Locking Plate Fixation of Proximal Humeral Fracture: Minimally Invasive vs. Standard Delto-Pectoral Approach

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Objective: *To evaluate the results of surgery of proximal humeral fractures using the MIPO technique and to compare that with the results of surgery using the traditional approach.*

Material and Method: *All PHILOS-plate osteosynthesis operations for two and three part proximal humeral fractures conducted at Chiang Mai University Hospital between January 2010 and December 2011 were evaluated retrospectively. Operative time, blood loss, mean fracture union time, and rate of axillary nerve injury were recorded for each patient.*

Results: *The records of twenty-eight consecutive osteosynthesis operations were reviewed and the patients were divided into two groups. Group A included 12 patients (4 males, 8 females, mean age 52 years) who were treated by MIPO. Group B included 16 patients (8 males, 8 females, mean age 62 years), who were treated using the conventional approach. The mean operative time in group A was 80 minutes (range 55-185), and in group B 110 minutes (range 90-180) ($p = 0.059$). The mean blood loss in group A was 87.5±42.0 ml, and in group B was 128.1±65.8 ml ($p = 0.073$). The mean length of hospital stay in group A was 5.7±1.7 days, and in group B was 8.4±4.3 days ($p = 0.091$). The mean fracture union time in group A was 12 weeks (range 10-24), and in group B was 20 weeks (range 12-28) ($p = 0.002$). Axillary nerve injury rates were not different between the two groups.*

Conclusion: *Compared to conventional techniques, MIPO offers the advantages of significantly shorter time to union, less blood loss, shorter operative time, and a shorter hospital stay.*

Keywords: *MIPO, Hospital stay, Blood loss, Operative time, Axillary nerve injury*

J Med Assoc Thai 2015; 98 (2): 196-200
Full text. e-Journal: *http://www.jmatonline.com*

Proximal humeral fractures are the third most common type in the elderly, accounting for about 5 to 8% of all humeral fractures[1,2]. Overall, eighty percent of fracture patients are afforded conservative treatment, resulting in a nonunion rate of between 1 and 23%[1,3,4]. The goal of treatment of this type of fracture is to alleviate pain and to allow the arm to function normally in daily life as soon as possible. Results of the operation depend on patient factors (age, co-morbidity, osteoporosis), injury factors (fracture type, displacement, comminution) and treatment factors (surgical technique, surgeon skill). Treatment failures such as loosening of fixation and malposition of the fracture can lead to nonunion or malunion. Osteoporosis and severely comminuted fractures are common causes of fixation failure.

A new method of treatment for proximal humeral fractures, Minimally Invasive Plating Osteosynthesis (MIPO), has been developed to reduce these complications. MIPO uses a newly designed locking plate, involves a smaller wound and causes less soft tissue damage compared to the conventional anterior delto-pectoral approach which creates a larger wound and involves stripping back anterior soft tissue to expose the fracture to accommodate open reduction. The traditional method may also cause damage to the vascular supply of bony fragments, leading to a higher nonunion rate.

Due to reduced soft tissue damage during the operation and the smaller wound with the MIPO technique, better results can be expected including a higher union rate, reduced blood loss, less pain, a shortened recovery period and better cosmesis.

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Literature Review

Proximal humeral fractures are found primarily in two different age groups: the elderly, where fractures are usually caused by minor falls, and the young, whose fractures are frequently caused by traffic accidents. Treatment options consist of conservative and operative treatment. The Neer classification system divides the proximal humeral

bone into four parts: greater tuberosity, lesser tuberosity, head and shaft. Displacement of each of these parts is defined as separation of more than 1 cm. or angulation of more than 45 degrees (Fig. 1).

Conventional surgery with the anterior delto-pectoral approach requires a widely opened wound to expose the fracture, causes additional tissue damage and may injure blood vessels. The MIPO technique, using the deltoid split approach and indirect fracture reduction, results in a smaller wound, less tissue damage and may reduce the nonunion rate (Fig. 2).

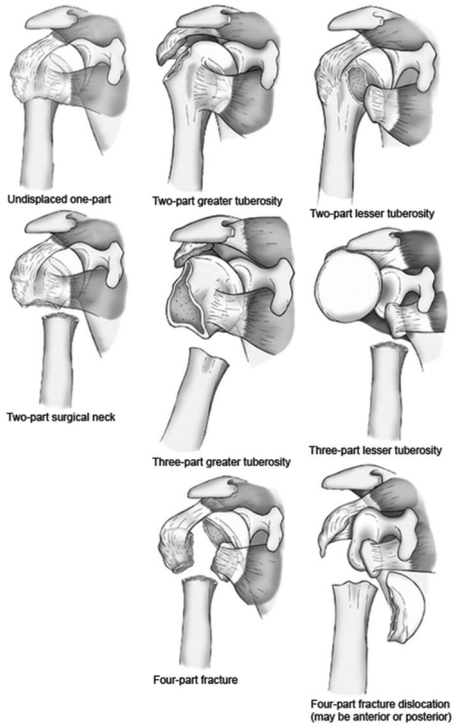

Fig. 1 Displaced fractures: separation >1 cm or angulation >45°.

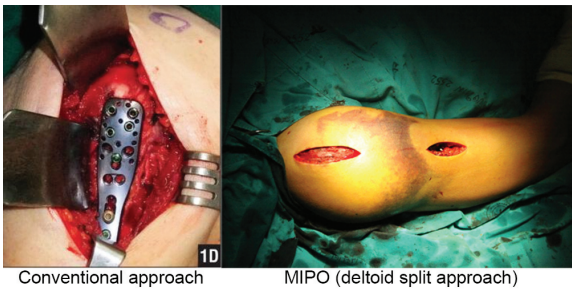

Fig. 2 Comparison of wounds with the conventional anterior delto-pectoral approach and with the MIPO approach.

Rationale

The differences between the MIPO technique and the delto-pectoral approach include wound size, reduction technique,degree of soft tissue damage. Treatment results may differ as well, including cosmesis. The objectives of this study are to compare the results of the two different treatments in terms of union rate, blood loss during surgery, operative time and length of post-surgery hospital stay.

Material and Method

The medical records and radiographs of 28 patients who had had a proximal humeral fracture operatively treated by proximal humeral locking plate (PHILOS) fixation during January 2010 through December 2011 at Chiang Mai University Hospital were reviewed retrospectively. Inclusion criteria included: closed proximal humeral fractures (two orthree-parts) and fractures not treated conservatively. Exclusion criteria included pathologic fractures, fractures with nonunion, open fractures and cases where the period between injury and surgical intervention exceeded three weeks. Among the data recorded for patients included in the study were the surgical approach, the mean fracture union time, the operative time, the amount of blood loss, the incidence of axillary nerve injury and complications such as inadequate reduction, screw migration, etc.

Both groups received the same post-operative rehabilitation program, starting with an arm sling for a few days then pendulum exercises and passive ROM exercises for the first two weeks followed by active assistive exercise as tolerated. PO checkups were scheduled for the second week, fourth week, and then every month thereafter to measure ROM and take X-rays to evaluate union.

Data was analyzed using the two independent sample method. Variation in the data from each group of patients was assumed to be the same for all patients in both treatment groups.

Descriptive analysis included frequencies, percent, mean and standard deviation. Quantitative data such as age, bleeding volumes, etc., were analyzed using Student's t-test for normal distributions and the Mann-Whitney U test for non-normal distributions. For categories such as gender and group, the Chi-square test or Fisher's exact test were used.

Results

Medical records and radiographs of the 28 patients meeting the complete inclusion criteria

were obtained. The patients were separated into two groups: Group A (MIPO) included 12 patients (4 males and 8 females, mean age 52 years) with 8 two part fractures and 4 three part fractures; Group B (conventional treatment) included16 patients (8 males and 8 females, mean age 62 years) with 6 two part fractures and 10 three part fractures. Patient data obtained included gender, age, operative technique, operative blood loss, union time, and length of hospital stay (Table 1).

The study results were analyzed using the SPSS program. For the analysis, patients in each of the two groups were divided into three sub-groups based on fracture characteristics: two part fractures, three part fractures, and both two and three part fractures. Student's t-test was used to compare the means of the two groups. For non-normal distributions, the Mann-Whitney U test was used. The Chi-square test was used to evaluate the relationship among the groups for descriptive and qualitative variables such as gender.

Analysis using the SPSS program found that the variables operative time and length of hospital stay were normally distributed, so Student's t-test was used for those variables. Mean blood loss (bleeding) and mean fracture union times (weeks), however, were not normally distributed, so the Mann-Whitney U test was used. Results of the analyses are shown in Table 1 below.

Hospital stay in the two part fracture sub-group treated with MIPO was significantly shorter than the conventional treatment group as was union time in the two and three part fracture groups combined.

Discussion

Studies of open reduction-internal plating in proximal humerus report a high complication rate including avascular necrosis (about 8%), screw cut-out

Table 1. Patient characteristics and comparison of results of MIPO and conventional treatment of proximal humeral fractures by fracture sub-group

Two part fracture sub-group	Group A (n = 8)	Group B (n = 6)
Age (years), mean (± SD)	49.5 (±20.3)	66.2 (±25.4)
Sex (male:female)	4:4	2:4
Operative time (minutes), mean (± SD) (p = 0.998)	89.1 (±35.6)	89.2 (±22.6)
Blood loss (ml), median (range) (p = 0.282)	100.0 (20-150)	100.0 (50-200)
Fracture union time (weeks), median (range) (p = 0.051)	12.0 (10-14)	28.0 (18-28)
Hospital stay (days), mean (± SD) (p = 0.008)*	6.2 (±1.6)	11.3 (±2.0)
Three part fracture sub-group	Group A (n = 4)	Group B (n = 10)
Age (years), mean (± SD)	56.8 (±10.2)	59.8 (±13.6)
Sex (male:female)	0:4	6:4
Operative time (minutes), median (range) (p = 0.188)	77.5 (70-185)	110.0 (90-180)
Blood loss (ml), mean (± SD) (p = 0.356)	95.0 (±49.2)	120.0 (±42.2)
Fracture union time (weeks), mean (± SD) (p = 0.214)	15.0 (±6.2)	19.0 (±4.7)
Hospital stay (days), median (range) (p = 0.304)	5.0 (3-7)	6.5 (3-19)
Two and three part sub-groups combined	Group A (n = 12)	Group B (n = 16)
Age (years), mean (± SD)	51.9 (±17.5)	62.2 (±18.3)
Sex (male:female)	4:8	8:8
Two part: three part (p = 0.252)	8:4	6:10
Operative time (minutes) median (range) (p = 0.059)	80.0 (55-185)	110.0 (90-180)
Blood loss (ml), mean (± SD) (p = 0.073)	87.5 (±42.0)	128.1 (±65.8)
Fracture union time (weeks), median (range) (p = 0.002)*	12.0 (10-24)	20.0 (12-28)
Hospital stay (days), mean (± SD) (p = 0.091)	5.7 (±1.7)	8.4 (±4.3)

MIPO = minimally invasive plating osteosynthesis
* Statistically significant (p<0.05)

(11.6%), and a re-operative rate of 13.7%. Complications with the conventional technique result from factors such as a widely opened wound as well as destruction of soft tissue and blood vessels which can disturb the union process. Other studies have reported additional complications with the conventional approach including implant failure and avascular necrosis. Studies of the MIPO technique in proximal humeral fractures have reported fewer problems with nonunion or avascular necrosis. Minimally invasive plate osteosynthesis (MIPO) in diaphyseal humerus and proximal humerus fractures[7]. Shorter time to union using the MIPO technique has been reported in several studies[8]. The safety of the MIPO technique and its ability to provide a better quality of life for the elderly have also been documented[6].

No studies comparing the MIPO technique and the conventional approach have been reported; this study is the first direct comparison between the two techniques. The present study found a significantly shorter union time using the MIPO technique in the two and three part fracture sub-groups combined as well as a shorter hospital stay in the two part fracture sub-group. Additionally, there was no axillary nerve injury in the MIPO technique group.

Conclusion

The MIPO technique for treating proximal humeral fracture has significant advantages over the conventional technique including shorter union time and a shorter hospital stay. Additional studies with a larger sample and involving patients from more than one hospital are needed to confirm the findings.

Limitations

This is a retrospective study rather than a controlled experiment. All the patients were treated in one hospital and the number of patients was limited. Some data were not recorded for all patients such as degree of motion of the shoulder joint, post-operative function of the shoulder, and fluoroscopic time. Auxiliary nerve function was obtained only by physical examination. Finally, the MIPO technique requires a high level of surgical skill, which complicates comparison with the conventional technique.

Acknowledgement

The authors are grateful to Sirichai Luevitoonvechkij MD, for his helpful suggestions and to G Lamar Robert PhD, for reviewing the manuscript.

What is already known on this topic?

The previous study of MIPO technique is limit. This study shown comparative results between MIPO technique and standard delto pectoral approach in Chiang mai University Hospital.

What this study adds?

This study shown the advantage of MIPO technique for treatment of two and tree part fracture of proximal humerus over the conventional operation.

Potential conflicts of interest

None.

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เปรียบเทียบผลการผ่าตัดกระดูกต้นแขนส่วนบนหักโดยวิธีแบบ minimally invasive plating osteosynthesis (MIPO) กับวิธีผ่าตัดแบบมาตรฐาน

ศิริพงค์ เชี่ยวชาญธนกิจ, พิรุณ ตั้งศรีพงศ์

ภูมิหลัง: *Standard delto-pectoral approach เป็นการผ่าตัดแบบมาตรฐานสำหรับการผ่าตัดเพื่อยึดตรึงกระดูกต้นแขนส่วนบนหัก โดยมีการเลาะเนื้อเยื่อและหลอดเลือดค่อนข้างกว้างและมีโอกาสเกิดหัวกระดูกต้นแขนขาดเลือด MIPO เป็นการผ่าตัดแบบใหม่ที่มีการทำลายเนื้อเยื่อและหลอดเลือดที่น้อยกว่าและกำลังเป็นที่นิยมในปัจจุบัน*

วัตถุประสงค์: *เพื่อเปรียบเทียบผลการผ่าตัดกระดูกต้นแขนส่วนบนหักโดยวิธี MIPO กับวิธีผ่าตัดแบบมาตรฐาน*

วัสดุและวิธีการ: *การศึกษาแบบย้อนหลังถึงผลการผ่าตัดยึดตรึงกระดูกต้นแขนส่วนบนหักชนิดสองและสามส่วนด้วยโลหะ ตั้งแต่เดือนมกราคม พ.ศ. 2553 ถึง ธันวาคม พ.ศ. 2554 ผู้ป่วยจำนวน 28 ราย แบ่งเป็น 2 กลุ่ม โดยกลุ่ม MIPO มี 12 ราย (ผู้ชาย 4 ราย ผู้หญิง 8 ราย, หักสองส่วนจำนวน 8 ราย หักสามส่วนจำนวน 4 ราย, อายุเฉลี่ย 52 ปี) และกลุ่มผ่าตัดแบบมาตรฐาน 16 ราย (ผู้ชาย 8 ราย ผู้หญิง 8 ราย, หักสองส่วนจำนวน 6 ราย หักสามส่วนจำนวน 10 ราย, อายุเฉลี่ย 62 ปี) โดยบันทึกข้อมูลในเรื่องระยะเวลาในการผ่าตัด ปริมาณเลือดระหว่างผ่าตัด อัตราการติดของกระดูก และการบาดเจ็บต่อเส้นประสาท axillary nerve*

ผลการศึกษา: *ระยะเวลาในการผ่าตัดโดยเฉลี่ย 80 นาที (ระหว่าง 55-185 นาที) ในกลุ่ม MIPO และ 110 นาที ในกลุ่มมาตรฐาน (ระหว่าง 90-180 นาที) (p = 0.059) ปริมาณเลือดระหว่างผ่าตัด 87.5±42.0 มิลลิลิตร ในกลุ่ม MIPO และ 128.1±65.8 มิลลิลิตร ในกลุ่มมาตรฐาน (p = 0.073) ระยะเวลาที่นอนในโรงพยาบาล 5.7±1.7 วัน ในกลุ่ม MIPO และ 8.4±4.3 วัน ในกลุ่มมาตรฐาน (p = 0.091) อัตราการติดของกระดูก 12 สัปดาห์ (ระหว่าง 10-24 สัปดาห์) ในกลุ่ม MIPO และ 20 สัปดาห์ (ระหว่าง 12-28 สัปดาห์) (p = 0.002) และไม่พบความแตกต่างในการการบาดเจ็บของเส้นประสาท axillary nerve ระหว่างสองกลุ่ม*

สรุป: *เมื่อเปรียบเทียบการผ่าตัดแบบ MIPO กับแบบการผ่าตัดแบบมาตรฐานพบว่า MIPO มีข้อได้เปรียบในเรื่องระยะเวลาหลังผ่าตัดจนกระดูกติดน้อยกว่าอย่างมีนัยสำคัญทางสถิติ ระยะเวลาการผ่าตัด ปริมาณเลือดที่เสีย และระยะเวลาที่นอนในโรงพยาบาลน้อยกว่าการผ่าตัดแบบมาตรฐาน*