



Extra-articular blocking technique for acetabular bone defect reconstruction

Zhonghua Xu, Zhiming Cheng, Jie Li, Yuan Zhang

Department of Orthopedics, Xinqiao Hospital, Army Medical University, Chongqing, China

Contributions: (I) Conception and design: Y Zhang; (II) Administrative support: Y Zhang; (III) Provision of study materials or patients: Z Xu, J Li; (IV) Collection and assembly of data: Z Cheng; (V) Data analysis and interpretation: Z Xu; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Yuan Zhang, MD, PhD. Department of Orthopedics, Xinqiao Hospital, Army Medical University, 183 Xinqiao Street, Shapingba District, Chongqing 400038, China. Email: joint_chueng@hotmail.com; zhangyuan@tmmu.edu.cn.

Abstract: The acetabular bone defect reconstruction is of great challenge in total hip arthroplasty (THA). Although several solutions such as autologous bone grafting, trabecular metal augment, or compromising techniques such as the medial protrusion, high inclination angle, and elevated hip center have been raised, their efficacy and reliability have not been fully substantiated. Traditional reconstruction methods may lead to bone resorption, aggravation of bone defects, unequal length of lower limbs, unbalance of hip-spine relationship, increased costs, and so on. Our team proved a new technique named extra-articular blocking to resolve this problem. The extra-articular blocking technique was a simple, economic and effective acetabular reconstructive method to resolve the massive acetabular bone defect in congenital (especially for developmental dysplasia of the hip, DDH), inflammatory, and osteolytic pathologies. This article organized as surgical technique, aims to report the surgical principle, indication, and procedure of using extra-articular blocking technique. With this technique, we have successfully solved the difficult problem of acetabular bone defect reconstruction. We found after 3 months of the surgery, there were fluoroscopic healing and remodeling. And there were no bone loss or graft absorption until the last follow-up as evidenced by radiographic observation. The survival rate of the acetabular component was 100%, no radiolucent line, changes in inclination and anteversion of the shell, as well as migration of the rotation center were identified.

Keywords: Blocking screw; bone defect; osteointegration; biomimetic reconstruction

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Introduction

Background

Although several solutions have been raised, the acetabular bone defect of the hip is still a serious challenge, especially for the developmental dysplasia of the hip (DDH) which is a common congenital abnormality that affects the developing hip joint. In a survey of prevalence of DDH in Chinese adults, Tian *et al.* (1) found 391 diagnosed as DDH in 29,180 individuals, yielding an overall DDH prevalence of 1.52%. They estimate the number of individuals with DDH in China to be approximately 16.05 million. The incidence

of congenital dislocation of the hip in other countries is also high, ranging from 0.1% to 5.4% in Japan (2), 1.2% in Mongolia (3), and 6.45% of preterm infants in Korea (4).

Acetabular bone defect, derived from congenital (e.g., DDH), osteolytic (e.g., aseptic loosening of the acetabular component), and inflammatory (e.g., rheumatoid arthritis) pathologies, presents great challenge to acetabular reconstruction in total hip arthroplasty (THA). While previous studies employed various options, such as autologous bone grafting (5), trabecular metal augment (6), or compromising techniques such as the medial protrusion, high inclination angle, and elevated hip center (7), the

clinical result has not been evidently substantiated. And it remains controversial whether these options are beneficial or not, which were reported as the deficiency in fitting-in with the host bone stock, infection predisposition, absorption and collapse of structural bone grafting, and cost-effectiveness disadvantage (8,9).

Rationale

To overcome abovementioned limitations, we presented an innovative technique to resolve the acetabular bone stock deficiency with a simple but reliable procedure called extra-articular blocking. Blocking screws were used to unload the strength of the cup and increase acetabular coverage to improve initial stability and long-term bone mass storage.

Objective

We firstly presented the application of extra-articular blocking technique in direct anterior approach THA, and established the standard protocol and clinical outcome in our previous work (10). This technique was proposed by Y.Z. and used in our institution from 2016, and clinical result was proved as excellent in terms of cost-effectiveness, bony integration, time required for weight-bearing, and functional assessment (11). We present this article in accordance with the SUPER reporting checklist (available at <https://aoj.amegroups.com/article/view/10.21037/aoj-23-14/rc>).

Highlight box

Surgical highlights

- This surgical technique was a new method of acetabulum reconstruction.

What is conventional and what is novel/modified?

- Conventional surgical technique for acetabular bone defect include autologous bone grafting, trabecular metal augment, or compromising techniques such as the medial protrusion, high inclination angle, and elevated hip center, etc.
- The extra-articular blocking technique was used two or more screws to robustly withstands the laterally exposed surface of the acetabular component, and the morselized cancellous bony fragments were used to fill the irregular bone defect, improving the initial stability and acetabular coverage.

What is the implication, and what should change now?

- This study implicated that this new simple, economic and effective technique would give a new choice in total hip arthroplasty with acetabular bone defect.

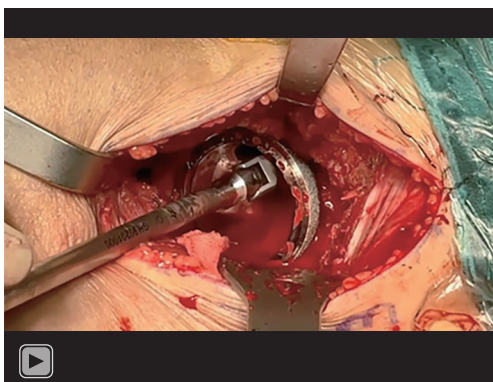
Preoperative preparations and requirements

This technique is mainly indicated for moderate bone defect in superolateral aspect of the acetabulum, which can be quantified as acetabular shell uncoverage more than 30%. A frequent scenario is advanced osteoarthritis and avascular necrosis of the femoral head due to DDH, inflammatory, and osteolytic pathologies combining acetabular defects (12), which could be grossly identified by radiographical analysis on anteroposterior pelvic X-ray image. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Medical Ethics Committee of Second Affiliated Hospital of the Army Medical University (No. 2022-508-01), and all the patients signed and permitted the informed consent form for the research use in this study.

Step-by-step description

Video 1 shows extra-articular blocking to resolve severe acetabular bone defect in THA procedure for a 57-year-old female patient diagnosed as DDH on her left hip (CROWE III and Hartofilakidis B). The patient was prepared in supine position and both of the lower limbs were disinfected according to the requirement of direct anterior approach THA (13,14). A standard direct anterior incision of 7 cm in length was made, the classical Heuter interval was found to reach minimally invasive hip arthroplasty via neuromuscular approach. After the femoral head was removed, the pathological acetabulum was mostly exposed, which can be further visualized by debriding the inflammatory lesions, resecting the labrum, removing the osteophyte.

The fossa ovalis and transverse ligament are landmarks to guide the acetabular reaming at the true level. The acetabular reaming was made gradually by 2 mm increment till -1 mm of planned cup size. A high-porous cementless titanium cup (Pinnacle, Depuy, Warsaw, IN, USA) was implemented using press-fit technique at planned position, with inclination 40° and anteversion 15°. After planting the cup, the superolateral aspect of the acetabulum component still had bone defect. To ensure the reaming at proper level and correct position, Intraoperative fluoroscopy was an option during surgery. Accessory intra-articular acetabular screws (6.5 mm in diameter, and 25–30 mm in length) were implanted into acetabular for stability. However, the initial stability was not sufficient in biomechanics, which indicating enhanced stability through extra-articular blocking technique.



Video 1 Extra-articular blocking: a novel surgical technique for acetabular bone defect in DDH patients. DDH, developmental dysplasia of the hip.

Initially, using sharp narrow osteotome or a small-sized acetabular ream to eradicate the cartilage layer of the acetabular defect, and grooving the subchondral bone step further, followed by a series of drilling using 2.0 mm Kirschner wires, with the depth of 10 mm, and 5 mm at intervals. Two acetabular screws (30–40 mm in length) were oriented at 30–40 degrees tangent to the exposed acetabular surface and inserted tightly into the bone above the acetabular cup to ensure that the tail of the screw is firmly bearing the lateral exposed surface of the acetabular component, creating a blocking effect to mitigate the shear forces guiding the acetabular cup proximally and medially. The exposed part of the screws should not be more than one-third of its length.

A full hydroxy-apatite (HA)-coating rectangular femoral stem (Corail, Depuy) was implanted into femur through the routine direct anterior approach technique. Morselized cancellous bony fragments were harvested from acetabular reaming and transplanted into the irregular bone defect area, as well as bioactive material carrying bone growth factor such as BMP 2. Two gelatin sponge strips were used to cover the bone graft in case of detachment. No drainage was needed and the patients can achieve partial weight-bearing on the first day after surgery (*Video 1*).

Postoperative considerations and tasks

The patient was able to leave bed for performing hip flexion and abduction training and walk with crutches (less than 2 weeks) under partial weight-bearing on the next day after

surgery. A full range of the hip motion can be achieved 1 week after surgery because the morselized cancellous bone mud mostly adhere to bone and screws, so it is very hard to detach them from the bone defect cavity.

Tips and pearls

Mechanistically, well-fixed extra-articular screws provide adequate immediate stability to the acetabular cup by alleviating the negative shear forces caused by early postoperative micro-movements and weight bearing (15). In addition, the transplanted cancellated bone serves as a rich reservoir of osteoblasts and stromal cells, and a variety of growth factors contribute to the early vascularization of the bone graft between the host bone stock and the acetabulum cup (16), further accelerating bone integration and remodeling, and promoting the permanent growth of the porous structure of the acetabulum cup (17).

Discussion

There was no bone loss or graft absorption before the last follow-up, which was confirmed by imaging observations. Fluoroscopy showed healing and remodeling 3 months after surgery. The survival rate of the acetabular component was 100%, no radiolucent line, changes in inclination and anteversion of the shell, as well as migration of the rotation center were identified.

The most important finding in this study was the technique of extra-articular blocking offers a promising option to address acetabular bone defect in many congenital, inflammatory, and osteolytic pathologies. Its advantage includes cost-effectiveness merit, enhanced osteo-integration, and early tolerance for weight-bearing activities.

The pitfall of this technique is that it is difficult for beginners to determine the resistance level of the blocking screw. Inadequate initial stability will lead to early failure if the screw does not bear the acetabular shell firmly.

Conclusions

In conclusion, the extra-articular blocking technique is an efficient attempt to reconstruct the defect of acetabulum in THA with cost-effective and immediate weight-bearing advantages, low failure rate, early osseous integration and remodeling.

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Footnote

Reporting Checklist: The authors have completed the SUPER reporting checklist. Available at <https://aoj.amegroups.com/article/view/10.21037/aoj-23-14/rc>

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://aoj.amegroups.com/article/view/10.21037/aoj-23-14/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Medical Ethics Committee of Second Affiliated Hospital of the Army Medical University (No. 2022-508-01), and all the patients signed and permitted the informed consent form for the research use in this study.

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