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## Journal of Clinical Orthopaedics and Trauma

journal homepage: [www.elsevier.com/locate/jcot](http://www.elsevier.com/locate/jcot)

# Evaluation of intramedullary nail fixation via the Neviasser portal for proximal humerus fracture

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## ARTICLE INFO

### Article history:

Received 14 July 2018

Received in revised form

8 January 2019

Accepted 7 February 2019

Available online 8 February 2019

### Keywords:

Proximal humeral fracture

Intramedullary nail

Portal

Neviasser

## ABSTRACT

**Objectives:** To our knowledge, no cases have been reported so far regarding the treatment of proximal humerus fracture with intramedullary nail fixation via the Neviasser portal. This study aimed at evaluating the results of intramedullary nail fixation via the Neviasser portal for proximal humerus fracture. **Methods:** Four patients with 2-part proximal humerus fracture, who underwent the intramedullary nail fixation via the Neviasser portal, were included in this study. All the patients were females, and the mean age was 78.8 years. We evaluated their clinical and radiographic findings retrospectively.

**Results:** The mean follow-up period was 12 months. All the patients achieved a bone-union without severe complications, such as deep wound infections or any neurological deficits. At the final follow-up, mean shoulder flexion, abduction, and external rotation were 123.5°, 118°, and 36°, respectively. Mean visual analog pain scale (VAS) score at the final follow-up was 21/100. Complications related to the implants were observed in two patients. In one patient, protrusion of the proximal tip of the nail occurred from the entry point, and this caused secondary subacromial impingement. In the other patient, insertion of the end-cap from the Neviasser portal was not possible, and this resulted in the failure of fixation postoperatively.

**Conclusion:** The Neviasser portal may be suitable for the insertion of an intramedullary nail, because it facilitates to make an entry-point at the top of the humeral head. However, the problems related to the use of the present instruments still remain and need to be improved.

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## 1. Introduction

The domain of indication for intramedullary nail for proximal humerus fractures is narrower than that for locking plate, because it has higher rate of complications, such as pain and stiffness in the shoulder.<sup>1</sup> The currently accepted ideal indication for the insertion of an intramedullary nail is an elderly patient with a displaced 2-part surgical neck fracture.<sup>2,3</sup>

It is very important to insert an intramedullary nail from the correct entry-point, because it ensures restoration of the anatomical alignment of the head and the shaft fragment.<sup>4</sup> However, we have experienced some difficulties in inserting a nail correctly via traditional anterolateral portal (the traditional method).

Knierim et al.<sup>5</sup> suggested, after studying fresh cadavers, that insertion of a short humeral nail is possible percutaneously via the Neviasser portal (medial from the medial border of the acromion and posterior to the acromioclavicular joint),<sup>6</sup> which is more

posterior and medial to the anterolateral portal. Dilisio MF et al.<sup>7</sup> reported the first case with bilateral humeral shaft fractures, which was treated with antegrade humeral nailing via the Neviasser portal (the Neviasser method). However, to our knowledge, no cases have been reported so far regarding the treatment of proximal humeral fracture with the Neviasser method.

The purpose of this study is to report and evaluate our experiences of proximal humeral fracture which treated with the Neviasser method.

## 2. Methods

From April 2014 to March 2017, we performed intramedullary nail fixation procedures for proximal humerus fractures in 13 cases. Four of 13 cases who met the following criteria were included in this study:

1. For the elderly patients, especially with the varus angulation of  $\leq 100^\circ$ , assessed by the inclination of the anatomical neck of the humerus relative to the long axis of the diaphysis [head-shaft

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inclination (HSI) angle],<sup>8</sup> which was defined as the severe varus deformity by Robinson CM et al.<sup>9</sup>

- For patients with thick subcutaneous fat and muscle of the shoulder, and no or a small displaced fracture of the greater tuberosity (GT) of the humerus.

We set these indications from our previous experiences, during which we faced difficulties in inserting a nail with the traditional method.

All the patients were females, and the mean age was 78.8 years (range: 56–94 years). All the patients had 2-part fractures, and two (Cases 1 and 4) patients had non-displaced greater tuberosity (GT) fractures (Table 1). Cause of the fracture was a low energy fall in all the cases. Three of 4 patients (Cases 2, 3, and 4) met the first criterion. All the patients were elderly (over 80 years) and manifested severe medical comorbidities (two patients: heart failure; one patient: renal failure). In the other patient (Case, 1), we recommended a plate fixation considering her age; however, she was not willing for the plate fixation because of cosmetic problems and opted for intramedullary nail fixation (Table 1). She met the second criterion of selection, and we treated her with the Neviaser method.

Trigen humeral nails (Smith & Nephew, Memphis, TN) were used in two cases (Case 1, 4), Targon PH nail (B. Brown Aesculap, Tuttlingen, Germany) was used in the one case (Case, 2), and T2 proximal humeral nailing system (Stryker, Schönkirchen, Germany) was used in the other case (Case 3).

Informed consent was obtained from all the patients in this study and the authors declare no conflicts of interest associated with this manuscript.

### 3. Operation method

Patients were positioned in the supine position. A 2-mm Kirschner-wire (K-wire) was inserted through the Neviaser portal (Fig. 1-A) and it was confirmed that the tip of K-wire was placed on the top of humeral head perpendicularly (Fig. 1-B).

Varus deformity of the humeral head was appropriate for us to insert a guide-wire on the top of humeral head perpendicularly, because the Neviaser portal was medial to the humeral head. However, when a varus deformity is severe, it is difficult to put the K-wire on the top of the humeral head perpendicularly through the Neviaser portal, because the head of the patient hinders the process. To correct a severe varus deformity appropriately, another 2-mm K-wire is inserted from the lateral side of the humeral head and used as a joy-stick.

Subsequently, a 2-cm incision was made on the Neviaser portal and muscle fibers of the trapezius and the supraspinatus were dissected bluntly. A guide pin was inserted perpendicularly into the humeral head from the top, and the situation of the guide pin was confirmed with orthogonal C-arm radiography.

An entry-point was made with a cannulated awl through the guide pin, and an intramedullary nail was inserted into the proximal humeral fragment (Fig. 1-C and D). The arm was then abducted to reduce the displacement of the distal fragment manually, and the nail advanced into the medullary canal of the distal diaphyseal

fragment (Fig. 1-D).

Finally, the interlocking screws were placed through the insertion handle and the end-cap was inserted (Fig. 1-E).

### 4. Postoperative rehabilitation

All the patients rested with a shoulder sling for a week postoperatively. Pendular exercises were performed by the patients during this period. Active and passive range of motion (ROM) exercises were recommended at three weeks postoperatively.

### 5. Radiographic and clinical evaluation

At every follow-up, we compared the preoperative and postoperative radiographs to measure HSI angle (Fig. 2) and to evaluate the bone-union. Visual analog pain scale (VAS) score and active ROM of shoulder flexion (Flex), abduction (Abd), and external rotation (ER) were also evaluated.

### 6. Results

The mean follow-up period was 12 months (range: 5–18 months). Three patients (Case, 1–3) could be followed-up for at least 12 months after the operation; however, one patient (Case, 4) could be followed-up for only 5 months, because her medical comorbidity worsened and she was admitted to the other hospital (Table 2). All the patients achieved the bone-union without severe complications, such as deep wound infections or any neurological deficits.

The mean HSI angles were 98.5° (range: 87–111°), 126° (range: 120–134°), and 117.5° (range: 94–132°) when measured preoperatively, postoperatively, and at the final follow-up, respectively (Table 3).

The mean ROM of shoulder Flex, Abd, and ER at final follow-up were 123.5° (range: 82–165°), 118° (range: 74–162°), and 36° (range: 32–42°), respectively. The mean VAS score at the final follow-up was 21/100 (range: 8–38) (Table 4).

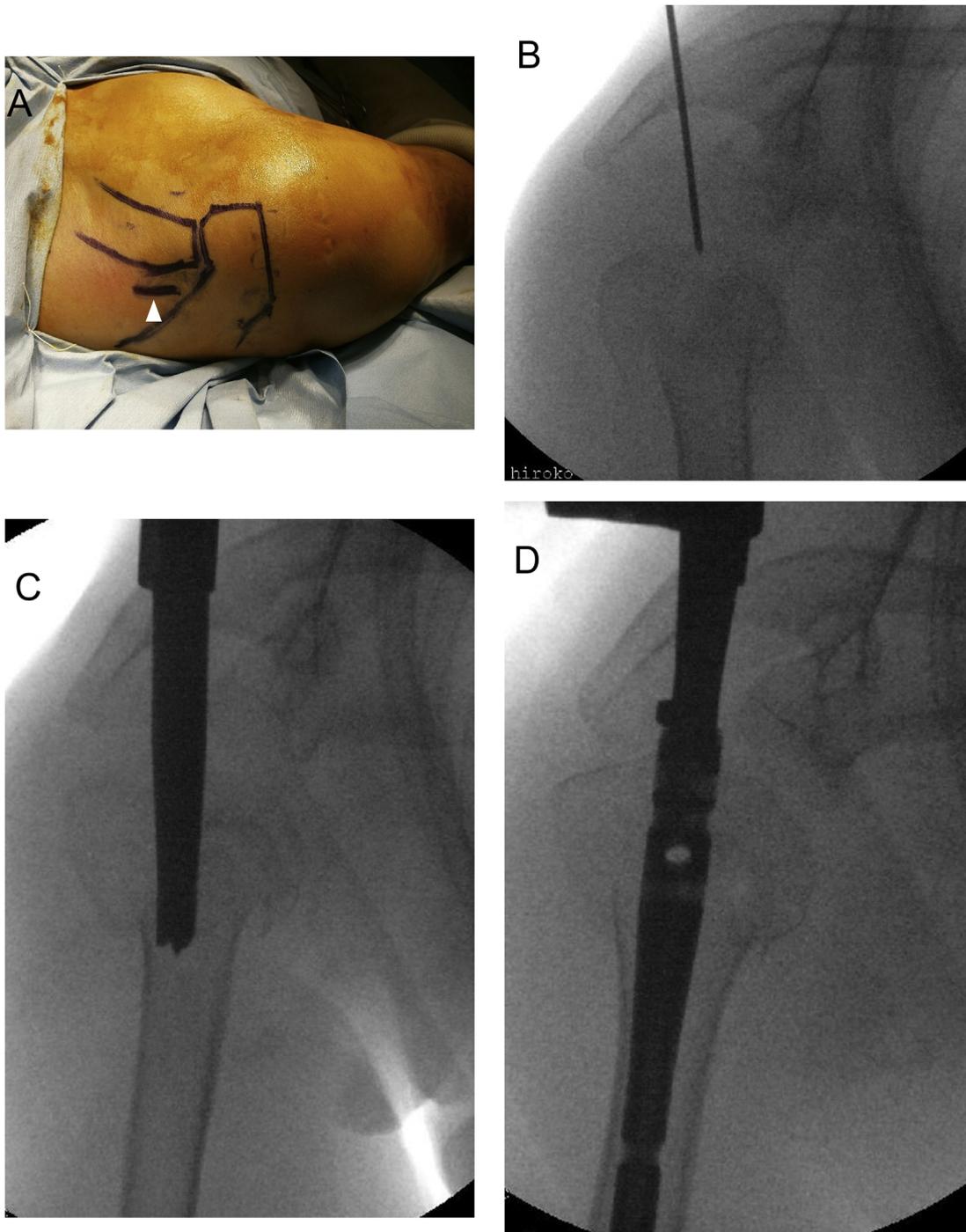
Complications related to the implants were observed in two cases. First, in Case, 1, we were not able to insert the nail in the humeral bone completely and 3-mm of the proximal tip of the nail protruded from the entry-point (Fig. 1-E), because the patient had thick subcutaneous fat and muscle in her shoulder and the contact of the insertion handle with the shoulder prevented farther insertion of the nail (Table 2). Postoperatively, she developed subacromial impingement secondary to the protrusion of the nail, and the pain during the shoulder abduction continued. Therefore, she underwent a nail removal operation after the bone-union was achieved. After the nail removal operation, her shoulder pain decreased and active ROM of shoulder abduction improved.

Second, in Case, 3, we were able to insert the nail without any difficulty; however, we were not able to insert the end-cap through the Neviaser portal, because the entry-point moved slightly to the lateral side after the fixation, and the medial edge of the acromion disturbed the shaft of the screwdriver used to insert the end-cap. (Fig. 3-A). In this case, we used a bent nail unlike the other three cases in which straight nails were used. We consider this difference can be a cause of this complication. This patient also experienced failure of fixation with recurrent varus deformity and slipping out of the proximal interlocking screw at 6 weeks postoperatively. However, she remained under observation, because her pain was within the manageable limit, and finally, she was able to achieve bone-union without any exacerbation of her symptoms (Fig. 3-B). Although active ROM of her affected shoulder was restricted and moderate pain was still experienced during the shoulder motion, she was able to use her affected arm to perform daily living

**Table 1**  
Patients' details.

Cases	Sex	Age	Types of fracture	Comorbidities
1	F	56	2-part + NDGT	None
2	F	83	2-part	Heart failure
3	F	94	2-part	Heart failure
4	F	82	2-part + NDGT	Renal failure

F: Female; NDGT: Non-displaced greater tuberosity fracture.



**Fig. 1.** A. Case 1. The Neviaser portal (white arrow head). It was placed medially from the medial border of the acromion and posterior to the acromioclavicular joint. B. A 2-mm Kirchner wire was inserted from the Neviaser portal and it was confirmed that it reached the top of the humeral head easily, before making the skin incision. C. The entry-point was made with a cannulated awl. D. An intramedullary nail was inserted through the entry-point of the proximal humeral fragment to the distal diaphyseal fragment. E. The end-cap was inserted to lock and stabilize the proximal locking screw. In this case, the nail could not be inserted into the humeral bone completely and 3-mm of the proximal tip of the nail protruded from the entry-point (white arrow head).

activities.

The other two patients achieved the bone-union without any complications, and the function of their affected shoulder almost recovered the same as before. In Case. 4, active ROM of the shoulder was severely restricted; however, she manifested this restriction even before the injury.

## 7. Discussion

In patients with the proximal humerus fracture, surgical treatment is generally considered in approximately 20% of cases only. Especially, it is rarely indicated in very elderly patients or in those with severe medical comorbidity.<sup>1</sup> However, Robinson et al.<sup>9</sup>



Fig. 1. (continued).

recommend surgical treatment when the varus deformity is more severe, because in these cases, the results of conservative treatment are more unpredictable, and the deformity may tend to worsen and may predispose to non-union of the fractured bone. As described by Robinson et al.,<sup>9</sup> in this study, we selected surgical treatment in three very elderly patients with severe medical comorbidities, who had unstable 2-part fractures and severe varus deformity (Cases 2–4). However, we chose to perform intramedullary nail fixation in these patients, unlike Robinson et al.<sup>9</sup> who had selected plate fixation, because we considered that the plate fixation involved more

soft tissue damage and might cause more bleeding,<sup>10</sup> and therefore, was not suitable for these patients.

Many authors are reticent about the selection of intramedullary nail fixation, because insertion of the nail from the entry-point via the traditional anterolateral approach may involve a risk of injury to the rotator cuff, especially in young patients.<sup>1</sup> However, in the other case (Case. 1) in this study, the patient was concerned about the cosmetic disfigurement and refused to undergo plate fixation, because it might produce a larger wound scar. Therefore, we performed an intramedullary nail fixation in this patient.

To minimize an iatrogenic damage to the rotator cuff during intramedullary nail insertion into the humerus, some authors have reported a new approach of nail insertion. Park et al.<sup>11</sup> reported nail insertion via the rotator interval in their clinical cases. Theoretically, this approach does not affect the cuff function, because in this approach incision is made only at the musculotendinous junction.

On the other hand, Knierim et al.<sup>5</sup> first reported the method of antegrade humeral nail insertion via the Neviaser portal in their cadaveric study and showed that this method may reduce the risk of tendon cuff injury, because all the insertions are performed through the supraspinatus muscle belly. Later, Dilisio MF et al.<sup>7</sup> reported for the first time the clinical case of bilateral humeral shaft fracture which was treated with this method, because the patient already suffered from rheumatoid arthritis and cuff tear arthropathy and it was not possible to insert the nail by using the traditional anterolateral approach.

The Neviaser portal has been well known as a useful and safe arthroscopic portal of shoulder surgeries, such as repairs of rotator cuff injuries and superior labrum anteroposterior tears.<sup>12,13</sup> We selected the Neviaser method in this study, because we believed that the Neviaser portal allows better nail insertion than the traditional anterolateral approach or the trans rotator interval approach described by Park et al.,<sup>11</sup> since in the proximal humeral fractures, the humeral head is usually displaced in the varus (medial) direction and the humeral head is naturally retroverted.<sup>14</sup>



Fig. 2. Head-shaft inclination angle (white star).

**Table 2**  
Postoperative results.

Cases	Follow-up period (Months)	Bone-union	Complications
1	18	Union	Protrusion of the proximal tip of the nail
2	12	Union	None
3	13	Union	1 Impossible to insert the end cap 2 Re-displacement
4	5	Union	None

**Table 3**  
Results of head-shaft inclination angle.

Cases	Preoperative (°)	Postoperative (°)	Final follow-up (°)
1	111	127	122
2	91	134	132
3	87	120	94
4	95	124	122

**Table 4**  
Results of range of motion of shoulders and VAS scores.

Cases	Flex (°)	Abd (°)	ER (°)	VAS Score
1	162	157	42	19
2	165	162	35	8
3	85	74	32	38
4	82	80	35	15

Flex: Flexion; Abd: Abduction; ER: External rotation.  
VAS: Visual analog pain scale.

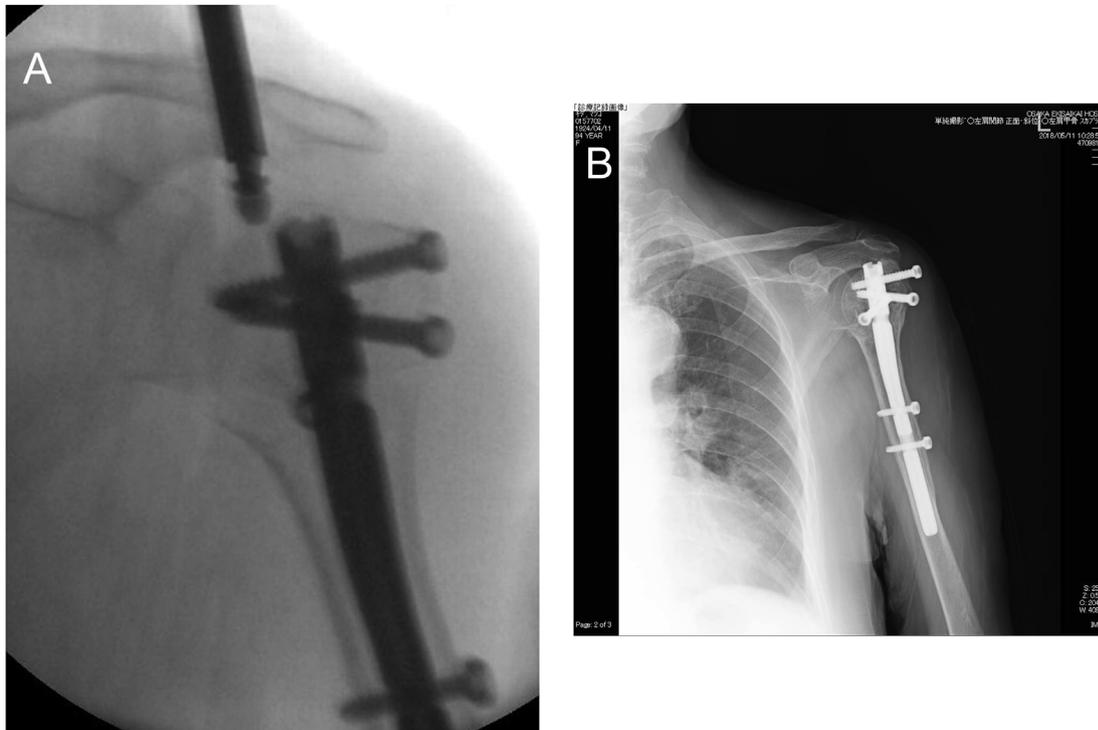
The Neviaser portal can be placed more medially and posteriorly as compared to the traditional anterolateral approach and the trans rotator interval approach.

In this study, we considered the indications of the Neviaser

method in case of elderly patients with severe varus deformity of the humeral head, patients with thick muscular and subcutaneous fat of the shoulder, and those with a fracture of GT. The reasons for such selection criteria were that, we earlier experienced some troubles during the insertion of an intramedullary nail via the traditional anterolateral approach in these types of patients.

For example, for inserting an intramedullary nail through the Neviaser portal to reduce a varus deformity of the head, a joy-stick Kirchner wire and sutures in the rotator cuff were used. However, for inserting an intramedullary nail at the correct entry-point via the traditional anterolateral approach, we needed to reduce the varus deformity of the head thoroughly and we have experienced to cut out the fragment and the rotator cuff, especially in the very elderly patients with severe varus deformity of the humeral head, because of the vigorous stress applied during the reduction of the deformity.

In addition, there is a greater risk of re-displacing the fracture during the nail insertion when the greater tuberosity is fractured and may result in more complex fractures with poor prognosis and a re-operative rate of 45%.<sup>2</sup> Therefore, care should be taken while making the entry-point at the very top of the humeral head and should attempt to prevent from widening the gap of GT fracture while opening the entry-point with a cannulated drill or awl.



**Fig. 3.** A. Case 3. The end-cap could not be inserted from the Neviaser portal, because it was hindered by the medial edge of the acromion.  
B. Anteroposterior radiograph at twelve months postoperatively. Bone-union was achieved, although recurrent varus deformity and slipping out of the proximal interlocking screw occurred.

However, we have experienced this difficulty with the traditional method especially in patients with large muscular or thick subcutaneous fat in the shoulder.

This study demonstrated that we can insert an intramedullary nail from the correct entry-point via the Neviaser portal without any difficulties, and therefore, the Neviaser method can be considered more suitable for these patients as compared to the traditional method because of the following two points: (1) Unlike the traditional method, it is easy to make a correct entry-point for an intramedullary nail via the Neviaser portal under some remaining varus deformity of the humeral head. Therefore, it is not needed to apply vigorous stress to reduce severe varus deformity of the humeral head; (2) the Neviaser portal is located medially to the humeral head and it allows to reach the top of the humeral head without crossing the fracture line of GT, unlike the traditional method. Therefore, we believed that the Neviaser method has less risk of widening the gap of GT fracture while making the entry-point as compared to the traditional method, especially in patients with large muscular or thick subcutaneous fat in the shoulder.

We could not evaluate the effects of this method on postoperative pain related to tendon cuff or articular cartilage damage in our study. Although two of our 4 cases experienced postoperative pain, one patient (Case. 1) developed protrusion of the end of the nail, because the contact of the insertion handle with her thick shoulder prevented farther insertion of the nail and she subsequently developed secondary acromial impingement, which caused the postoperative pain. In the one patient (Case. 3), the postoperative pain was exacerbated after the failure of fixation. In addition to insufficient reduction of the varus deformity of the humeral head, the failure of the insertion of the end-cap led to improper locking of the screws into the nail and decreased the rigidity of the fixation,<sup>3,15</sup> and this might have resulted in the failure of fixation. We consider that the causes of postoperative pain are related to not the damage of tendon cuff but the problems of using the present instruments in both the cases. In addition, we consider the effects of this method on postoperative pain related to tendon cuff or articular cartilage damage should be evaluated in young cases. However, three of four cases in this study were very elderly whose tendon cuff could have been already damaged and it was difficult to evaluate cuff tendon in our cases.

This study has some limitations. This was a retrospective study

that involved only 4 cases and lacked a control group. In addition, implants used in this study were various and they can affect results of each case.

In conclusion, the Neviaser portal may be suitable for intramedullary nail insertion in some cases, because it facilitates to make the entry-point at the top of the humeral head to insert an intramedullary nail. However, problems related to the use of the present instruments still remain and need to be improved.

### Conflicts of interest and source of funding

None.

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