

The Results of Ender Nailing for the Proximal Humerus Fractures - Radiological Evaluation -

Jin Soo Park, M.D., Moon Sang Chung, M.D.*, Kang Sub Yoon, M.D., Goo Hyun Baek, M.D.*,
Ji Ho Lee, M.D., Seung Baek Kang, M.D., and Dong Wook Kim, M.D.*

Department of Orthopaedic Surgery, Seoul Muncpal Boramae Hospital, Seoul, Korea
Department of Orthopaedic Surgery, College of Medicine, Seoul National University, Seoul, Korea*

— Abstract —

Purpose : The authors compared the results of Ender nailing for the proximal humerus fractures with those of the conservative methods radiographically.

Materials and Method : Nine patients(mean age: 69 years.) received Ender nailing, and the other nine patients, conservative treatments(mean age: 73 years). All fractures were 2 part fractures. The Ender nails were inserted either through posterior elbow approach or transepicondylar approach. A simple Velpeau bandage was applied to the conservative treatment group. The average follow-up was 15 months.

Results : The initial status of the anatomical reduction, i.e., the values of the medial shift, overlapping and the varus angulation, were little changed at follow-up radiographs in both the Ender nailing group and the conservative treatment group. There was no significant difference for the status of anatomical reduction between the Ender nailing group and the conservative treatment group. The stability of fixation by Ender nails, i.e., the degree of fanning out of the nails was poor in most cases. Not a few problems/complications happened in cases of Ender nailing group; backing out of the nail in three cases, penetration of the nails into the humeral heads in 3, fractures or cracking of the humerus around the nail insertion area in 4 and reduction loss in one.

Conclusion : We could not get better results with the use of Ender nail. We use no longer Ender nails for the proximal humerus fractures. Further studies are needed for the better option for the proximal humerus fractures.

Key Words : Proximal humerus, Fracture, Ender nail

INTRODUCTION

Proximal humerus fractures are common in elderly patients who have significant osteoporosis, particularly since this site is

known to be weak point^{3,10)}, thus called to be a fragility fracture^{2,17,18)}. Because bony union develop easily in this area with adequate reduction of the fracture, most surgical neck fractures of the humerus are treated with conservative methods,

※통신저자 : 박진수
서울특별시 동작구 신대방 2동 395번지
서울시립 보라매병원 정형외과

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such as hanging cast, Velpeau's bandage, or a simple sling^{2,8,15,17,18,20,22)}.

However, complex and displaced fractures continue to be difficult problems for orthopaedic surgeons. The optimum treatment of these fractures has remained a matter of controversy⁹⁾. The traditional operative approaches to this type of fracture have tended to jeopardize the vascular supply to the head in order to maintain the stability of the reduction. Extensive dissection of soft tissues is necessary for the reduction and the application of a plate over the bicipital groove on the anterolateral humeral surface. This is precisely the region where the blood vessels enter the humeral head⁶⁾.

With the objective of preservation of vascularity to the articular segment, operative approaches have emphasized minimum exposure and appropriate fixation^{1,4,5,7,12,13,16,21,23)}. Szyszkowitz et al²³⁾ advocated the procedure of minimal, rather than rigid, fixation after careful assessment of the condition of the soft tissue and blood supply of the humeral head fragments. Cuomo et al¹⁾ also used a technique of limited internal fixation to achieve fracture stability. High percentage of acceptable results was obtained in their series¹⁾.

In the current study, 18 proximal humerus fractures were treated with either Ender nailing or conservative method. The effectiveness of fracture stabilization with Ender nailing were compared with those of the conservative methods radiographically.

MATERIALS and METHODS

From 1996 to 1998, in the orthopaedic department of our hospital, there were 18 patients with displaced 2 part proximal

humerus fractures who received closed reduction with Ender nailing or conservative method.

The indication for the Ender nailing or for the conservative treatment was not clearly set initially. But if the fracture demonstrated abnormal motion, especially rotational movement, on passive mobilization after manual reduction, and if the patient seemed to be tolerable for the operation, then internal fixation with Ender nail was chosen. We excluded all severely displaced irreducible three and four-part fractures and all fractures that involved splitting of the articular surface of the humeral head; these kinds of fractures were treated with open reduction and fixation with the use of a limited-dissection technique.

1. Ender nailing group

The age of the patient ranged from 59 to 75 years, with a mean age of 69 years. Of the nine patients, 6 were older than 70 years and had moderate osteoporosis. Four patients were men and 5 were women. One patient had bilateral fractures, and there were no additional fracture or dislocation around the shoulder. The cause of trauma was falling down on the side, with or without hand outstretched in all cases. Open fracture was not included in this series. There were no axillary nerve paresis associated with fracture.

2. Operative procedure

The procedures were performed with patient under the interscalene block or general anesthesia. The patient was placed in the supine position on an operating table, thereby allowing for a clear view on an image intensifier. Before drap-

ing, the fracture was reduced manually and maneuvers necessary for the fracture reduction were rehearsed.

1) Posterior elbow approach

A longitudinal posterior midline incision of 3 or 4cm was started close to the olecranon and continued proximally. The triceps tendon was split to expose extrasynovial fat, but the joint was not entered. A 7mm awl was passed blindly into the proximal slope of the olecranon fossa, and its position was checked on a lateral view. The hollow of the olecranon fossa helped to maintain the awl in the midline. The cortex was pierced and the hole enlarged with the hand reamers, making a round entry. With the use of the image intensifier a nail of adequate length was inserted through the opening, and the fracture was manually reduced.

2) Transepicondylar approach

One to 2cm sized bilateral skin incisions were made over the each epicondylar ridge area. A 7mm awl was passed into the condylar medullary cavity. The cortex was pierced and the nail was inserted through this portal at both side under the guide of image intensifier.

We tried to make the proximal end of the nail be reached to the subchondral area of the humeral head as possible. An equal or nearly equal length of C-shaped nails that snugly filled the medullary canal were then added. The distal ends of the nail should not protrude beyond the edge of the portal. An attempt was made to distribute the tips of the nails in both the humeral head and the greater tuberosity. A thin wire that passed through the eyelets of the nails was then tightened to prevent loosening of individ-

ual nails.

After surgery, the elbow was kept at 90° flexion, and the arm was supported at the patient's side with a sling. In those fractures that appeared stable at the fracture site on passive shoulder mobilization as viewed fluoroscopically, the patients were allowed to begin protected passive range of motion exercise of the shoulder and elbow within 2 weeks. The passive elevation of the shoulder was restricted to 90° and external rotation to 0°. When the rotational movement at the fracture site remained after surgery, passive range of motion exercise was postponed for 3 to 4 weeks until the fracture became stable. Plain radiographs of the fracture were then taken every two weeks to assess adequate reduction of the fracture during rehabilitation period. If any abnormal displacement at the fracture was detected on radiograph or if motion pain occurred on passive motion, then the shoulder was immobilized. A little displacement or angulation at the fracture site without rotational movement was allowed if pain during the protected passive motion of the shoulder did not increase.

3. Conservative treatment group

The age of the patient ranged from 55 to 89 years, with a mean age of 73 years. Of the nine patients, 6 were older than 70 years and had moderate osteoporosis. Three patients were men and 6 were women. The cause of trauma was falling down on the side, with or without the hand outstretched, in all cases. At the initial visit, the fracture side was immobilized with Velpeau bandage. The elbow was kept at 90° flexion, and the arm was supported at the patient's side with a Vel-

peau bandage. The bandage was kept for the first 2 weeks, then changed to simple arm sling. The patients were allowed to begin protected passive range of motion exercise of the shoulder and elbow after 2 weeks. At 5th week if there is stable callus formation, the passive elevation of shoulder was started with maximum range of 90°.

Clinical features of the shoulder and elbow joint were examined at final follow-up.

4. Radiological evaluation

Postoperative radiographs were reviewed

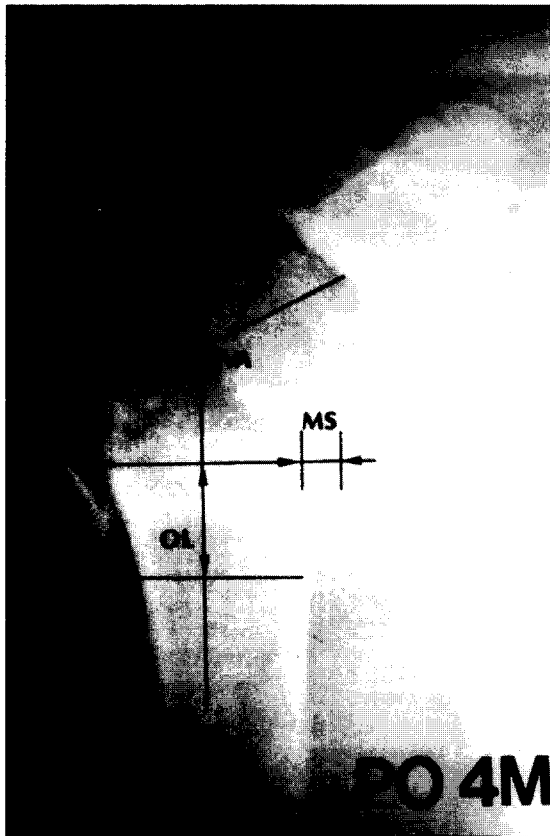


Fig. 1. The deformities of the humeral neck at the fracture site were examined on anteroposterior radiographs of the proximal humerus to evaluate the medial shift(MS) of the distal fragment, varus angulation of the humeral neck(VA) and overlapping of the each fragment(OL).

every two weeks for evidence of fracture healing. Union occurred when a solid bar of periosteal callus crossed the site of fracture and no motion or pain occurred on palpation or manipulation of the arm. On initial and follow-up radiographs, we evaluated the extent of the anatomical reduction by measuring the medial shift of the distal fragment relative to the proximal fragment, overlapping of each fragment and the varus angulation which is thought to be related with the abduction range of the shoulder¹⁸⁾ (Fig. 1). The stability of the fixation was assessed by measuring the horizontal stability and the vertical stability. On radiograph we defined the horizontal stability as the ratio of the width between each nail to the humeral head diameter and the vertical stability as the ratio of the nail length to the length of the proximal fragment (Fig. 2). According to the value of the horizontal stability, the fanning out of the nails was graded as good (greater than 0.5) poor (less than 0.5). The follow-up period was from 12 months to 40 months (mean, 15 months). Statistical significance was evaluated with use of

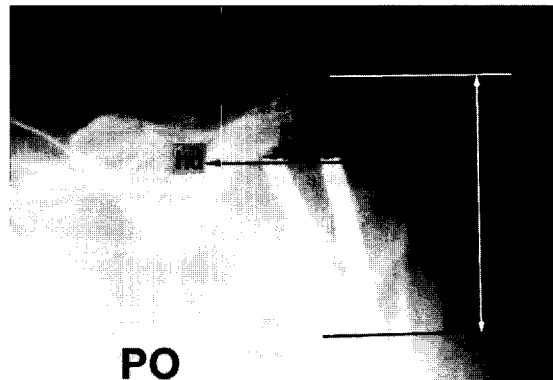


Fig. 2. The horizontal stability(HS) as the ratio of the width between each nail to the humeral head diameter($HS=nw/hd$) and the vertical stability(VS) as the ratio of the nail length to the length of the proximal fragment($VS=nl/fl$).

a Mann-Whitney U test(nonparametric 2 independent samples test) in which all matched variables were compared for the two groups. A p-value of less than 0.05 was considered significant.

RESULTS

As for the mean age, there was no statistically significant difference between the Ender nailing group and conservative treatment group($p=0.450$). As for the anatomical reduction, the average medial shift of the distal fragment at initial radiograph in the Ender nailing group was 1.0mm(range, -6mm~8mm) compared with 1.8mm(range, -8mm~20mm) in the conservative treatment group; no significant difference could be detected between the groups($p=0.925$). The average overlapping of the each fragments in AP film in Ender nailing group was 1.7mm(range, 0.5mm~15mm) where as that for conservative treatment groups was 3.2mm(range, 0mm~15mm); again, there was no significant difference between the two groups($p=0.317$). We also could not detect a significant difference with respect to the mean varus angulation of the humeral neck between the two groups($p=0.615$) (Table 1, 2). As for the stability of fixation, the average value of the horizontal stability was 0.4, and the value of the vertical stability was 0.6. The initial status of the anatomical reduction, ie, the values of the medial shift, overlapping and the varus angulation, were little changed at the follow-up radiographs in both the Ender nailing group and the conservative treatment group. At final follow-up, the average medial shift of the distal fragment in the Ender nailing group was 1.2mm(range, -6mm~8mm) compared with 0.3mm(range, -10mm~20

mm) in the conservative treatment group; no significant difference could be detected between the groups($p=0.467$). The average overlapping of the each fragments in AP film in Ender nailing group was 1.9mm(range, 0mm~15mm) where as that for conservative treatment groups was 2.9mm(range, 0mm~15mm); again, there was no significant difference between the two groups($p=0.481$). We also could not detect a significant difference with respect to the mean varus angulation of the humeral neck between the two groups($p=0.438$) (Table 1, 2).

1. Ender Nailing Group

Two Ender nails were inserted in the medullary canal except one case in which only one nail was inserted. All fractures healed without nonunion or delayed union. And the average period of healing was 6 weeks. This correlated with decreasing pain and increasing motion of the shoulder and elbow as the callus gradually obliterated the site of the fracture. All patients complained of elbow pain after surgery. According to the classification by Neer, all fractures were 2 part fractures, in which 4 cases had additional greater tuberosity fractures without significant displacement. But this greater tuberosity fractures hindered the Ender nails being fanned out in coronal plane, because if the nail inserted into the greater tuberosity, the stabilization could not be obtained. Ender nails were inserted through the olecranon fossa area in three cases, transepicondylar approach in 6 cases. Backing out of the nails were seen in two cases. Although the magnitude of backing out of the nails did not influence the lack of elbow extension, the patient had to suffer from pain by backing out into the subcutaneous tissue

Table 1. Radiographic Features of Ender Nailing Patients at Followup

case	age	sex	Neer's classification	approach	Postoperative radiographic findings										Problems/Complications	
					Initial					Follow up						
					MS(mm) overlapp ing(mm)	varus (deg)	horizontal stability	fanning out	vertical stability	MS (mm)	overlapp ing (mm)	varus (deg)	penet ration			
1	65	f	2 part	transepicondylar	0	0	0.42	poor	0.71	0	0	0	0	0	no	small cracking of epicondyle
2	76	m	2 part	transepicondylar	-6	0	0.89	good	0.88	-6	0	0	0	21	1	cracking of distal humerus, protrusion of nail into elbow(1)
3	59	f	2 part	transepicondylar	-5	0	0.43	poor	0.18	-5	0	0	28			nearly no reduction, no purchase of proximal head portion by Ender nail
4	71	m	2 part, greater tuberosity fracture	transepicondylar	5	0.5	0.32	poor	0.70	5	0.5	30				
5	62	f	2 part	trans olecranon	0	0	0.38	poor	0.77	2	0	20				
6	74	f	2 part, greater tuberosity fracture	transepicondylar	8	0	0.13	poor	0.48	8	0	0	0	1		fracture of distal humerus-long arm casting(6wk)
7	71	m	2 part, greater tuberosity fracture	transepicondylar	7	1.5	0.42	poor	0.82	7	1.5	60	1			
8	71	f	2 part	trans olecranon	0	0	0.47	poor	0.60	0	0	0	0	no		
9	75	m	2 part, greater tuberosity fracture	trans olecranon	0	0	0.37	poor	0.50	-0.5	1.5	0				reduction loss at postop 3 day. Reoperation and augmentation with K-wires & cast
Mean	69.3				1.0	1.7	15.9	0.4	0.6	1.2	1.9	17.7				
S.D.	6.0				4.9	5.0	21.3	0.2	0.2	4.9	4.9	20.4				

* MS: medial shift of the distal fragment

Table 2. Radiographic Features of Conservative Treatment Patients at Followup

case	age	sex	Neer's classification	Radiographic findings					
				Initial			Follow up		
				MS(mm)	overlapping(mm)	varus(deg)	MS(mm)	overlapping(mm)	varus(deg)
1	71	f	2 part	0	0	0	0	0	0
2	56	f	2 part	0	0	34	0	0	34
3	89	f	2 part	0	0	20	0	0	20
4	81	f	2 part	20	3	0	20	3	0
5	55	m	2 part	0	0	0	0	0	0
6	84	f	2 part, greater tuberosity fracture	0	0	0			
7	58	m	2 part	9	8	0	-2	4	0
8	76	m	2 part	-8	3	30	-10	4	35
9	83	f	2 part, greater tuberosity fracture	-5	15	0	-5	15	0
Mean	72.6			1.8	3.2	9.3	0.3	2.9	9.9
S.D.	13.2			8.2	5.2	14.5	8.1	4.9	15.4

* MS: medial shift of the distal fragment

of the elbow until removal of the nail. Penetration of the nail into the shoulder joint was noted in 3 cases that caused the continuous postoperative shoulder pain and delay of initiation of exercise(Fig. 3). Most of the Ender nails were not spread against each other ideally; eight cases had poor or no fanning out of the nails, so the stability could not be given(Table 1). The most disastrous complications were fracture of the humerus around the nail insertion point area. In two cases, complete fracture of the distal humerus occurred so that the elbow should be immobilized for 4 weeks in long arm cast. Two cases had cracking on the supracondylar area. In one case, redisplacement after reduction was noted 3 days after operation. So the fracture was reoperated with Ender nail and additional numerous Kirschner wire insertion.

2. Conservative Treatment Group

All patients had pain relief after 1 to 2 weeks after immobilization. All fractures healed, and the average period of healing was 6 weeks(Fig. 3, Table 2). This was correlated with decreasing pain and increasing motion of the shoulder and elbow as the callus gradually obliterated the site of the fracture.

DISCUSSION

The treatment of complex proximal humeral fractures present a challenge to orthopaedic surgeons. First, these fractures are osteoporotic fractures, which by definition represent metaphyseal fractures that occur primarily in

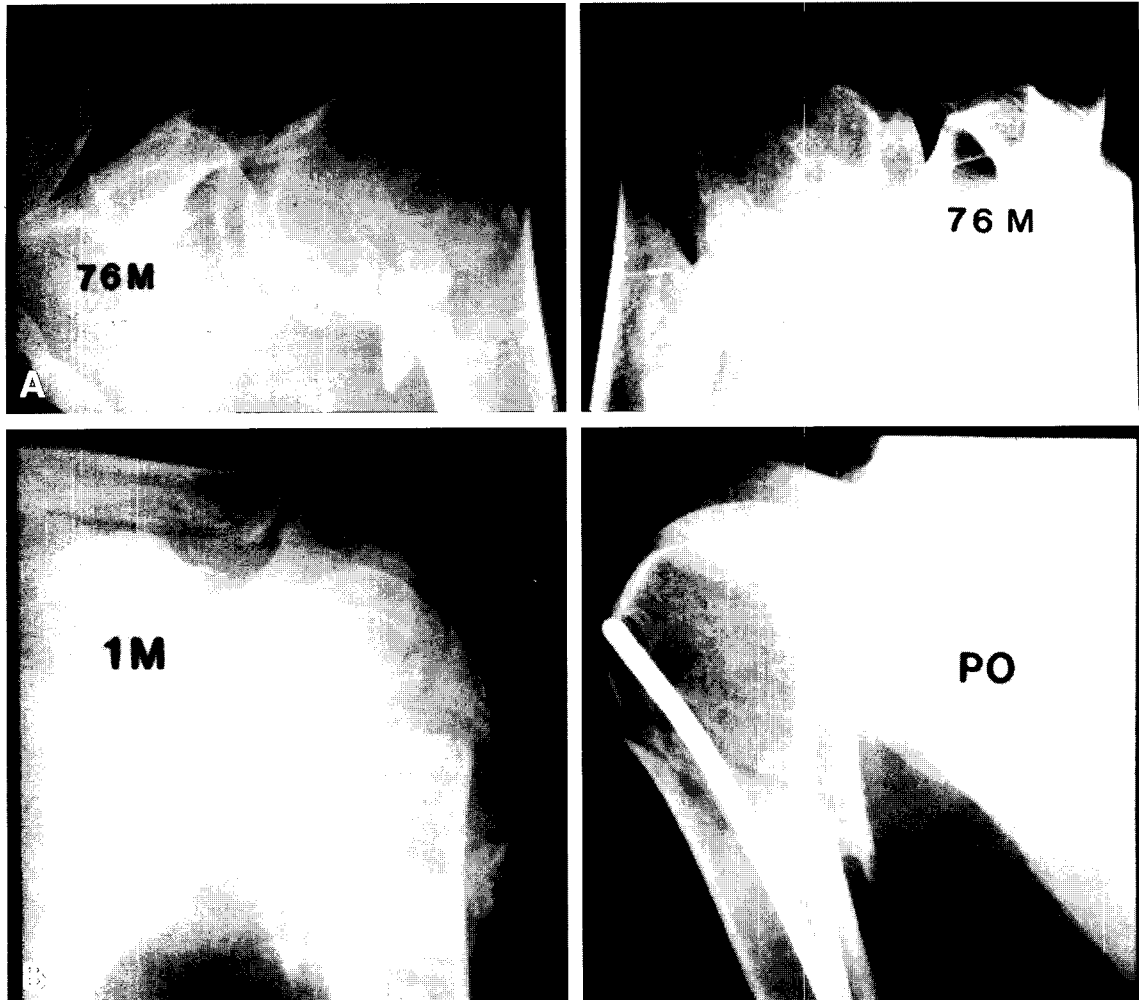


Fig. 3. A 72 year old male patient with Neer's type II bilateral proximal humerus fractures(A-R, A-L). Two Ender nails were inserted on the right side of the fracture, but the penetration of a nail was noted and the head was united in varus status(B-R). Large amount of callus formation was noted on the left side at 1 month with simple sling method(B-L).

women over the age of 50. The osteoporosis results in compromised bone quality, which limits the potential to achieve secure internal fixation. Second, the muscular attachments of the proximal humerus and the associated deforming forces make it difficult to obtain and maintain an acceptable closed reduction. Third, radiographic evaluation of the fractures can also be challenging because of the displacement patterns and the overlapping bony structures. And

fourth, fractures that result in displacement of the articular segment and the tuberosities are at significant risk for the development of osteoporosis²⁴.

There is no consensus on the best way to treat complicated fractures of the proximal humerus. Various methods of internal fixation using wires and screws¹⁵, plates¹⁰, external fixators¹¹ and T-plates¹⁹ have been reported but none of these methods has been consistently successful. For full

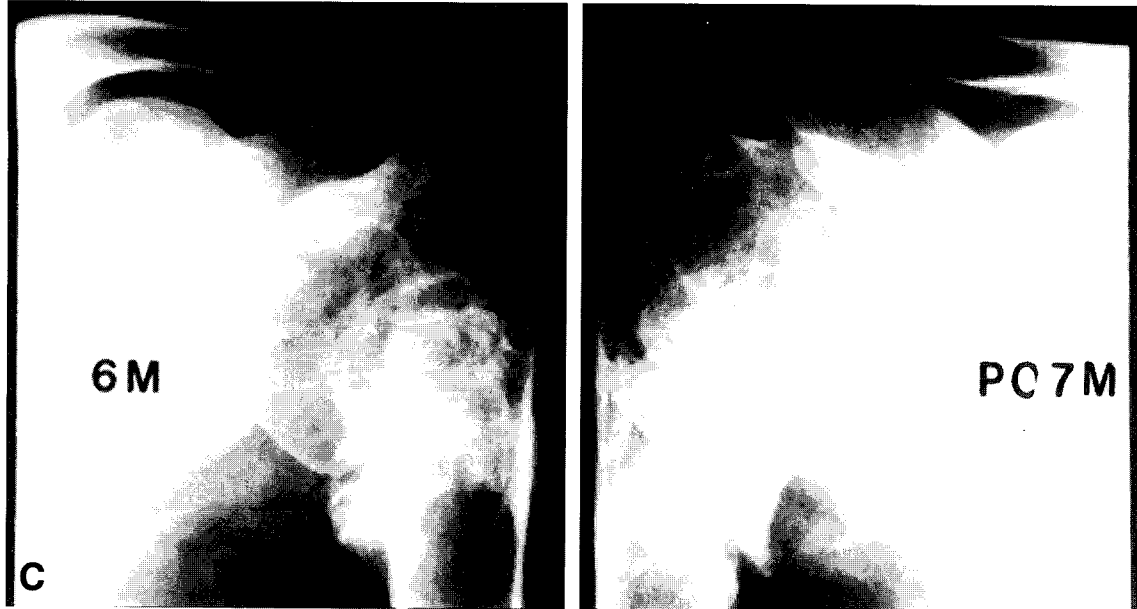


Fig. 3. Comparing each other, there was no difference in radiographic results(C-R, C-L).

functional recovery anatomical reduction, stable fixation and early mobilisation are required. These relative unsatisfactory results cause us think that alternative techniques should be evaluated.

As Ogiwara et al¹⁸⁾ reported, the major advantage of Ender nailing for displaced and unstable surgical neck fracture of the humerus are pain relief, stabilization of the unstable fragment, protected early postoperative passive motion exercise. The process of internal fixation with Ender nail is technically simple and does not cause damage to the soft tissue around the fracture fragment³⁾, thus many patients experience pain relief in the early postoperative period and can resume their activities of daily living. Even if the postoperative stabilization of fracture was not sufficient to allow early postoperative passive motion, the patient could still receive relief from pain after surgery. Because of an acceptable reduction of the fracture fragments, stabilization of the fragment

could be obtained with initial immobilization 3 to 4 weeks after surgery, followed by performance of passive range of motion exercises.

At first we began the retrograde Ender nailing based on the following reasons: 1) the process of internal fixation with Ender nail is technically simple and does not cause damage to the soft tissue around the fracture fragments; 2) the elbow would be blocked effectively with brachial plexus block unlike the shoulder on which there would be pain-block sparing area after regional block because most of cases had medical problems that had many risks if in state of general anesthesia; 3) If the nails be spread out effectively within the proximal area, i.e., fanned out, the fracture fragment will be effectively stabilized so that early shoulder range of motion would be possible; 4) The postoperative elbow problems would be too little to be considered

In fact the technique was not simple nor

easy. Because the entry into the humeral medullary canal of the Ender nail was difficult in our series, fracture of the distal humerus occurred in 2 cases and significant cracking around the epicondylar area in 3 cases. For these reasons, 2 patients had to have long arm casting for 6 weeks. For the patient with cracking around the epicondylar area, elbow immobilization was done for 3 to 4 weeks, thus accompanying shoulder exercises was delayed. Because the medullary canal was narrow, we usually could not insert three nails which would be the best condition for the stabilization of the proximal fragment.

The key point in the reason of using the Ender nail was fanning out of the nails in the humerus head area. In most cases we had poor fanning out so could not have satisfactory stability by using the Ender nail in our series. In fact the nails could not be spread against each other as we wanted in many cases. There are some reasons why the nails could not be fanned out. At first, the medullary canal is too narrow for the nails to be managed as the surgeon wanted. Furthermore, four cases had greater tuberosity fractures for which the nail could not be entered into the greater tuberosity, thus limiting the plane of fanning out of the nail. In fact, many cases of the proximal humerus fractures are accompanied by the greater tuberosity fractures, either displaced or not. This may limit the generalized use of Ender nail.

In three cases penetration of the nail into the shoulder joint occurred. They had moderate to severe shoulder pain and limitation of motion. But the nail was kept in site, and 6 to 10 weeks later, after

confirmation of the stable union in the X-ray, the nails were removed. One patient complained of lack of complete extension of elbow with 10 degrees of extension lag. And most of patients cannot completely extends elbows, though little problem in activity of daily living.

It seems that the Ender nailing cannot afford satisfactory results for the patients. In summary, we could not get better result with the use of Ender nails than with the conservative treatment. We use no longer Ender nails for the proximal humerus fractures. Further studies may be needed for the treatment of the proximal humerus fractures.

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— 국문초록 —

상완골 근위부 골절의 Ender 정을 이용한 치료 결과 - 방사선학적 분석 -

서울시립 보라매병원 정형외과, 서울대학교 의과대학 정형외과학교실*

박진수 · 정문상* · 윤강섭 · 백구현* · 이지호 · 강승백 · 김동욱*

목적 : 상완골 근위부 골절환자들을 대상으로 Ender 정을 삽입한 군과 보전적 치료를 한 군간의 비교 연구를 하였다.

대상 및 방법 : Ender 정 삽입군의 경우 9례에서 삽입하였으며 평균 연령은 69세였고, 보전적 치료군의 경우 9례였으며, 평균 연령은 72례로 두군간의 연령의 통계적 차이는 없었다($p=0.450$). 모든 예가 2분 골절이었다. Ender 정은 상완골 원위부 또는 양측 외상과부를 통하여 삽입하였으며 보전적 치료군의 경우 Velpeau 붕대 고정으로 치료하였다. 평균 추시기간은 15개월이었다.

결과 : 해부학적 정복의 정도는 원위부의 내측 전위, 골편의 중첩, 골절부의 내반각 변형등을 기준으로 평가하였는데, 두 군 모두 초기의 해부학적 정복 정도는 추시상 변화가 없었으며, 이러한 해부학적 정복의 정도의 두 군간의 차이는 없었다. Ender 정외의 경우 고정의 안정도는 대부분의 례에서 불량한 결과를 보여주었고, Ender 정외의 삽입부로의 후방전위(3례) 및 그로 인한 주관절 통증 및 운동제한, 골두의 천공(3례), Ender 정 삽입부에서의 상완골 원위부의 피질골 파열 또는 골절(4례), 골절 정복 후 재전위(1례) 등의 문제점들이 있었다.

고찰 및 결론 : Ender 정외의 역행성 삽입후의 결과는 보전적 치료군에 비해 별다른 차이점을 보이지 않았으며, 오히려 많은 문제점들을 가지고 있었다.