การเปรียบเทียบการผ่าตัดด้านหลังข้อศอกแบบเปิดกล้ามเนื้อ Triceps และแบบไม่เปิดกล้ามเนื้อ Triceps ในการรักษากระดูกต้นแขนบริเวณข้อศอกหักในเด็ก

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บทคัดย่อ

กระดูกต้นแขนบริเวณข้อศอกหักในเด็กแบบเคลื่อนออกจากกันเป็นภาวะที่พบได้บ่อย การรักษาส่วนใหญ่ใช้การรักษาโดยการผ่าตัดจัดกระดูกให้เข้าที่และใส่เหล็กดาม การเปิดแผลผ่าตัดมีหลากหลายวิธี ยังเป็นที่ถกเถียงทั้งข้อดีข้อเสียโดยดูจากการง่ายในการผ่าตัดและผลแทรกซ้อนหลังการผ่าตัดการวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาเปรียบเทียบผลของวิธีการผ่าตัดด้านหลังข้อศอกแบบเปิดกล้ามเนื้อ Triceps และแบบไม่เปิดกล้ามเนื้อ Triceps ในการรักษากระดูกต้นแขนบริเวณข้อศอกหักในเด็กโดยศึกษาเปรียบเทียบ เวลาในการผ่าตัด, การสูญเสียเลือดในระหว่างผ่าตัด,การติดตามผลที่ระยะ 6 เดือนหลังผ่าตัดโดยดูจากผลเอกซเรย์หลังการผ่าตัด, การงอเหยียดข้อศอกหลังจากกระดูกติดแล้วโดยมีรูปแบบการศึกษาเป็นการศึกษาจากเหตุไปหาผลแบบย้อนหลังทำการศึกษา (Retrospective cohort study) ทำการศึกษาโดยการเก็บข้อมูลจากเวชระเบียนผู้ป่วยเด็กกระดูกต้นแขนหักที่มารับบริการที่โรงพยาบาลสมเด็จพระยุพราชสว่างแดนดินในช่วงเวลาตั้งแต่ เดือนสิงหาคม พ.ศ. 2555 ถึง เดือนธันวาคม พ.ศ. 2563 กลุ่มตัวอย่างคือผู้ป่วยเด็กที่อายุน้อยกว่า 10 ปี ที่มีปัญหากระดูกต้นแขนบริเวณข้อศอกหักแบบเคลื่อนออกจากกัน (Gartland classification Type III) และไม่สามารถรักษาโดยการจัดกระดูกจากภายนอกให้เข้าที่ จำนวน 88 คน แบ่งเป็น 2 กลุ่ม กลุ่มที่ 1 ได้รับการรักษาการผ่าตัดทางด้านหลังข้อศอกแบบเปิดกล้ามเนื้อ Triceps จำนวน 43 คน และ กลุ่มที่ 2 ได้รับการรักษาการผ่าตัดแบบไม่เปิดกล้ามเนื้อ Triceps จำนวน 45 คน วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนาและสถิติวิเคราะห์ใช้ Chi-square และ independent T-test กำหนดค่านัยสำคัญทางสถิติที่ 0.05

ผลการศึกษา: ผู้ป่วยเด็ก 88 ราย อายุเฉลี่ย 6.4 ปี ส่วนใหญ่เป็นเพศชาย กลุ่มที่ 1 การผ่าตัดแบบเปิดกล้ามเนื้อ Triceps ใช้เวลาในการผ่าตัดน้อยกว่ากลุ่มที่ 2 อย่างมีนัยสำคัญ (38 และ 53 นาที ตามลำดับ, $p<0.001$) ส่วนการเสียเลือดในระหว่างผ่าตัด, ผลเอกซเรย์หลังการผ่าตัด, ภาวะแทรกซ้อน, การงอเหยียดข้อศอกเมื่อติดตามผลที่ 6 เดือน ไม่มีความแตกต่างกันอย่างมีนัยสำคัญในทั้ง 2 กลุ่ม

สรุปการวิจัย: การผ่าตัดเข้าไปทางด้านหลังแบบเปิดกล้ามเนื้อ Triceps มีประสิทธิผลดีกว่าแบบไม่เปิดกล้ามเนื้อ Triceps ในแง่ใช้เวลาในการผ่าตัดน้อยกว่าอย่างมีนัยสำคัญ ผลที่ได้จะนำไปใช้พัฒนาในการดูแลรักษาผู้ป่วยต่อไป

คำสำคัญ: กระดูกต้นแขนบริเวณข้อศอกหัก, การผ่าตัดด้านหลังข้อศอกแบบเปิดกล้ามเนื้อ Triceps, การผ่าตัดด้านหลังข้อศอกแบบไม่เปิดกล้ามเนื้อ Triceps

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Comparison of Clinical Outcome Between Triceps-Splitting and Triceps-Sparing Posterior Surgical Approaches in The Supracondylar Humeral Fractures in Children.

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Abstract

Supracondylar humeral fractures are the most common type of upper arm injury in children. The most cases require open reduction and internal fixation (ORIF). A variety of approaches can accomplish surgical exposure. An ideal surgical approach should enable safe and rapid reduction to obtain full anatomic alignment and lower rate of complication is also crucial. The purpose of this retrospective cohort study was to compare Triceps-splitting and Triceps-sparing posterior surgical approaches in treating supracondylar humeral fractures in children in terms of operative time, blood loss, according to the 6 month follow-up; radiological results, elbow range of motion. This study was conducted from August 2012 to December 2020 at Orthopedics department of Sawangdandin Crown Prince Hospital, Sakon Nakhon. Sampling comprised of 88 patients age less than ten years old with closed supracondylar humeral fracture and Gartland's classification Type III. The patients were separated into two groups according to the surgical approach. Group I, 43 patients were treated with Triceps-splitting posterior surgery, and group II, 45 patients were treated with Triceps-sparing posterior surgery. Statistics analysis using descriptive statistics, Chi-square and independent T-test. The result was considered statistically significant if the two - sided p-value was less than 0.05.

Results: 88 patients from eight years collecting data, mean age 6.4 years old, male more than female. Group I Triceps-splitting posterior approach had shorter operative time compared with Triceps-sparing posterior approach (38 and 53 minutes, respectively with statistically significance $p<0.001$). No statistically difference was determined between the groups regarding intraoperative blood loss, radiological results, complication, elbow range of motion and clinical outcome at 6 months follow up.

Conclusion: Triceps-splitting posterior approach was as practical as the Triceps-sparing posterior approach but provided a shorter operative time in treating supracondylar humeral fractures in children. The outcomes will help surgeon to preterm surgical decision-making in the future treatment of supracondylar humeral fractures in children.

Keywords: Supracondylar humeral fractures, Triceps-spitting posterior approach, Triceps-sparing posterior approach.

Introduction

Supracondylar humeral fractures are the most common type of elbow fracture, found up to 60% in children.[1-2] The injury is usually caused by a fall with an outstretched hand.[1-2] The Incidence rate of supracondylar humeral fractures has been reported to be higher in boys than in girls[2] and subdivided by Gartland's on the basis of displacement extent.[1-3]

Type I are undisplaced fractures: often in these cases the fracture line is not easily visible and the fat pad sign could help for obtain a proper diagnosis.

Type II fractures the posterior cortical is intact but there is an angulation and the humeral line is positioned anterior to the middle of capitellum.

Type III fractures are completely displaced, the direction is often posteromedial, without continuity between the two fragments According to Gartland's classification of supracondylar humeral fractures type III (Figure 1): fractures often have oblique patterns with severe displacement and rotation.[4-6] Most severe type of displaced supracondylar humeral fracture (Gartland's classification Type III) cases that could not be treated by external fixation, primarily caused by muscle, joint capsule and periosteum interposition of fractures. Archibeck et al[7] also discovered that the brachialis muscle interpose induced failure to conduct closed reduction with adequate bone alignment. Just 2–12% of these cases required open reduction and internal fixation (ORIF), it should be challenged to treat and entails technically complex procedures for orthopedic surgeons.[1-2]

Figure 1 Type III of Gartland's classification (film from patient's in Sawangdandin Crown Prince Hospital with permission)

A variety of approaches can accomplish surgical exposure lower rate of complication is also crucial. An ideal surgical approach should enable safe and rapid reduction to obtain full anatomic alignment and adequate functional and cosmetic outcomes. The literature[8-9] has concluded no consensus on which surgical approach should be preferred for open reduction of a displaced supracondylar humeral fracture. The proposed approaches include various data[8-9] on post-operative complications and post-operative success rates. The previous studies defined anterior, medial, lateral, and posterior approaches and their combinations.[8-10]

The medial approach has the advantage of better restoration of rotation by direct vision, preventing damage to the ulnar nerve during medial K-wire insertion. The posterior approach can be considered relatively simple, with a broad view of the fracture line and minimal neurovascular dissection. However, posterior incision involves a risk of separation of the triceps muscle in the longitudinal axis, resulting in restricted movement. The lateral approach has the advantage of involving less soft-tissue dissection and being less invasive.[5,8-10] Some researcher[8] supported that Although the posterior approach technique was as effective as the combined medial-lateral approach in the treatment of supracondylar fractures but provided shorter operative times[8] , while some researchers[11-12]

was supported that Triceps-sparing posterior approach helped preserve the extensor mechanisms esthetically along with satisfactory postoperative function.[11-12] Triceps-splitting posterior approach affords broad exposure for fracture fixation. It facilitates reduction and fixation of humeral shaft and articular distal humeral fractures.[13]

Supracondylar humeral fractures are common pediatric injuries represented in Sawangdandin Crown Prince Hospital. Incidence had been reported 20-30 patients per year, about 5–10 patients of these cases were displacement fractures that required open reduction and internal fixation (ORIF). It challenged to treat and entail technically complex procedures for orthopedic surgeons.

Objectives

The purpose of this study was to compare Triceps-splitting and Triceps-sparing posterior surgical approaches in treating supracondylar humeral fractures in children in terms of operative time, blood loss and result at the 6-month follow-up; radiological results, elbow range of motion.

Methodology

Study design: retrospective cohort study

Population and sampling; children with supracondylar humeral fracture treat in Sawang-dandin Crown Prince Hospital from August 2012 to December 2020, comprised of 88 patients of both genders.

Setting: conducted at orthopedics department of Sawangdandin Crown Prince Hospital.

Inclusion criteria were patients with:

(1) less than ten years of age.

(2) acute injury (less than 7 days).

(3) unilateral closed supracondylar humeral fracture and Gartland's classification Type III

(4) had surgery by using Triceps-splitting and Triceps-sparing posterior surgical approaches with K-wire fixation.

(5) history of normal elbow function before the injury.

(6) no history of pathological fractures (primary or metastatic bone tumors).

(7) no other ipsilateral limb injuries

(8) no significant neurological deficits.

Exclusion criteria were patients with:

(1) by transfer to other hospital.

(2) severe complication (multiple organ injuries or dead).

(3) Incomplete data

The patients divided to 2 groups by surgical approach technique; 43 were of Triceps-splitting and 45 were of Triceps-sparing posterior surgical approaches.

Methods

Surgical technique

Patients with supracondylar displaced humeral fractures (Gartland classification Type III) were treated with open reduction and internal fixation (ORIF) to re-align and hold the bones together with K-wire.

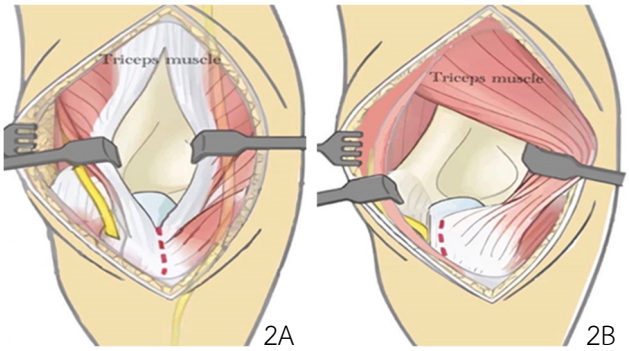
(1) The patients would be given general anesthesia, and placed in lateral decubitus position.

(2) The first part was the open reduction, beginning by incising the skin at the tip of the olecranon and running proximally in a straight line along the posterior midline of the arm. Fascia should be split in line by incision. Then, the subcutaneous tissue was dissected from the deep fascia.

2.1 For Triceps-splitting posterior approach group; The triceps tendon was split in the

midline from the tip of the olecranon to the upper limit of the olecranon fossa. The triceps tendon and aponeurosis were further typically split 3-4 cm proximal to the fracture line, providing a clear view of the olecranon fossa. Two smooth soft tissue retractors were inserted, and the triceps muscle was split longitudinally and released the muscle from the bone only as much as needed and protected the ulnar nerve medially.(Figure 2A)

2.2 For Triceps-sparing posterior approach group; Once the triceps muscle was in vision, it mobilized and retracted laterally. This might be achieved by bluntly dissecting the medial head of the triceps from the posterior aspect of the humerus. Depending on the fracture location, the exposure might need to be extended distally. (Figure 2B)



2A Triceps-splitting posterior approach

2B Triceps-sparing posterior approach

Figure 2 posterior approach

(3) Internal fixation was carried out using 1.6 mm K-wires crossed pinning; two in each column (Figure 3), which was a -robust construction biomechanically. After inserting the drain, the muscle, fascia, and subcutaneous tissue were closed by an interrupted suture with vicryl, while nylon suture was applied to the skin. A posterior long arm splint was applied with the elbow in 90 flexion and forearm in pronation. The wound closure and postoperative care of both groups were similar.

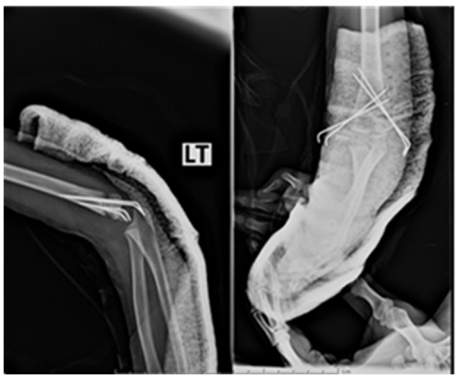


Figure 3 Internal fixation was carried out using 1.6 mm K-wires crossed pinning; two in each column, which was a -robust construction biomechanically.

(4) The sutures and the wires were removed after two weeks and four weeks, respectively. Afterward, active elbow motions were exercised. Follow-up examinations of the patients, employing standard anteroposterior and lateral radiographs of the elbow, were made at 4-week intervals until the union was confirmed, follow-up period range from 3-6 months. (Figure 4)

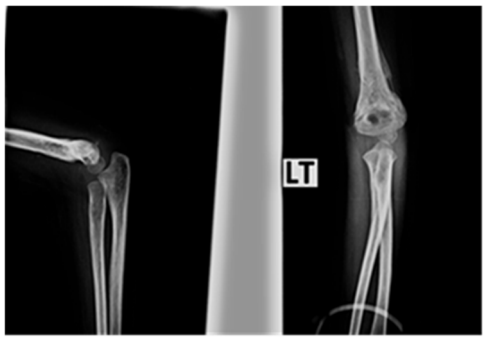
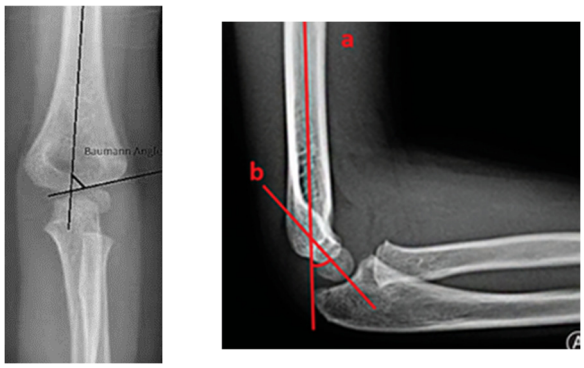


Figure 4. The union was confirmed. (follow-up period range from 3-6 months)

In addition, operative time, blood loss, according to the 6-month follow-up; radiological result (Baumann's angle, Shaft condylar angle), elbow range of motion and complications (pin tract infection, implant loosening and reduction loss) were documented.

Baumann's Angle[14]; humeral capitellar angle: angle between long axis of humeral shaft and growth plate of lateral condyle, normal valve is about 64 – 89 degree. (Figure 5A)

Shaft condylar angle[15]; The angle is defined as the angle between the axis of the humeral and the capitellum (a line was drawn on a lateral view along the anatomical axis of the humerus, b line was drawn to bisect the capitellum into equal parts. (Figure 5 B) normal valveis about 40 ± 6 (34-46) degree in lateral elbow film



5A 5B

5A. Baumann's angle **5B**. Shaft condylar angle

Figure 5 Radiological measurement of elbow angle

Statistics Analysis

Descriptive statistics were compiled for demographic data, outcome comparison used analytic statistics. The categorical variables were compared using Chi-square while independent samples student's T-test was used to compare continuous variables between two groups. The result was considered statistically significant if the two - sided p value was less than 0.05.

Ethic Consideration

Approved by Sawangdandin Crown Prince Hospital. Approval number: No .SWDCPH 2021 – 004; date issue 31 August 2021

Results

A total of 88 patients, male more than female (60.2% and 38.9%) age ranging from 2-10 years old (mean = 6.4), were included throughout the study period. The patients were separated to two groups: group 1 included 43 patients operated on using the Triceps-spitting posterior approach, and group 2 included 45 patients operated on using the Triceps-sparing posterior approach. All patients were followed up for more than three months after discharge from the hospital. The follow-up period range from 3-6 months (mean=4.4 months). The demographic characteristics data related to each group were demonstrated in Table 1.

The mean operative time was 38 minutes for the Triceps-spitting posterior approach group and 53 minutes for the Triceps-sparing posterior approach group, the mean difference was statistically significant ($p<0.001$). The mean blood loss in group I Triceps-spitting (109 ml.) was lesser than group II Triceps-sparing (111ml.) but had no statistically different ($p=0.703$). There were 5 pin tract infections (5.7% of all case). Nevertheless, according to the 6-month follow-up, the differences in radiological result (Baumann's angle, Shaft condylar angle), elbow range of motion (elbow flexion and extension) and complication had no statistically significance. (Table 1.)

Table 1: The demographic characteristics and outcome of children with supracondylar humeral fracture. (N=88)

Factors	group I Triceps-spitting posterior approach group (n=43)	group II Triceps-sparing posterior approach group (n=45)	P-value
I. characteristics			
Gender			
Male	25 (58.1%)	28 (62.2%)	0.695
Female	18 (41.9%)	17 (37.8%)	
Age (year old):			
mean (SD)	6.3 (2.1)	6.5 (2.2)	0.664
range	2-10	2-10	
Injured arm			
Right	15 (34.9%)	19 (42.2%)	0.479
Left	28 (65.1%)	26 (57.8%)	
Injury period to operation (days):			
mean (SD)	1.5 (0.2)	1.6 (0.3)	0.070
range	0-3	0-3	
II. Outcome Mean operative time (min)			
mean (SD)	38 (4.1)	53 (4.3)	<0.01
range	30-45	45-60	
Blood loss (ml)			
mean (SD)	109 (24.2)	111 (25.1)	0.703
range	50-150	50-150	
Length of hospital stay (days):			
mean (SD)	3.2 (0.4)	3.3 (0.5)	0.304
Range	2-5	2-5	
Baumann's angle difference from normal side (degree)			
mean (SD)	3.8 (1.4)	4.0 (1.5)	0.520
range	1-7	1-7	
Shaft condylar angle difference from normal side (degree)			
mean (SD)	1.9 (0.4)	2.0 (0.5)	0.304
range	1-3	1-3	
Elbow flexion (degree)			
mean (SD)	128 (8.1)	130 (7.2)	0.214
range	90-145	90-145	
Extension lack (degree)			
mean (SD)	5.1 (2.0)	5.3 (2.1)	0.648
range	1-10	1-10	
Complication Pin tract infection	3 (7.0%)	2 (4.4%)	0.632

Discussion

This study has been reported to be higher in boys than in girls (60.2% vs 39.8%). This had variable from part until now, In 1998 Farnsworth et al [2] reported on 391 fractures and concluded that there were more fractures in girls than boys in the 0-1 and 6-7 age groups. They reported that there were no significant differences between boys and girls in all other age groups. In 2008 Omid et al.[1] reported a 2:1 ratio in boys than girls. In 2020 Pilla et al.[16] recently reported 42 males (56%) and 33 females (44%). In 2020 LiBrizzi et al.[17] found no significant difference in the distribution of girls (52%) vs boys (48%) in 1231 pediatric supracondylar humeral fractures. Previous studies were differences between boys and girls due to variety of factor (education, society and culture) similar to age and injured arm. The average age in this study was 6.4 years old this similar to other study.[16,18] One possible explanation is that those were in naughty age. This study has been reported to be higher in left side injury than right side. (61.3% vs 38.7%) similar to Wutphiriyaangkul[8] study in 2015 but difference from Pilla et al.[16] Injured arm has been reported by a variety of factor (hand dominant or mechanism of injury).[8,16]

In this study found that average injury period to operation 1.5 days similar to Wutphiri-yaangkul[8] article that reported mean injury time to operation 1.4 days, postoperative complications note in both groups were not significantly different (p = 0.660), 7 case of superficial infections and 2 patient developed stiffness of elbow, due to shorter injury period to operation should be easy for surgery because less swelling soft tissue, and results in low risk of infection and stiffness of the elbow.[8] In this current study found few pin tract infections in both groups (5.7% of all cases) and could be resolved by oral antibiotics and removing the pins, according to Larson et al[19] reported 399 patients of supracondylar fractures treated operatively, 48% were pinned within 24 hours, vs 52% pinned >24 hours after the injury. No difference was in detected in rates of major complications between the early and delayed treatment group, similar to Abbott et al[20] that retrospectively reviewed 297 pediatric patients had found the time from the emergency department to the operating room was not significantly correlated with increased complications (8.4% vs 9.4%). This had variable studies, inconclusive injury period to operation correlated with increased complications.

When considering about operation time, blood loss, radiological results, elbow range of motion and complication according to the 6 -month follow-up; this study found that Triceps-splitting posterior approach group was significantly shorter operative time 38 minute (SD=4.1) compared with Triceps-sparing posterior approach group 53 minute (SD=4.3). No significant difference was determined regarding blood loss, radiological results, complication and elbow range of motion according to the 6-month follow-up, similar to Kashani et al[21] and Remia et al.[23] In surgical treatment of humeral supracondylar fracture with normal neurovascular state in children, due to its simplicity, greater exposure, lack of interference with vital structures due to significantly shorter operative time and less blood loss in the posterior approach particularly posterior triceps splitting method but no significant difference was determined between the groups radiological results, elbow range of motion, but difference from Zengin et al[22] reported that extra-articular distal humeral fractures patients revealed to statistically significant difference of triceps

strength (p=0.009), but no significant difference of elbow flexion (p =0.475) , elbow extension and contracture (p =0.188), similar union rates and complication were obtained in both approaches. This had variable study from past until now, both the triceps-sparing and triceps splitting approaches can be used safely in supracondylar humeral fractures and the experience of the surgeon can help determine which is best suited to the circumstances.

Conclusion

Triceps-spitting posterior approach was as practical as Triceps-sparing posterior approach in the treatment of supracondylar humeral fractures, with a tendency to achieve comparable good results. However, Triceps-spitting posterior approach had more advantages in shorter operative time than Triceps-sparing posterior approach. The outcomes will help surgeon to preterm surgical decision-making in the future treatment of supracondylar humeral fractures in children.

Limitation of the study:

It was a retrospective study, some data may be loss.

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