

Reverse fracture displacement direction closed reduction technique (RCRT) for the treatment of valgus impacted femoral neck fracture

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Technical advance

Keywords: Valgus impaction; femoral neck fracture; Reverse; closed reduction; technique

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Title page

1. Title: **Reverse fracture displacement direction closed reduction technique (RCRT)for the treatment of valgus impacted femoral neck fracture**

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[Abstract]

Background Impacting locked in fracture site of valgus impacted femoral neck fracture may be the difficulty to achieve anatomical reduction. The aim of this article is to introduce a novel technique to successful complete anatomical reduction. **Methods** After identify the fracture classification and displace direction. Two 2.0 mm diameter kirschners wire were inserted crossing the femoral head and fixed into acetabular bone. under the continuous image guiding and monitoring, reversing fracture displacement direction with internal rotation and abduction of the hip to complete the closed reduction. **results** anatomical reduction was achieved in X-ray and CT data postoperative. **conclusions** This technique provides anatomical reduction, simple procedure, and few interference of internal environment of hip and fracture site in valgus impacted femoral neck fracture.

[Key words] Valgus impaction; femoral neck fracture; Reverse; closed reduction; technique

Background

Due to the bony impacting at the fracture site, there were comparatively lower rate of osteonecrosis and non-union in valgus impacted femoral neck fractures compared with displaced femoral neck fracture^[1,2,3]. High rate of fracture re-displacement has been found in valgus impacted femoral neck fracture patients with Conservative treatment^[4,5,6]. Fracture fixed in situ without anatomical reduction contributed to increasing reports of complications, which would reduce the Harris Hip Score such as femoral neck shortening, inferior offset and femoroacetabular impingement syndrome^[3,7,8]. Anatomical reduction and internal fixation has been considered necessary to enhance bony healing and reduce the rate of avascular necrosis and complications.

Valgus impacted femoral neck fracture is one type of irreducible femoral neck fractures. The difficulty of reduction involved the disimpaction from valgus impacting fracture site into anatomical position. The purpose of the current study is to introduce a reversing fracture displacement direction closed reduction technique(RCRT) to disimpact valgus impacted femoral neck fracture into the anatomical position and internal fixation.

Methods

20 years old man with left femoral neck fracture was sent to hospital, with general health and no affiliated disease. the operating time was arranged on the third day after admission. The direction and degree of the femoral head backward tilting and valgus displacement in valgus impacted femoral neck fracture would be identified by the preoperative X-ray and computed tomography data.

After patient was positioned on the traction table, the general closed reduction technique(longitudinal traction and internal rotation lower limb) was applied under image intensifier observation in the anteroposterior view and lateral images. As the traditional closed reduction technique was mostly unsuccessful, and sometimes make the fracture site segregated (Figure 1), we proceeded to perform our RCRT technique.

First, the direction of femoral head tilting and valgus displacement should be confirmed again by surgeon. suffering limb was remained slightly traction and placed in appropriate abduction and extorsion position according to the fracture displacement degrees and direction. This would be save enough space for further reduced action. After skin preparation and draping are completed, 1 Kirschner wires of 2 mm diameter were hammered from upon of the greater trochanteric, along the direction of femoral head of approximately 100 degrees **and** crossing the femoral head into the top of acetabulum bone. From anterior of hip, Another Kirschner wires along the direction of up-backward crossing the femoral head into the posterior column of the acetabulum (Figure 2). In this way, an solidly whole of new fragment of proximal fracture was combined with femoral head and acetabulum.

Then, under continuous image guiding and monitoring, the reversing fracture displacement direction closed reduction technique was being applied. femoral head backward tilting was corrected by internal rotation of the suffering limb, and valgus impacting was disimpacted by the hip abduction(Figure 3). The reset action would be stopped immediately when the anatomical reduction were completed successfully.

Remain the situation of anatomical position, 3 guide Kirschner wires were being inserted in the femoral neck with inverted triangle configuration and made the inferior kirschner as closed as possible to the femoral calcar(Figure 4). After that, three parallel cannulated screws with 7.3 mm diameter were twisted into femoral head(Figure 5).

Result

Anatomical reduction was obtained and validated by X-ray and CT data postoperative. The procedure time was 30 minutes and blood loss was 10 ml. There were no complication had been found with 3 months following up.

Discussions

Because of impacting locked in fracture site of valgus impacting femoral neck fracture, in situ internal fixation would be a option by some surgeons^[2,3,5,9]. Anatomical reduction internal fixation has been considered as satisfying treatment of femoral neck fracture due to the lower rate of complications^[1,2,3]. For anatomical reduction, many closed and even open reduction technique were used during operation of femoral neck fracture. Traditional reduction technique like Leadbetter's technique^[10] and Flynn's technique^[11] put the hip capsule at a tension situation by lower limb traction. The fracture was squeezed by tightly hip articular capsule, and more forceful manoeuvre of a series action(such as rotation, adduction and abduction et al) were made to settle the fracture site. Because the impacting fracture site would not be unlocked, the failure

of fracture reduction is unavoidable. 10.3%(32/308) failure of treatment was reported by Song et al. ^[1] with reduction technique of internal rotating the leg and applying pressure in an antero-posterior direction.

Percutaneous poking reduction technique has been introduced by Yang et al. ^[12] and Lorich et al. ^[13] 1-3 Kirschner wires were inserted into proximal and distal fracture or fracture site as "joystick" motion to complete osteosynthesis. The joystick is frequently interfered with tight capsule and fascia that may reduced the success rate of closed reduction. In addition, the above-mentioned technique providing multiple reduction attempts may increase damage to blood supply.

Our designed technique may be similar to Mahajan et al. ^[14] and Noda et al. ^[15]. Combined with femoral head and acetabular, a greater proximal fracture was formed to match distal fracture. That make the closed reduction relatively easy. There are some advantages in our method: (1) two Kirschner wires chaining femoral head and acetabular formed a solid whole and remain more stable to against force during reduction. That could effectively achieve satisfying reduction by altering the position of distal fracture. (2) Gentle accurate reset action full-time under continuous image guiding and monitoring avoided excessive reduction of fracture even made the femoral head dissociated, successful rate of fracture reduction was enhanced. (3)The simple reduction procedure has decreased the harm of femoral head blood vessels supply that from only one reduction attempt. Meanwhile provide a clear internal environment of hip which promoted fracture healing.

There are some noteworthy feature needing attention in this technique: (1) Accurate classification is needed as this technique is not suitable for the fracture type of dissociated femoral head like Garden type II and III. More complex behave presented in dissociated femoral head than in impacting femoral neck fracture. If the dissociated femoral head has been firmed into acetabular with 2 Kirschner wires, the replacement effect from tight capsule would not be realized. (2) It is advisable to use 2 Kirschner wires because multiple plane fixation would be stronger to against reset force. To reduce the damage of hip articular cartilage as much as possible, the diameter of Kirschner wire might be 2.0 or 2.5 mm and would not bigger than it. However, Kirschner wire that is very thin also would not be applied as it is broken or bended easily. (3) It is recommended to hammer rather than screw the Kirschner wires may loose the fracture site and make better feeling in hands for accurate inserting into the acetabular bone.

One of the imperfection in this technique is the damage of hip articular cartilage which inserting with fixing Kirschner wires. We have performed 9 patients in last four years with 2 Kirschner wires of diameter 2 mm. Hip MR examination in 1 year of postoperative showed no manifestations of articular cartilage injury and no osteonecrosis. Further studies will be needed to observe functional recovery and complications such as fracture nonunion and avascular necrosis of femoral head.

conclusions

This preliminary study introduces a new and simple technique that enables anatomical reduction of valgus impacting femoral neck fractures. It also have advantage with few interference of internal environment of hip and fracture site. A perfect closed reduction would be depended on accurate evaluation of fracture classification and displace direction. Gentle and logical technique procedure would enhance success rate of anatomical reduction.

List of abbreviations

1. RCRT reversing fracture displacement direction closed reduction technique
2. CT computer tomography

Declarations

1. Ethics approval and consent to participate: This study was approved by the Ethical Review of our Hospital. Patient signed a written information consent before enrollment into this study.
2. Consent for publication: Written informed consent for publication was obtained from all participants.
3. Availability of data and materials: Not applicable.
4. Competing interests: The authors do not have any possible conflicts of interest.
5. Funding: No funding.
6. Authors' contributions: Qiuliang Zhu designed the technique and wrote the paper. All authors performed the experiments read and approved the manuscript.
7. Acknowledgements: Not applicable.

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Legends:

Figure 1 Twenty-one years old male suffering with valgus impacted femoral neck fracture. The fracture site was separating at anteromedial and impacting at posterolateral of femoral neck after traction of lower limb.

Figure 2 One kirchner wire hammered from up of greater trochanteric crossing femoral head fixing into acetabular bone(left). Another k-wire from infra-anterior of hip crossing femoral head hammering into the posterior column of the acetabulum(right).

Figure 3 Closed reduction was successful completed with internal rotation and abduction on suffering lower limb under continuous image guiding and monitoring. There show one k-wire was bended by reduction force.

Figure 4 Three guide K-wires were being inserted in the femoral neck with inverted triangle configuration and made the inferior kirschner as closed as possible to the femoral calcar.

Figure 5 Three parallel cannulated screws with 7.3 mm diameter were twisted into femoral head.

Figures



Figure 1

Twenty-one years old male suffering with valgus impacted femoral neck fracture. The fracture site was separating at anteromedial and impacting at posterolateral of femoral neck after traction of lower limb.

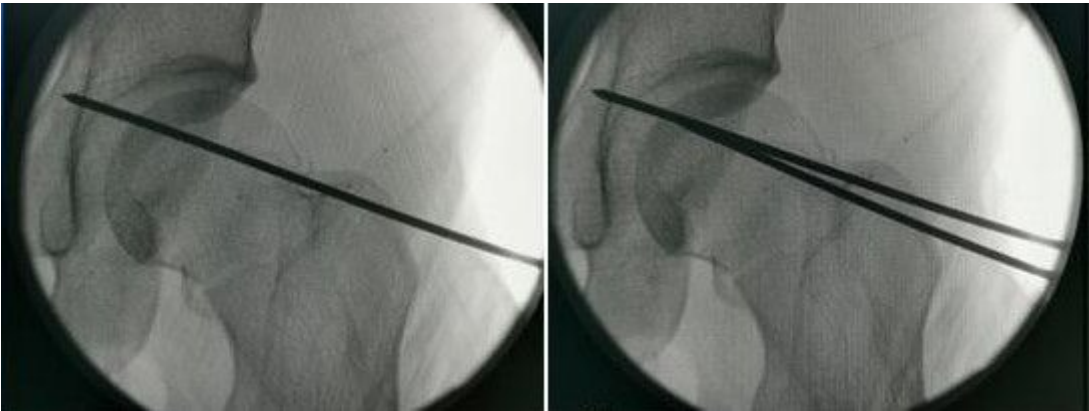


Figure 2

One kirchner wire hammered from up of greater trochanteric crossing femoral head fixing into acetabular bone(left). Another k-wire from infra-anterior of hip crossing femoral head hammering into the posterior column of the acetabulum(right).

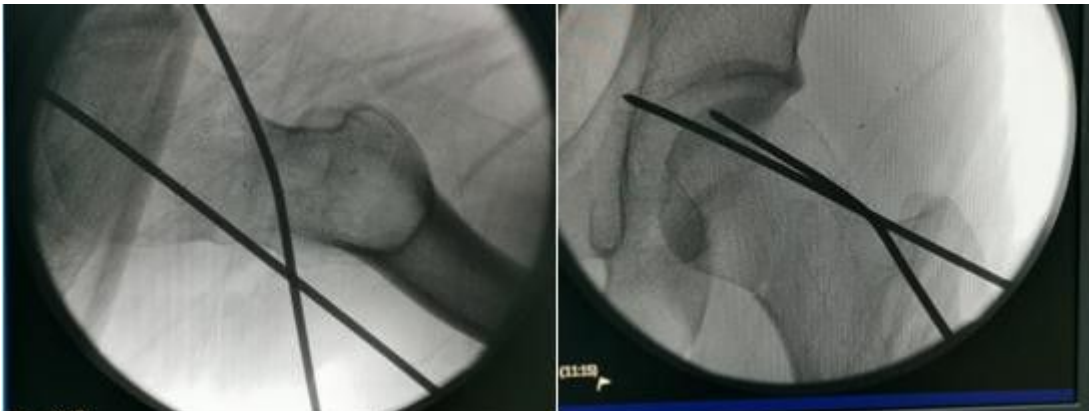


Figure 3

Closed reduction was successful completed with internal rotation and abduction on suffering lower limp under continuous image guiding and monitoring. There show one k-wire was bended by reduction force.

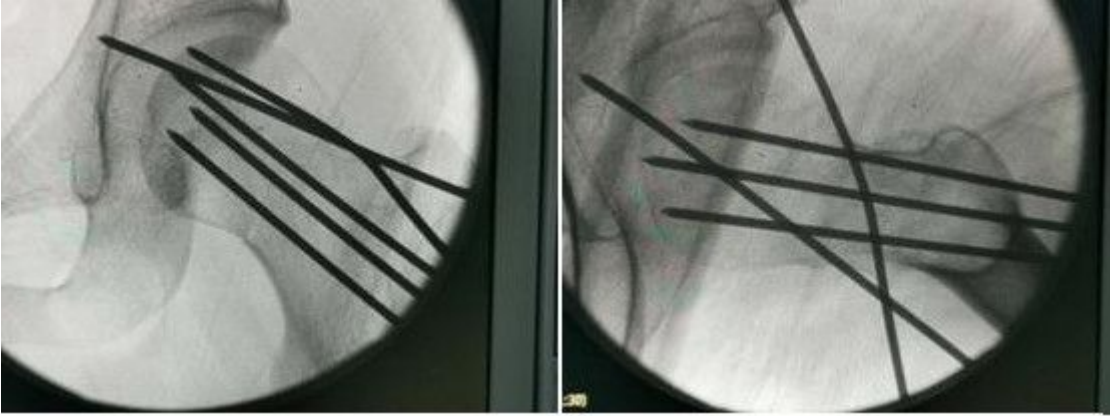


Figure 4

Three guide K-wires were being inserted in the femoral neck with inverted triangle configuration and made the inferior kirschner as closed as possible to the femoral calcar.

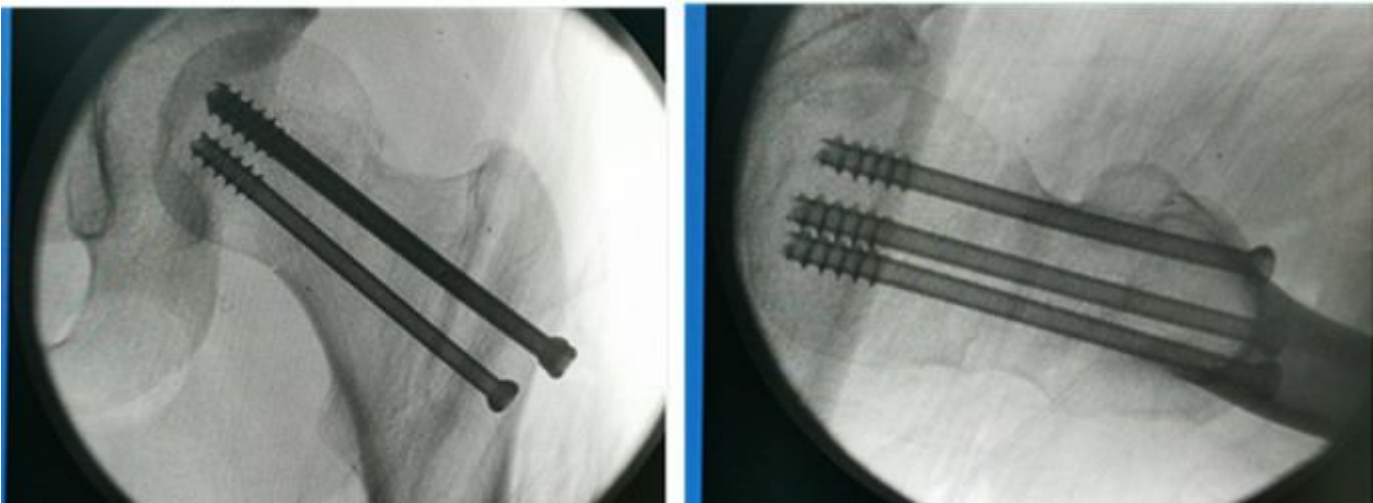


Figure 5

Three parallel cannulated screws with 7.3 mm diameter were twisted into femoral head.