Zagazig University Medical Journal
www.zumj.journals.ekb.eg
https://doi.org/10.21608/zumj.2024.234154.2873 Volume 30, Issue 7, Oct. 2024
Manuscript ID ZUMJ-2407-3495 (R1) DOI . 10.21608/zumj.2024.307989.3495
ORIGINAL ARTICLE

Assessment of Triangle Tilt Surgery in Treatment of Obstetric Brachial Plexus Injury

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Submit date: 29-07-2024
Revise Date: 01-08-2024
Accept date: 07-08-2024

ABSTRACT

Background: An obstetric brachial plexus injury (OBPI) occurs when the brachial plexus is subjected to severe traction during the labor and delivery procedure. These individuals may see considerable improvements in shoulder function and glenohumeral congruity after undergoing the triangle tilt operation. This research aimed to assess the clinical, functional as well as radiological outcomes of managing obstetric brachial plexus injury using triangle tilt surgery.

Methods: Eighteen patients who were treated for obstetric brachial plexus injury using triangle tilt surgery technique in this prospective clinical study with follow up period of at least 2 years clinically and radiological by x-ray and CT of shoulder joints. Postoperative evaluation was performed according to Mallet Score.

Results: Posterior supination significantly increased after intervention from 14.16±2.25 to 25.50±2.72 ($p<0.001$).The measurements of the glenoid version showed significant improvement which was about 29.55±3.27 and improved to be about 22.66±2.95 ($p<0.001$).There was significant improvement in the abduction angle while preoperative was 78.05±10.72 and became post operative 149±9.85 ($p<0.001$). There was significant improvement in SHEAR deformity grades while preoperative was grade 3 and grade 4 and became post operative grade 2 ($p<0.001$). Glenoid version significantly improved from preoperative compared to post operative ($p<0.001$).Abduction angle significantly increased from pre to post as 78.05±10.72 to 149±9.85 ($p<0.001$).Nonunion of the clavicular osteotomy happened in 3 cases only and was managed by wire fixation.

Conclusions: This study underscores that triangle tilt surgy could be a safe as well as effective method for management of secondary deformities of obstetric brachial plexuses injury in children in different ages.

Keywords: Triangle Tilt Surgery; Obstetric Brachial PlexusInjury; Children

INTRODUCTION

An obstetric brachial plexus injury (OBPI) occurs when the brachial plexus is subjected to severe traction while the baby is being born. Brachial plexus injuries during childbirth occur at a rate of 0.9% to 2.3% per

1000 live births. Various factors, such as the extent and severity of the nerve damage, determine the natural course [1-5].

Roots of the C5 and C6 nerves are most often affected, with C7 roots being less likely and C8-T1 roots being extremely uncommon, and injuries can range from simple stretching to different degrees of rupture or avulsion [6].

Reports often indicate a recovery rate of 80-90%. Shoulder contracture is a potential side effect of OBPI. There is evidence that long-term contractures can lead to skeletal malformations; thus, it is crucial to manage the patient by preventing more contractures. Having said that, it has never been proven that a cohort of children with OBPI had a high prevalence of contractures [5].

Secondary abnormalities and impaired shoulder function can be corrected with a variety of treatments, including soft-tissue and bony operations. While soft-tissue operations like tendon transfers and muscle releases can alleviate shoulder contractures and improve range of motion, they cannot correct a damaged glenohumeral joint [3].

Though traditional humeral derotational osteotomy can correct the arm's resting posture, it does nothing to address glenohumeral deformities or scapular elevation and rotation. Medial rotation contracture often returns after humeral osteotomy because the underlying scapular deformity goes undetected [6].

Then, to fix this scapular deformity, a one-of-a-kind bone technique called triangle tilt is recommended. The goal of the triangle tilt procedure is to alleviate the problem of the anteriorly tilted distal acromioclavicular triangle pressing on the humeral head and the abnormal twisting of the clavicle. This is achieved by releasing the clavicle from the medial spine of the scapula and by releasing the medial clavicle through osteotomy. By returning the distal triangle to its neutral position, the glenohumeral joint can be appropriately realigned, alleviating the aberrant elevation and rotation of the scapula [7].

So, the current research aimed to assess the clinical, functional as well as radiological outcomes of managing obstetric brachial plexus injury using triangle tilt surgery.

METHODS

This prospective clinical study was conducted on eighteen patients who were treated for obstetric brachial plexus injury using triangle tilt surgery technique at the Orthopedic Department Zagazig university hospital from January 2023 to January 2024 with follow up period of at least 2 years.

After institutional review board approval of IRB (#6890), written informed consent was obtained from all participants. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

We included patients who aged more than 2 years and less than 16 years, with SHEAR deformity (scapular hypoplasia elevation and rotation) and failed other surgical techniques.

Exclusion criteria: all patients who had the following conditions were excluded; age >16 years and <2 years, patients with traumatic obstetric brachial plexus injury or any vascular injuries.

Every patient had a thorough medical history taken, with extra attention paid to the afflicted limb, any prior surgeries, particularly those involving the shoulder joint, and any chronic health conditions. Observation during rest, peaceful alertness, and agitation is necessary for a comprehensive evaluation. Muscle groups should be palpated for tone and voluntary contractions, and the patient's spontaneous movements should be carefully observed in a wake patient. Supine and prone positions are required for observations. While a child can abduct their shoulder in supine posture with gravity at their back, bending their elbows in that position (with gravity's

help) can make it look like their biceps are working when in fact they aren't. The examiner must hold the patient's chin in place as they lie prone on the examiner's forearm in order to measure elbow flexion. Thus, the upper limb droops freely, and the only muscle group that can be activated by bending the elbow is the biceps.

As a result, the patient is unable to do tasks such as external rotation, supination, touching his lips (as with the other limb), or raising his affected arm above his head. Pulsation of the peripheral arteries in the afflicted limb evaluation.

Radiologically:

X ray:

standard anteroposterior view on the shoulder joint.

Antroposterior and axial radiographs should be taken of both shoulders for evaluation. The afflicted side may show the following alterations on the anterosterior radiograph: The scapula is smaller and higher up. Acromion and coracoid process elongation with beaking.Glenoid decreases in size and depth. Clavicular hypoplasia.

CT scan of shoulder joint.

The osseous borders were used as indications in a CT scan to reveal abnormalities such as an elevated and hypoplastic scapula, a shallow and flattened glenoid fossa, an inferiorly directed coracoid process, and an unnaturally tapering acromion. There was a noticeable delay in maturity and the humeral head is poorly developed, flattened, and hypoplastic. Additionally, the clavicle can be shortened or have lateral deformities. A well-known consequence was posterior sublaxation or even shoulder dislocation. Although actual shoulder dislocation was an extremely rare comorbidity, posterior sublaxation is the hallmark of this condition. Using axial CT images, the glenoid version (normal value=0) was measured according to the method outlined by Friedman et al. [8]. To construct a scapular line, one uses Universal Desktop Ruler (AVPSoft.com, Voronezh, Russia) to join the mid-glenoid to the medial spine of the scapula. The glenoscapular angle was estimated by calculating the angle produced between the scapular line and a line drawn tangential to the glenoid surface that interacted closely with the humeral head.

Laboratory Investigations:

Before surgery, all patients underwent standard laboratory testing, which included a full blood count, random blood glucose level, bleeding profile, and evaluation of liver and kidney function.

Operative management:

Anesthesia:

The study's patients were all administered general anesthesia. A broad-spectrum antibiotic was taken around half an hour prior to the induction of anesthesia as a precaution.

Surgical preparations:

During the procedure, the clavicle, acromion process, and scapula were osteotomized to bring the acromioclavicular plane—where the ACT is located—to a neutral and functional position. This allowed for a more anatomical positioning of the humeral head within the glenoid fossa.

In particular, the osteotomy of the clavicle at the joint of the middle and distal thirds was an integral part of the triangle tilt procedure. bone grafting performed on the acromion process where it meets the scapular spine. decreased scapular winging after ostectomy at the superomedial scapular angle. restriction of motion while the limb is in an adducted, externally rotated, or forearm supinated position.

Operative Technique:

Following the patient's supine position, an incision was made along the medial edge of the superomedial border of the scapula to initiate the surgery. The scapula's pronounced superomedial angle was removed with a bone cutter after soft tissue was removed from the area, resulting in a smoother surface. An electric saw was used to cut the scapular spine

after soft tissue dissection revealed it through an incision made across the scapula's spine. Following osteotomy, the scapula and acromion process derotated, suggesting that the elevated scapula had already twisted and rotated internally before the procedure. A morselized piece of bone was implanted into the space between the scapular spine and the acromion process using the bone that was removed during the osteotomy procedure. To access the clavicle, a cut was made across its distal third and the surrounding soft tissue was removed. Using an electric saw, the clavicle was osteotomized. The distal and proximal clavicle segments were then semirigidly fixed together using titanium screws and absorbable suture. Following the osteotomy, it was seen that the clavicle segments "twisted" in relation to one another, suggesting that the clavicle was torsioning as a result of scapular elevation. After making an incision above the posterior glenohumeral joint, the posterior glenohumeral capsule was exposed by delicate dissection through the deltoid muscle. A purse-string-style circumferential suture was used to reduce capsule laxity. With the humerus externally rotated and in a neutral position, the patient was splinted in adduction and supination and wounds were dressed in numerous layers. After six weeks of full-body splinting, the patient had a three-month phase of nighttime splinting. A 6-month course of physical therapy was recommended (**Figure S1**).

Postoperative follow-up:

Radiological and clinical evaluations, including x-ray and CT scans, were conducted on patients at2, and 3, 6, 12, 24 months. Results were evaluated by looking at how much better the patient's arm sat in a more normal position when at rest and how much better their hand-to-mouth movement was. Postoperative evaluation was performed according to Mallet Score and rehabilitation by physiotherapy.

STATISTICAL ANALYSIS

Coded, inputted, and analyzed using Microsoft Excel software, data was gathered from the patient's history, basic clinical examination, laboratory investigations, and outcome measures. The data was subsequently loaded into SPSS version 20.0, which stands for Statistical Package for the Social Sciences, in order to do the study. The following tests were utilized to determine if there were significant differences, based on the type of data: quantitative (represented by mean ± SD) and qualitative (represented by number and percentage). Using a paired t test, we can compare two quantitative groups. We set the P value at less than 0.05 for outcomes that were considered significant and less than 0.001 for those that were considered high significant.

RESULTS

This study included 18 children with age range from 2 years and 16 years with mean age 5.22 years. Out of the 18 children 10 males represented 66.6% and 8 females represented 44.4% of the study. As regards side of injury 55.6% of cases had injures in left sude and 44.4% were right and 55.6% of cases had C5&C6 nerve affection majority followed by C5&C6&C7 (33.3%) then C5&C6&C7&C8 (11.1%) (**Table 1**).

As regards clinical evaluation based on Mallet score items including abduction, hand to mouth, hand to neck, hand to spine, external rotation as well as total mallet score improved significantly after intervention ($p<0.001$ for all items) (**Table 2**).

Posterior supination significantly increases after intervention from 14.16±2.25 to 25.50±2.72 with p value <0.001 (**Table 3**).

The radiological evaluation:

The Glenoid Version: The measurements of the glenoid version showed significant improvement which was about 29.55±3.27 and improved to be about 22.66±2.95 .The Abduction angle: There was significant improvement in the abduction angle while pre operative was 78.05±10.72 and became post

operative 149±9.85 .SHEAR Deformity: There was significant improvement in SHEAR deformity grades while pre operative was grade 3 and grade 4 and became post operative grade 2. (**Table 4**).

In the diabetic retinopathy group, 0% of cases exhibited abnormalities in the optic disc, 2.4% showed abnormalities in the macula (macular edema), while 9.5% showed irregularities in the periphery of the retina (3 cases showed microaneurysm and one case showed neovessels formation). Conversely, in the group without diabetic retinopathy, all patients (100%) displayed normal findings in the optic disc and macula. Moreover, 90.5% of cases in this group exhibited a healthy periphery of the retina (Table 4).

Glenoid version,Abduction angle, and total Mallet score significantly improved from preoperative (29.55±3.27, 78.05±10.72, and 9.66±1.81 respectively) to postoperative (22.66±2.95,149±9.85, and 17.83±1.24 respectively) with P value <0.001. (**Table 5**).

Nonunion of the clavicular osteotomy occurred in minority of patients (3 cases) early in the series and was treated by wire fixation. This complication led to the introduction of semi-rigid fixation of the clavicular fragments by titanium pins connected by an absorbable suture. The titanium pins were subcutaneous and tied together with absorbable sutures.

A 9 years old male, presented with Rt upper limb deformity with inability to make hand to mouth movement, Pre operative radiological evaluation:SHEAR Deformity: Grade 4, Glenoid Version: 30, Abduction Angle : 85, diagnosis was obstetric brachial plexus injury at right side, he was managed by triangle tilt surgery, Post operative radiological evaluation :There was improvement at scapula position and shoulder. SHEAR Deformity: Grade 3, Glenoid Version: 25, Abduction Angle: 160 (**Figure 1**).

A 6 years old male, presented with Rt upper limb deformity with inability to make hand to mouth movement, Pre operative radiological evaluation: SHEAR Deformity : Grade 3 Glenoid Version : 28, Abduction Angle : 65, diagnosis was obstetric brachial plexus injury at right side, he was managed by triangle tilt surgery, There was improvement at scapula position and shoulder after management SHEAR Deformity : Grade 2, Glenoid Version : 20, Abduction Angle : 140 (**Figure 2**).

Table 1: Age, sex distribution, side of inkury and nerve involvement among studied group

		Age	
Mean± SD		5.22±1.86	
Median (Range)		5.0 (3-9)	
		N	**%**
Sex	**Male**	10	55.6
	Female	8	44.4
	Total	18	100.0
		N	**%**
Side	**Left**	10	55.6
	Right	8	44.4
Nerve involved	**C5&C6**	10	55.6
	C5&C6&C7	6	33.3
	C5&C6&C7&C8	2	11.1
	Total	18	100.0

Table 2: Mallet score items and total distribution among studied group pre and post intervention**.**

	Pre	Post	Paired t	P
Abduction	2.05±0.702	3.50±0.51	9.953	0.00**
Hand to mouth	1.38±0.40	3.38±0.50	11.063	0.00**
Hand to neck	2.22±0.54	3.83±0.39	11.248	0.00**
Hand to spine	1.77±0.42	3.72±0.46	35.000	0.00**
Ext.Rotation	2.22±0.54	3.38±0.50	12.907	0.00**
Total mallet score	9.66±1.81	17.83±1.24	22.448	0.00**

Table 3: Posterior supination distribution among studied group pre and post intervention

	Pre	Post	Paired t	P
Posterior supination	**14.16±2.25**	**25.50±2.72**	**24.403**	**<0.001****

Table 4: SHEAR Deformity

Shear deformity	**pre**	**post**	**p**
	Grade 3 & 4	**Grade 2**	**00**

Table 5: Glenoid version, Abduction angle distributions, and total mallet score among studied group pre and post intervention

Glenoid version	**Pre**	**Post**	**Paired t**	**P**
	29.55±3.27	**22.66±2.95**	**17.434**	**0.00****
	Pre	**Post**	**Paired t**	**P**
Abduction angle	**78.05±10.72**	**149±9.85**	**39.644**	**0.00****

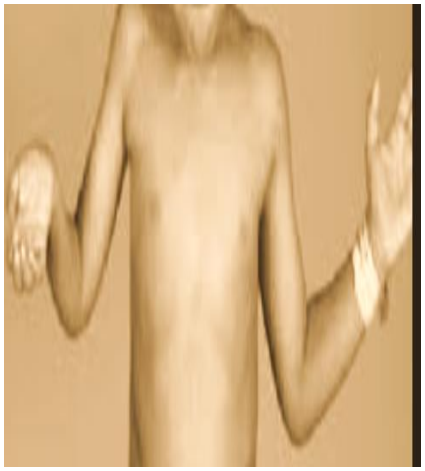
Total mallet score	**pre**	**Post**	**Paired t**	**p**
	9.66+_1.81	**17.83+_1.24**	**22.448**	**0.00**

a.abducation

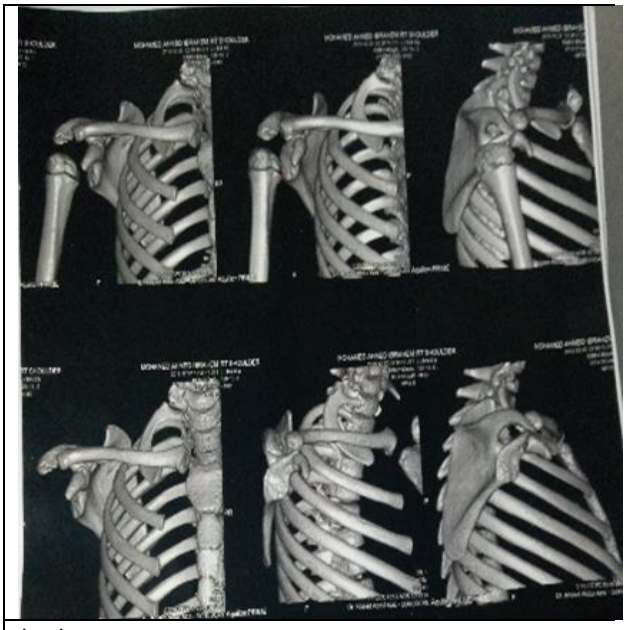
b.hand to mouth

c. hand to spine

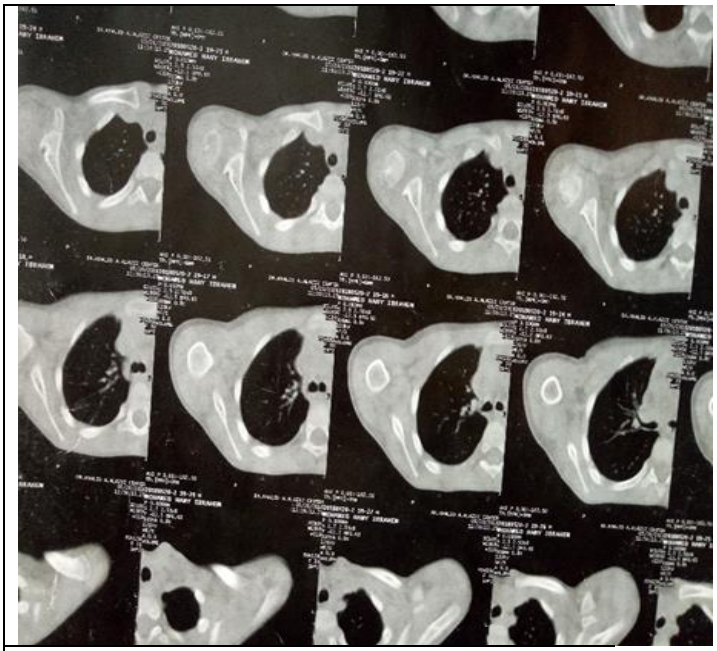
d. hand to neck



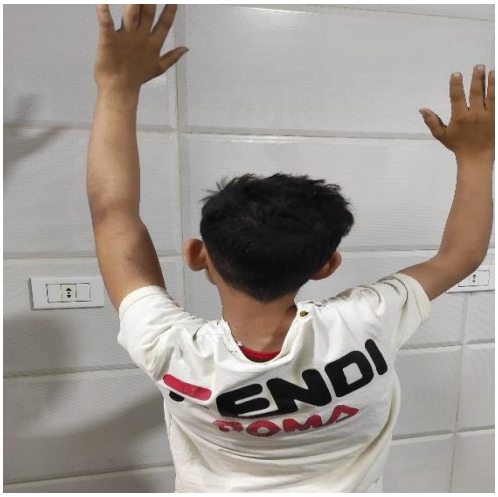
e. ext.rotation



(B1)



(B2)



a. abduction

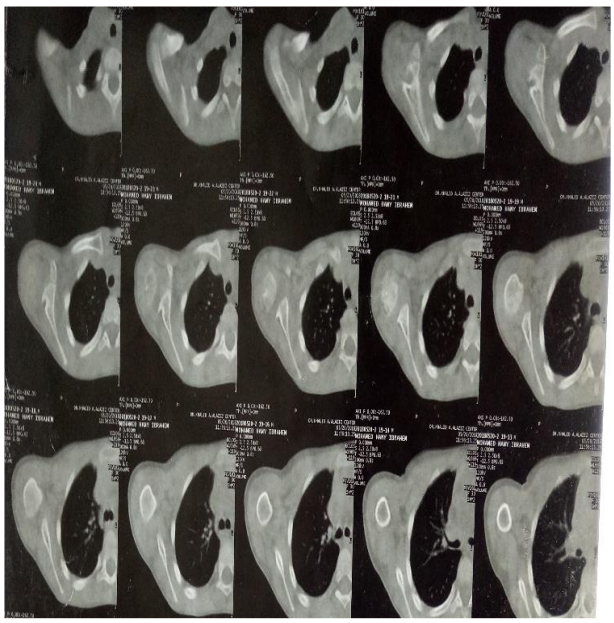
b. hand to mouth

c. hand to neck

d. hand to spine

e. ext.rotation

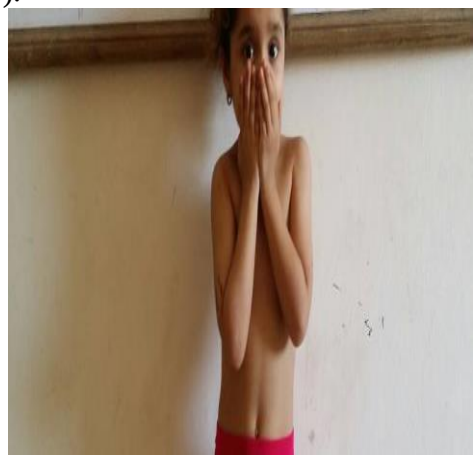
(D1)



(D2)

Figure 1: (A, B) Pre operative clinical evaluation (a.abduction. b.hand to mouth , c.hand to neck , d.hand to spine , e.ext.rotation) (B) pre operative radiological evaluation (B1: CT of affected shoulder B2:.axial view of shoulder), (C) Post operative clinical evaluation (a.abduction. b.hand to mouth , c.hand to neck , d.hand to spine , e.ext.rotation), (D) post operative radiological evaluation after 6 months (D1.3D CT of shoulder, D2.axial view of shoulder).

a. abduction



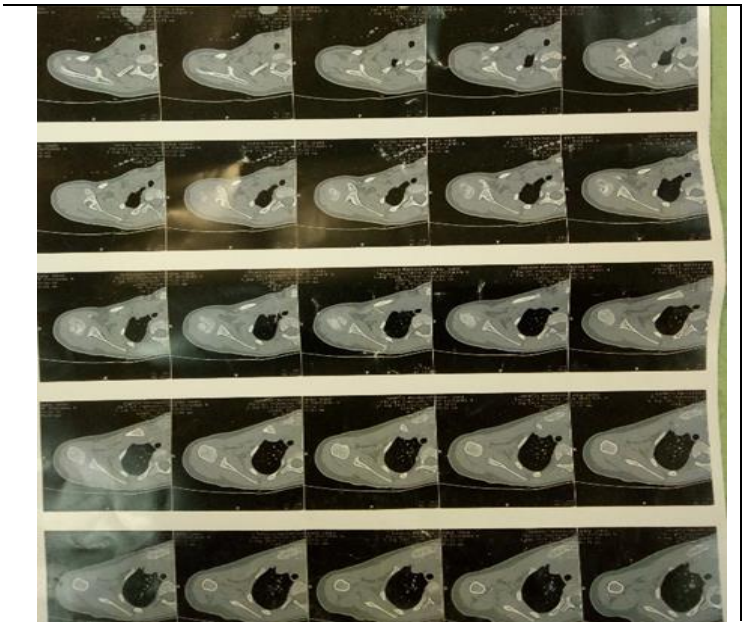
b. hand to mouth

c. hand to spine

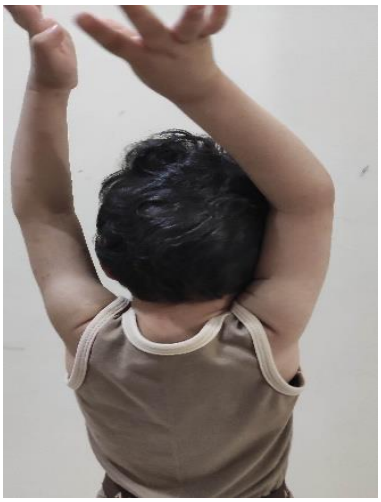
d. hand to neck

e. ext.rotation

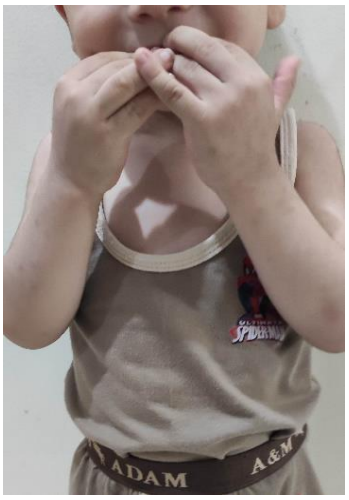
(B1)



(B2)



a. abduction

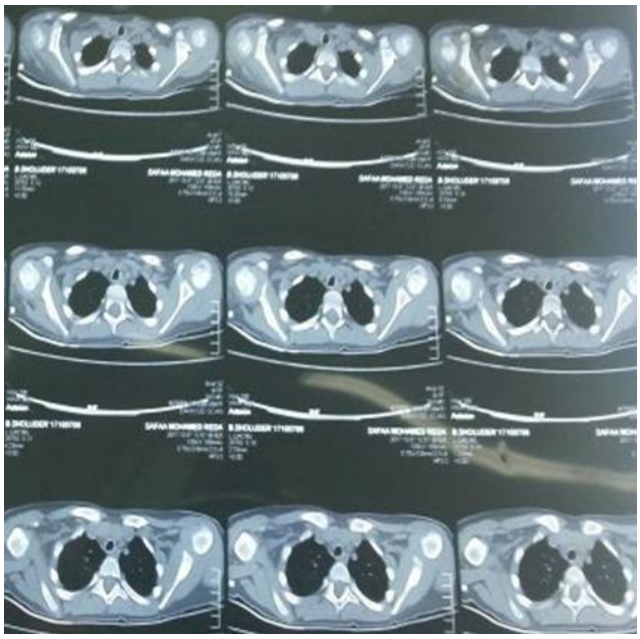


b. hand to mouth

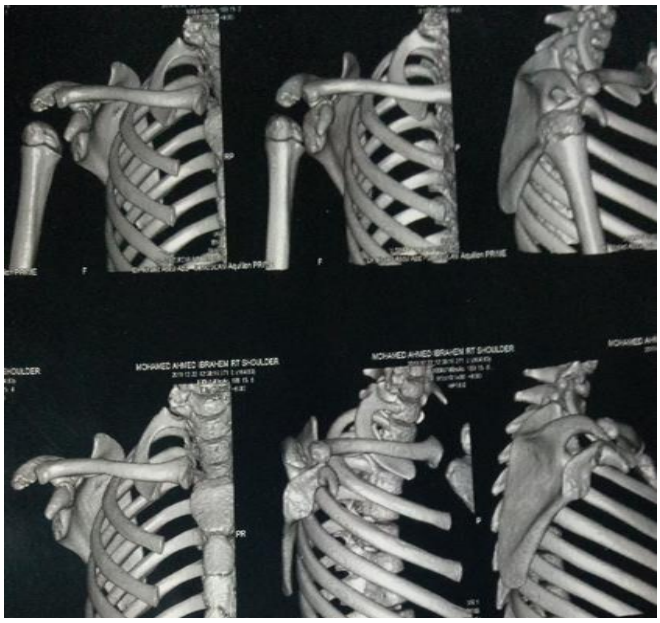
c. hand to spine

d. hand to neck

e. ext.rotation



(D1)



(D2)

DISCUSSION

Worldwide, the incidence of brachial plexus birth injuries ranges from 0.40 to 4.60 per 1000 live births. Mechanical traction to the brachial plexus after birth, caused by the expanding of the space between an infant's neck and shoulder, is the prevailing theory about the mechanism of injury. [9].

The brachial plexus damage that happens during labor and delivery is known as obstetric brachial plexus injury (OBPI). Macrosomia, breech presentation, and shoulder dystocia are all symptoms that may accompany OBPI. The triangle tilt technique has been successfully utilized to treat children in the past, and it can be applied to teenagers without any adjustments. A patient's age range, in theory, from 8 months to 16 years, could be considered for the surgery [10].

Patients with scapular elevation and medial rotation contracture are good candidates for triangle tilt. If these abnormalities are present, the surgery can successfully treat mild, moderate, and severe neurological defects, complete glenohumeral dislocations, and patients whose prior reconstructive surgeries failed [10].

Achieving the ideal range of motion in the shoulders by improving glenohumeral alignment is a crucial objective in treating children with obstetric brachial plexus injuries. These patients often have shoulder abnormalities, which manifest as impaired function, discomfort, and diminished quality of life starting in adolescence [11].

Shoulder soft tissue treatments, such as tendon transfers, axillary nerve decompression, and contracture releases, can alleviate the abduction deficiency. Medial rotation results from the SHEAR deformity, but contracture is more challenging to treat [5].

The main scapular elevation and rotation cannot be corrected by external rotation osteotomy of the humerus, but it can enhance the position of the hand and forearm and perhaps aid in both the resting posture and active external rotation of the shoulder. Since the SHEAR deformity is characterized by improper skeletal development, corrective

surgery involving the bones is necessary to fix the condition. The forward tilt of the acromioclavicular plane, caused by the prolonged scapula and the aberrant anterior rotation of the clavicle, impacts the humeral head with the acromion. Since Triangle Tilt surgery gets to the bottom of what's causing the medial rotation, it's a more targeted procedure [11].

This study included 18 children with age range from 2 years and 16 years with mean age 5.22 years. Out of the 18 children 10 males represented 66.6% and 8 females represented 44.4% of the study. As regards side of injury 55.6% of cases had injures in left sude and 44.4% were right and 55.6% of cases had C5&C6 nerve affection majority followed by C5&C6&C7 (33.3%) then C5&C6&C7&C8 (11.1%). As regards clinical evaluation based on Mallet score items including abduction, hand to mouth, hand to neck, hand to spine, external rotation as well as total mallet score improved significantly after intervention ($p<0.001$ for all items). After Triangle Tilt Surgery, the abduction angle showed highly significantly increased from pre- to post-operative 149° (SD= 9.85) ($p = <0.001$). The pre-operative glenoid version score was 29.55° deg. (SD = 3.27) and improved significantly after Triangle tilt surgery to 22.66° deg. (SD = 2.95). It highly significantly increased from pre- to post-operation ($p = <0.001$). and improvement in SHEAR deformity while preoperative was grade 3 and grade 4 and became post operative grade 2. the overall results are interpretated by Mallet score were improved from (9.66+_1.81) preoperative to (17.83+_1.24) post operative with p value <0.001.

These results were in line with those of Kirkos et al. [12] who studied 22 of OBPI with internal rotaion contracture. The mean age was 10 years, with a variable follow-up period. Among the global shoulder function effects after humeral derotation osteotomy, there was no discernible rise in shoulder abduction [27 degrees (range 0-60 degrees)]. The exterior rotation increased by 250 degrees on average (with a range of 5-85 degrees).

Also, Rahul and Somasundaram. [13] managed 22 patients of OBPI with medial rotation contracture and scapula deformity, ages ranging from (2.1 – 11.8 years). Post-operative of triangle tilt surgery 5-years follow-up shows an evaluation of functional movements and improvement of mallet scale score from 14.1° (SD= 2.7) preoperatively to 20.3° (SD= 2.5) post-operative.

In the same line, Wateres and Bae. [14] reported that twenty-seven patients of brachial plexus birth palsy with posterior subluxation of scapula who were followed for a minimum of two years (average, 3.7 years) are reported in managed with derotaional osteotomy. The mean aggregate Mallet classification score improved from 13 to 18 points ($p < 0.01$). The average amount of external rotation was 64° (35° to 90°) [8].

Nath et al. [15] managed 25 cases of complete OBPI with glenohumeral deformity with a range age of (0.75-12) years, conjugated with limited shoulder function, the results of Triangle tilt surgery on shoulder function and development. All cases have been followed up clinically for more than two years, and the results were a significant increase in the overall Mallet score from 12° to 14.6° (2.6 points, $p < 0.0001$) and improvement in shoulder function Also, the CT and 3DCT reconstructions humeral radiological results

of Nath et al. [15] study showed posterior subluxation improvement from 13 % pre-operative to 30.4 % postoperative ($p < 0.05$) and glenoid version increasing from -28 deg. to – 16.5 deg. ($p < 0.05$). The results showed the effectiveness of Triangle tilt sugary bony surgical procedure and outcome in OBPI Their total Mallet functional score improved from 9.66 ° (SD= 1.81) pre-operative to 17.83 ° (SD= 1.24) after the operation. It showed highly statistically significant (p=0.001) [16].

In Nath [17] study, of their 20 patients of OBPI with post.glenohumeral contracture , 18 had triangle tilt, and 2 had only mod Quad. Among 18 patients, 8 had only triangle tilt, and ten had mod Quad as revision surgeries. The pre-operative glenoid version score was -31.6 deg. (SD = 19.3) and improved significantly to -16.3 deg. (SD = 11) ($P < 0.0002$) [103]. And results were improved in overall mallet score from 11 deg to 15.7 deg .

After undergoing triangle tilt surgery, 34 patients with obstetric brachial plexus injuries, deficits in abduction, and medial rotatory contracture were followed up for an average of 31.2 months, with both continuous and intermittent physiotherapy, according to Ghieth and Saoudy [18]. Applying modified Mallet scoring yielded varying degrees of improvement across all cases. After the operation, the average aggregate Mallet score increased from 11.2 (ranging from 7 to 14 points) to 19.7 (ranging from 15 to 24 points), with a mean difference of 8.5 and a p-value of 0.0001.

Limitations:

The study's sample size of only 18 patients may not be large enough to draw statistically significant conclusions. With such a small sample, the findings may not be generalizable to a broader population. Due to the small and possibly non-representative sample, the findings may not be applicable to a wider population of patients with obstetric brachial plexus injury, particularly those with different demographic characteristics. The study had a short follow-up period of 2 years only and so the study might not capture long-term outcomes or potential complications associated with the procedure.

CONCLUSIONS

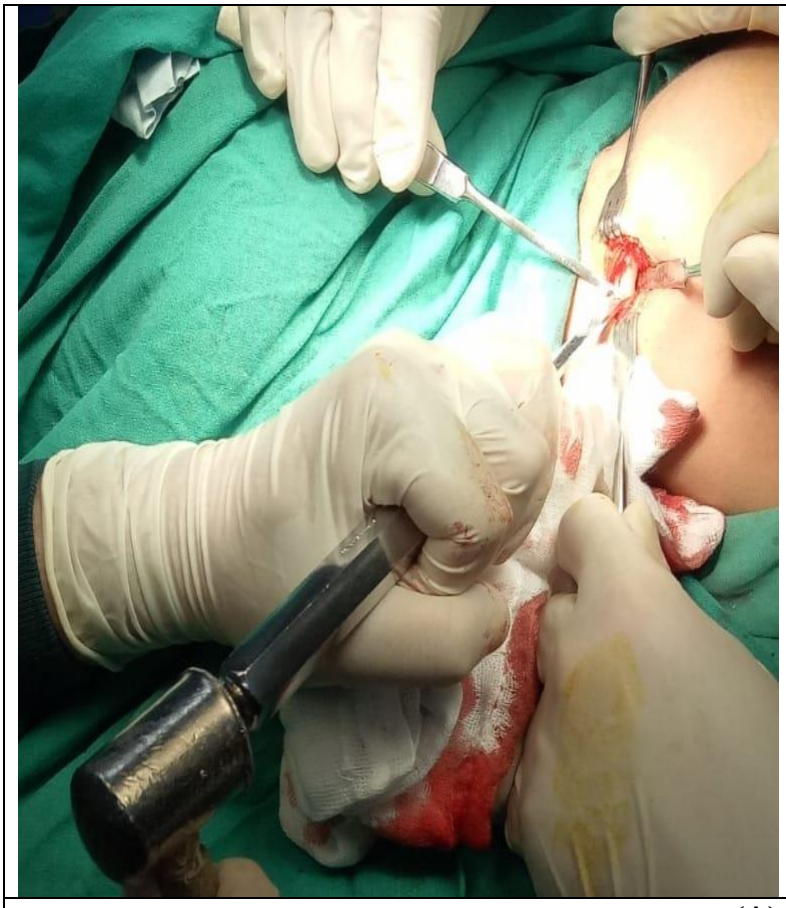
Triangle tilt surgy is a safe and effective method for treatment of secondary deformities of obstetric brachial plexuses injury in children in different ages.

No potential conflict of interest or financial disclosure reported by the authors.

REFRENCES

1. Dunham EA. Obstetrical Brachial Plexus Palsy. OrthopNurs 2003;22(2).
2. Maillet M, Romana C. Complete obstetric brachial plexus palsy: surgical improvement to recover a functional hand. J Child Orthop 2009;3(2):101–8.
3. Nath RK, Humphries AD. Computed tomography of the shoulders in patients with obstetric brachial plexus injuries: a retrospective study. Ann SurgInnov Res 2008;2:4.
4. Nath RK, Amrani A, Melcher SE, Eichhorn MG. Triangle tilt surgery in an older pediatric patient with obstetric brachial plexus injury. *Eplasty*. 2009;9:e26.
5. Nath RK, Paizi M. Scapular deformity in obstetric brachial plexus palsy: A new finding. SurgRadiolAnat 2007;29(2):133–40.
6. Sabapathy SR, Bhardwaj P, Venkatramani H. Value of Soft Tissue Release Procedure around the Shoulder to Improve Shoulder Abduction in Birth Brachial Plexus Palsy and Analysis of the Factors Affecting Outcome. *J Hand Surg Asian Pac Vol*. 2017;22(2):174-83.

7. Bains R, Kattan A, Curtis CG, Stephens D, Borschel G, Clarke HM. Active Range of Motion Over Time in Patients With Obstetrical Brachial Plexus Palsy: A 10-Year Analysis. *J Hand Surg Am*. 2018;43(4):386.e1-386.e7.
8. Friedman RJ, Hawthorne KB, Genez BM. The use of computerized tomography in the measurement of glenoid version. J Bone Joint Surg Am 1992;74(7):1032–7
9. DeFrancesco CJ, Shah DK, Rogers BH, Shah AS. The Epidemiology of Brachial Plexus Birth Palsy in the United States: Declining Incidence and Evolving Risk Factors. J PediatrOrthop. 2019;39(2):134-40.
10. Nath RK, Somasundaram C, Melcher SE, Bala M, Wentz MJ. Arm rotated medially with supination - the ARMS variant: description of its surgical correction. BMC MusculoskeletDisord. 2009;10:32.
11. Hudić I, Fatusić Z, Sinanović O, Skokić F. Etiological risk factors for brachial plexus palsy. J Matern Fetal Neonatal Med. 2006;19(10):655-61.
12. Kirkos JM, Papadopoulos IA. Late treatment of brachial plexus palsy secondary to birth injuries: rotational osteotomy of the proximal part of the humerus. J Bone Joint Surg Am 1998;80(10):1477–83.
13. Nath RK, Pretto J, Somasundaram C. Comparing the Surgical Outcomes of Modified Quad and Triangle Tilt Surgeries to Other Procedures Performed in Obstetric Brachial Plexus Injury. Open Orthop J 2013;3(7):15–21.
14. Waters PM, Bae DS. The effect of derotational humeral osteotomy on global shoulder function in brachial plexus birth palsy. J Bone Joint Surg Am 2006;88(5):1035–42.
15. Nath RK, Mahmooduddin F. Triangle tilt surgery: effect on coracohumeral distance and external rotation of the glenohumeral joint. Eplasty. 2010;10:e67.
16. Nath RK, Karicherla P, Mahmooduddin F. Shoulder function and anatomy in complete obstetric brachial plexus palsy: Long-term improvement after triangle tilt surgery. Child's NervSyst 2010;26(8):1009–19.
17. Nath RK, Somasundaram C. Improvements after mod Quad and triangle tilt revision surgical procedures in obstetric brachial plexus palsy. World J Orthop. 2016;7(11):752-7.
18. Ghieth M, Saoudy S. One step shoulder soft tissues reconstruction and surgery treatment of triangle tilt of glenoid due to sequlae of brachial plexus birth palsy. ARC j. orthop.2017, 2 (1): 7-17.



(A)

Figure S1: (A): Osteotomy of the clavicle, (B): Drilling of clavicle

(A, B) Pre operative clinical evaluation (a.abduction. b.hand to mouth , c.hand to neck , d.hand to spine , e.ext.rotation) (B) pre operative radiological evaluation (B1: CT of affected shoulder B2:.axial view of shoulder), (C) Post operative clinical evaluation (a.abduction. b.hand to mouth , c.hand to neck , d.hand to spine , e.ext.rotation), (D) post operative radiological evaluation after 6 months (D1.3D CT of shoulder, D2.axial view of shoulder).

Figure 2: (A, B) Pre operative clinical evaluation (a.abduction. b.hand to mouth , c.hand to neck , d.hand to spine , e.ext.rotation) (B) pre operative radiological evaluation (B1: CT of affected shoulder B2:.axial view of shoulder), (C) Post operative clinical evaluation (a.abduction. b.hand to mouth , c.hand to neck , d.hand to spine , e.ext.rotation), (D) post operative radiological evaluation after 6 months (D1.3D CT of shoulder, D2.axial view of shoulder).

Citation:

Abdellatif, G., Kamel, A., Al-Nashar, H., Ahmed, I. Direct Ophthalmoscopy versus Fundus Photography in Children with Type 1 Diabetes Mellitus. *Zagazig University Medical Journal*, 2024; (3607-3623): -. doi: 10.21608/zumj.2024.307231.3492