wave therapy.

or family history, had undergone a cesarean section, and had no history of blood transfusions.

Physical examination

The patient had an arc-shaped surgical scar approximately 20 cm long on the anterior side of her left hip, resulting from the periacetabular osteotomy (PAO) and orthopedic screw fixation through an anterior hip approach. She experienced pain during active flexion and hip extension, but passive movement was possible. No evident local tenderness was observed. Skin sensation, temperature, and blood circulation at the local site were normal.

Laboratory examinations

Laboratory examinations were unnecessary.

Imaging examinations

X-ray imaging showed the left ischial branch in normal alignment, with a clear fracture line and no signs of bone union. The internal fixation position of the ilium osteotomy was correct and stable, with no displacement (Figure 1C).

FINAL DIAGNOSIS

Non-union of the ischium following a left PAO.

TREATMENT

The patient underwent a structured ESWT regimen using a focused shock wave generator (HK.SWT-007, Huikan AG, China) device. The protocol included six cycles, each consisting of five ESWT sessions on alternate days, with a four-week interval between cycles. Each session lasted approximately 20 minutes and was conducted without local anesthesia (Figure 2). This personalized treatment regimen is tailored based on the feedback collected following each treatment session. We will evaluate the patient's pain levels and functional mobility pre-treatment and post-treatment through the visual analog scale (VAS) and comprehensive physical examination. We utilized this as a valid basis for assessing the duration of treatment efficacy and implementing regular follow-up evaluations. Upon completing each treatment regimen, patients typically show significant reductions in pain and improvements in functional activity compared to pre-treatment baselines. If VAS scores and physical examination outcomes worsen relative to the conclusion of the previous treatment cycle, the subsequent intervention will be initiated and continued until the non-union is healed.

The procedure is as follows: The patient was positioned supine with a flexed left hip to prevent occlusion of the ischium. The unhealed part of the left hip was identified by C-arm X-ray, and two treatment points were selected along the osteotomies. A total of 1200 pulses at 16–19 kv were applied, divided across four points.

The shock wave's direction was optimized to ensure unblocked energy delivery to the fracture ends, avoiding areas covered by internal fixation and neurovascular structures. Post-treatment examinations were conducted to assess local complications and the patient's condition. After the treatment, the patient resumed her usual weight-bearing condition and was advised to avoid strenuous activity.

OUTCOME AND FOLLOW-UP

The patient completed a total of six cycles of ESWT. After the final treatment cycle, a 10-month follow-up evaluation was conducted, which assessed local tenderness at the osteotomy site, hip range of motion, and weight-bearing capabilities of the affected limb. Notably, new bone formation at the bridging callus and circumferential osteotomy sites was observed on plain films after each cycle, with significant progression seen during the third to fourth treatment cycles and the first six months of the follow-up period.

The X-ray image also depicted a gradual decrease in the gap between the amputated ends and an enhancement in bone density around the original osteotomy site that continued to improve over time (Figure 1D and E). By the sixth month of imaging, the transverse fracture line had nearly disappeared (Figure 1F), indicating a fully formed bony union with cortical remodeling.

As the fracture site healed, the patient's active pain was eliminated, and she resumed her daily activities without any abnormal symptoms (Figure 1G). Importantly, no local complications attributable to ESWT were observed during the entire treatment process (Figure 1H).

DISCUSSION

As defined by the United States Food and Drug Administration, non-union is characterized by persistent bone disruption or failure to achieve bone union within nine months post-surgery and a lack of union signs for at least three consecutive months[9,10]. In this case, the diagnosis of non-union was made based on radiographically discontinuous osseous union and radiographic penetration of the osteotomy site. Complete bone healing is defined as the formation of a bone bridge at the osteotomy site, with a continuous trabecular pattern observed. Various factors influence non-union, including systemic factors such as osteoporosis, hormone usage, nutritional status, and smoking. Local factors, such as the local blood supply, degree of local injury, and contact with the fracture end, also play a significant role[11].

ESWT, first reported by Valchanou and Michailov in 1991 for treating cases of delayed union and non-union, has emerged as a promising technique. ESWT has been used to treat various musculoskeletal disorders, including rotator cuff calcific tendonitis, lateral epicondylitis, and chronic plantar fasciitis. The mechanisms of ESWT support its positive effects on bone biology through enhanced biomechanical properties (increased bone mass and strength) and angiogenesis[12].



Figure 2 The treatment of non-union of periacetabular osteotomy with extracorporeal shock wave therapy. A and B: Images of the shockwave device and console; C: X-ray-guided extracorporeal shock wave therapy positioning for non-union; D: The patient's treatment course, which was conducted without the use of anesthesia.

However, a universally accepted standard for ESWT timing is yet to be established.

In this case study, the patient underwent osteotomy following the classical sequence without receiving anesthetic treatment for the ESWT, thus avoiding the risks and complications of anesthesia. High patient compliance is a crucial factor due to the extended duration of this type of treatment. Each course of treatment only lasted 20 minutes, and our patient only needed six courses of treatment, with a short interval (about four weeks) before the next cycle. At the sixth month of follow-up, the non-union had healed, and the patient could participate in normal physical activity at his last visit. No local complications were observed throughout the treatment regimen.

The characteristics of our treatment regimen can be summarized as 'repeatability' and 'fractionation', corresponding to 5 times per cycle and a total of 6 cycles with shorter intervals in the regimen, respectively. A significant advantage of our treatment regimen is that the ESWT with fractional repetition allows progressive shock wave stimulation of the treated area while maintaining the same total number of prior treatments, giving the body a proper interval of time to repair itself. This case study illustrates the potential of ESWT in treating ischial non-union after PAO and proposes a new therapeutic approach for this condition.

Although this is only a case study and not representative, it provides valuable insights into the potential of ESWT as a non-surgical treatment option for deep bone non-union. Further research is needed to optimize ESWT treatment protocols and accumulate more clinical experience in treating ischial non-union after PAO.

CONCLUSION

The findings from this case study suggest that a structured, multi-cycle, short-interval ESWT regimen can significantly improve non-union healing in patients who prefer non-surgical treatment options. Consequently, this ESWT regimen might present a promising and viable therapeutic strategy for managing ischial non-union following PAO. While these results are encouraging, further research is necessary to validate and optimize this treatment approach, contributing to the broader understanding and management of such orthopedic conditions.

FOOTNOTES

Author contributions: Xing GY and Yan J conceived the designed the study; Zhao FF, Xiao J, Li H, Wang MX, Guo J, and Cui L performed the research and analyzed the data; Zhu JY wrote the paper; all authors have read and approved the final manuscript.

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