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ARTHROSCOPIC RELEASE OF SUBSCAPULARIS TENDON IN TREATMENT OF ADDUCTION INTERNAL ROTATION CONTRACTURE OF THE SHOULDER JOINT SECONDARY TO OBSTETRIC BRACHIAL PLEXUS PALSY

By

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ABSTRACT

Background: Children with unresolved brachial plexus palsy frequently develop a disabling internal rotation contracture of the shoulder. Several surgical options, including soft tissue procedures such as muscle releases and/or transfers, and bone operations such as humeral osteotomy are available to correct this deformity.

Objective: To evaluate the results obtained with arthroscopic release of subscapularis tendon in treatment of adduction internal rotation contracture of the shoulder joint secondary to obstetric brachial plexus paralysis.

Patients and methods: This was a prospective study which had been conducted at Orthopedic Surgery Department, Al-Azhar University Hospitals (Al-Hussein and Sayed Galal Hospitals), the study included 10 patients with shoulder contracture secondary to obstetric brachial plexus palsy,from January 2020 to August 2021, Follow up, scheduled at immediately after operation, 2 weeks, 4 weeks, 2 months and 6 months post operatively.

Result: The mean passive external rotation (ER) was 72.3° (40° - 90°) and the mean active ER was 72.9° (20° - 90°) at the end of follow up. The mean global Mallet score improved from 11.6 ± 1.07 SD (range from 10 to 13) preoperatively to 17.5 ± 2.22 SD (from 13 to 20) postoperatively. There were statistically significant differences between passive ER and Mallet score pre and post operatively. Passive ER, active ER and mallet score were higher among group with partial injury than complete injury but with no significant differences. There have been no intraoperative or postoperative complications.

Conclusion: Isolated subscapularis tendon release was an easy, efficient and safe procedure in young children with shoulder adduction–internal rotation contracture due to obstetric brachial plexus palsy. It improved abduction and external rotation, but has no statistically significant influence on internal rotation.

Keywords: Obstetric Brachial Plexus Palsy, Shoulder internal rotation contracture, Subscapularis release, Shoulder arthroscopy.

INTRODUCTION

Normal shoulder development requires a balanced range of motion between humeral head and glenoid. The rotator cuff muscles including subscapularis, supraspinatus, infraspinatus, teres minor muscles and the deltoid muscle are the prime movers of the shoulder. The biceps, latissimus dorsi, teres major, and pectoralis major muscles also contribute to shoulder movement *(Kozin, 2014)*.

Normal shoulder function and development is dependent on osteocartilaginous elements, joint capsule, muscles and central nervous system factors. The shoulder is by far the most frequently affected joint in birth palsy. 25% of estimated nerve fibers within the brachial plexus pass to the shoulder girdle *(Yuceturk, 2011)*.

The shoulder is the joint most often involved in paralytic sequelae and internal rotation contracture is the problem most seen at that joint. It is secondary to muscular imbalance between the active internal rotators and the paralyzed external rotators *(Gilbert et al., 2010)*.

Shoulder dislocation in birth palsy can be attributed to muscle imbalance, and to the gradual flattening of the humeral head *(Dunkerton, 2010)*.

Diagnosis of secondary deformities of the shoulder is important in the assessment of the feasibility of the secondary surgical techniques. For soft tissue secondary reconstructive procedures, the absence of severe secondary deformities is considered a prerequisite *(van der Sluijs et al., 2013)*.

The best treatment of shoulder sequelae in birth palsy is prevention which is possible *(Birch, 2011)*.

Almost near normal shoulder function can still be reached in children who could not receive primary early neural reconstruction, by arthroscopic release of subscapularis tendon or by combined muscle release and transfer, Operations which are performed before the development of severe glenohumeral deformities *(Aydin et al., 2014)*.

As severe internal rotation contracture of the shoulder can produce dysfunction of the hand, Arthroscopic correction of internal rotation adduction contracture of the shoulder joint improves abduction and external rotation, allowing the patient to bring the hand to the mouth or other parts of the head, correcting the cosmetic defect, and improves trunk posture during use of the upper limb *(Zancolli and Zancolli, 2010)*.

The aim of this study was to evaluate the results obtained with arthroscopic release of subscapularis tendon in treatment of adduction internal rotation contracture of the shoulder joint secondary to obstetric brachial plexus paralysis.

PAITENTS AND METHODS

This was a prospective study which had been conducted at orthopedic surgery department of Al-Azhar University Hospitals (Al-Hussein and Sayed Galal Hospitals), was included 10 patients with shoulder contracture secondary to obstetric brachial plexus palsy, in one search group from january2020 to August 2021.

Follow up: Scheduled at immediately after operation, 2 weeks, 4 weeks, 2 months and 6 months post operatively.

Inclusion criteria:

1. Patient age is between three to ten years.
2. All patients are adduction internal rotation contractue of the shoulder joint secondary to obstetric brachial plexus palsy(paralysis).

Exclusion criteria:

1. Global palsy (C5-T1).
2. Patient age is less than three years or more than ten years.
3. Refusal of patient parents.
4. Patient with severe congenital heart disease or unfit for surgery.

Full records:

All patients had been done according to the data supplied in the orthopedic sheet (personal history, complaint, present history, past history, family history).

Examination: In the form of:

1. General examination.
2. Local examination (shoulder contracture).

Investigations:

1. Laboratory (CBC, Coagulation profile, Kidney functions, Liver functions).
2. Radiological (shoulderX-ray anterior-posterior view).

Technique:

- Every case was studied individually and according to the mentioned criteria.
- Complete aseptic conditions.
- Anesthesia: General anesthesia.

The surgical technique:

Passive external rotation (with the arm at the side, and at 90 degree of abduction) and passive abduction of the shoulder were evaluated under general anaesthesia , with the patient in the lateral decubitus position.

After identifying the landmarks, arthroscopy was performed with a small joint 2.7 mm arthroscope, the glenohumeral joint was distended with 20 ml of saline, using 20 G spinal needle.

The posterior portal was created at the posterolateral corner of the acromion, taking care not going too low, to avoid injury to the articular surface.

Because of the contracture, an assistant held the arm in approximately 90 degrees of abduction while applying longitudinal traction, to facilitate entry of the arthroscope into the joint through the posterior portal.

The anterior portal was placed under arthroscopic visualization from the posterior portal, with the aid of a spinal needle.

The anterior capsule, anterior glenohumeral ligaments, rotator interval and subscapularis tendon were identified, and an electrocautery was introduced through the anterior portal.

The thickened superior and middle glenohumeral ligaments along with the upper intra articular portion of the subscapularis tendon were released, then the transition of the subscapularis tendon to its muscular portion was identified, and release continued solely to the capsule , taking care to preserve the inferior and lateral portions of the subscapularis tendon to maintain active internal rotation.

An arthroscopic punch was then used to release the inferior glenohumeral ligament taking care not to injure the axillary nerve, finally the arthroscopic instruments were removed and manipulation of the shoulder joint was done with the arm at the side and also with the arm at 90 degree of elevation.

An audible click was noted, suggesting joint reduction; passive external rotation of > 70 degree was obtained, suggesting that no additional release of the subscapularis tendon or the axillary pouch was necessary.

Postoperatively, the shoulder is immobilized in shoulder spica cast in 90 degree of abduction and in external rotation for 4 weeks. Then physical therapy was initiated including stretching exercises and bracing in external rotation at nights for another 4 weeks.

Statistical analysis:

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

RESULTS

The average age was 4.3 years (3 – 10 years). Six children were males and four females. Seven children had an injury at C5-C6, one had an injury at C5-C6-C7 and two had a complete injury. The median follow-up was 15 months (7 - 18 months) **(Table 1)**.

Table (1): Baseline data of the patients

Parameters	Mean+SD N (%)
Age (years)	
Mean ± SD	4.4±0.68
Median (Range)	3(3-10)
Sex	
Male	6(60%)
Female	4(40%)
Affected side	
Right	5(50%)
Left	5(50%)
Roots affected	
C5,6	7(70%)
C5,6,7	1(10%)
Complete	2(20%)
Follow-up (Months)	
Mean ± SD	12.7±4.2
Median (Range)	15(7-18)

The mean passive ER was 72.3° (40° - 90°) and the mean active ER was 72.9° (20° - 90°) at the end of follow up. The mean global Mallet score improved from 11.6 ± 1.07 SD (range from 10 to 13) preoperatively to 17.5 ± 2.22 SD (from 13 to 20) postoperatively. There were statistically significant differences between passive ER and Mallet score pre and post operatively (p<0.005) **(Table 2)**.

Table (2): Preoperative versus postoperative data of the patients

	Preoperative	**Postoperative**	**P value**
Passive ER **Mean ± SD** **Median (Range)**	9.7±2.38 10(5-13)	72.3±16.6 78(40-90)	**<0.001**
Active ER **Mean ± SD** **Median (Range)**	NA NA	72.9±24.9 83(20-90)	
Mallet score **Mean ± SD** **Median (Range)**	11.6±1.07 12(10-13)	17.5±2.22 17.5(13-20)	**<0.001**

Case:

Sex: male
Weight at birth: 3800 g
Presentation: vertex
Age: 4 years
Type of lesion: incomplete (C5, C6)
Side of affection: right
Operative procedure: arthroscopic release of subscapularis tendon.

Table (4): Preoperative and postoperative assessment of the case

	Preoperative	**6 months postoperative**	**Final follow up**
Abduction	140	170	170
Passive ex. rotation*	30	>90	>90
Active ex. Rotation	0	>90	>90

*Passive external rotation was measured in adduction

(A) Preoperative.

(B) Final follow up

Figure (1): Preoperative and postoperative assessment.

DISCUSSION

Many authors reported improvement of shoulder internal rotation contracture after arthroscopic subscapularis release. In their study on 33 children, *Pearl (2013)* reported that arthroscopic subscapularis release without tendon transfer can restore passive external rotation and a centered humeral head in children younger than three years old.

Kozin et al. (2010) reported a great improvement in all outcomes after arthroscopic release with or without tendon transfer in 44 children with obstetrical brachial plexus palsy (OBPP).

Elzohairy and Salama (2016) study included 15 children with OBPP and treated them with an arthroscopic subscapularis release alone and they reported good restoration of shoulder range of motion and functions.

In our study, we preferred arthroscopic subscapularis release without tendon transfer for restoring external rotation and remodeling of the glenohumeral joint. Since, after the transfer of latissimus dorsi and teres major, there are no internal rotators of the shoulder left for active internal rotation, which can lead to an unstable shoulder after capsulotomy. In addition, the arthroscopic release procedure is minimally invasive that allows more precise subscapularis release with better visualization of the intra-articular deformities and provide a better cosmesis for the patient. Unlike, the open surgery that may carry a risk to pave the way for extensive scar tissue.

Our prospective study included ten patients with shoulder contracture secondary to obstetric brachial plexus palsy presented with shoulder internal rotation contracture with passive external rotation <20° secondary to obstetric palsy with average age 4.3 years (3 – 10 years) and average follow-up 15 months (7 - 18 months). Seven children had an injury at C5-C6, three cases had an injury at C5-C6-C7. They were treated with shoulder arthroscopy to release the subscapularis tendon without any tendon transfer.

Regarding the suitable age of patients at surgery, there is no evidence about that, but the common choice now to prevent glenohumeral deformities is to perform shoulder surgery early *(Kruit et al., 2016)*.

Zayed et al. (2020) found a statistically significant negative correlation between age and postoperative range of motion (ROM) and modified Mallet score. There was significant improvement of shoulder function can be reached in children by subscapularis muscle release which are performed before the glenohumeral deformities occur.

The first authors who described the relation between age of patients and postoperative results of operation were *Gilbert et al. (2011)* who showed good results for children operated in age less than 2 years compared with children older than 4 years.

No remarkable difference between the younger and older age groups regarding postoperative results was reported by *Newman et al. (2012)*, this may be owing to small sample size.

This study shows promising results in the form of improved Mallet score and increased range of shoulder motion specially abduction and external rotation after arthroscopic subscapularis release. There were no intraoperative or postoperative complications.

Average preoperative passive ER was 40° degrees, which improved at 1-year postoperatively to 90° degrees at the end of follow up (average of 72.3° range, 40-90 degrees), Average preoperative active ER was 20° degrees, which improved at 1-year postoperatively to 90° degrees at the end of follow up (average of 72.9° range, 20-90 degrees). In agreement with our study, *Hassan et al. (2015)* reported that passive ER was 70° on average (40° - 90°) and active ER was 60° (20° - 90°) at the latest follow-up.

Similarly, *Kozin et al. (2010)* reported that average preoperative passive ER was 35° degrees, which improved at 1-year postoperatively to 90° degrees at the end of follow up (range, 35-90 degrees).

In consistent with our study, *Kokkalis et al. (2013)* reported that average preoperative active ER was 20° degrees, which improved at 1-year postoperatively to 50° degrees at the end of follow up (range, 35-50 degrees).

Naoum et al. (2015) showed active abduction improved 21° (15–45°) at 6 months and continued to do so up to last follow-up with an overall improvement of 31° (20–50°). Active external rotation improved 52° (40–60°) at 6 months but showed a gradual loss of improvement with time, reaching an overall improvement of 35° (25–45°) at last follow-up.

In the present study, the global Mallet score improved from 11.6 ± 1.07 SD (range from 10 to 13) preoperatively to 17.5 ± 2.22 SD (from 13 to 20) postoperatively.

In agreement with our results, *Hassan et al. (2015)* reported that global Mallet score improved from 11.29 ± 1.06 SD (range from 10 to 13) preoperatively to 17.38 ± 2.14 SD (range from 13 to 20) postoperatively.

In accordance to our study, *Kokkalis et al. (2013)* reported that global Mallet score improved from 12 points preoperatively to 17 points postoperatively) at last follow-up.

Similarly, *Andreo Cong et al. (2015)* study showed that global Mallet score improved from 11 points preoperatively to 17 points postoperatively) at last follow-up.

There were statistically significant differences between passive ER and Mallet score pre and post operatively that was in agreement with *Naoum et al. (2015).*

Our results were similar to those reported by *Chen et al. (2010)* and *Newman et al. (2012)* who showed a significant improvement in upper limb function based on the Mallet score following isolated subscapularis release at an average follow-up of 3.5 years and 1 year respectively. Although shoulder abduction continues to show some improvement 2 years after surgery, the greatest positive difference occurs during the first 6 months following surgery. Shoulder external rotation does not follow the same improvement pattern, since loss of postoperative improvement tends to occur over time despite a sustained rehabilitation program. We do not have any explanation for the discrepancy between abduction and external rotation improvement over time.

Our findings were similar to those of *Carlioz and Brahimi (2010), Pichon & Carlioz (2010)* and *Kirkos et al. (2013).* Some of their patients showed a progressive loss in shoulder mobility over time. They explained it by a possible secondary surrounding tissue contracture, degenerative changes in the glenohumeral joint later in adult life and finally by the fact that young teenagers tend to prefer to use the healthy limb. The lack of improvement or even in some cases worsening of internal rotation is the biggest unsolved problem of this procedure, sometimes interfering severely with activities of daily living. Sever reported a difficulty in internal rotation in almost all operated children 1 year after surgery *(Chen et al., 2010)*.

Pedowitz et al. (2012) assessed the ability of arthroscopic release to reduce glenohumeral joint subluxation. Twenty two children with an average age of 3.9 years underwent preoperative magnetic resonance imaging (MRI), arthroscopic surgery with or without tendon transfers, and postoperative imaging in their spica cast. Prior to surgery, the involved shoulder preoperative mean PHHAwas15.6% -13.5% and the mean glenoid version was 37±15. After surgery and within the cast, the mean PHHA corrected to 46.9%, 11.2% and the mean glenoid version improved to 8±8. The immediate improvement in glenoid version was primarily attributed to reduction of the humeral head from the pseudoglenoid onto the native glenoid and secondary to the fast remodeling and pliable pediatric cartilage.

Pearl (2013) also reported follow-up on the first 33 children that underwent arthroscopic surgery. Nineteen children (all <3 years of age) underwent isolated arthroscopic release and 14 children (mean age, 6.7 years) underwent concomitant tendon transfer. Improved external rotation was noted in all children, except 1 child that was 12 years old. Passive external rotation increased between 60 and 80 dependent upon the procedure. Minimal improvement in mean active elevation was noted, even in the tendon transfer cohort. Four children (21%) that were treated with arthroscopic release alone required repeat surgery with an additional tendon transfer. Although internal rotation was not measured consistently prior to surgery, substantial reduction was note following surgery ranging from ‘‘moderate to severe.’’ MRI follow-up at 2 years revealed ‘‘marked remodeling’’ in 12 out of 15 children with a pseudoglenoid deformity.

This study showed promising results in the form of improved Mallet score and increased range of shoulder motion specially abduction and external rotation after arthroscopic subscapularis release. Although regular and continuous physical therapy did not prevent the gradual loss of external rotation improvement after the first 6 postoperative months and did not improve internal rotation, the data reported in the current study does not allow us to recommend decreasing or discontinuing rehabilitation 6 months after surgery.

The success of this procedure was entirely dependent on early diagnosis (as soon as the passive external rotation is 10 degrees with the arm side to the body) and early intervention, which makes the procedure less invasive. It may prevent permanent glenohumeral deformation, which is not always reversible.

The strength of this study was that arthroscopic release procedure allows more precise release with minimally invasive technique. In addition, dynamic assessment may be performed under arthroscopic control.

Another strength point was that this study gave information about not commonly used procedure managing not so rare cases.

There were some limitations of this study including; no control group, the long learning curve of the procedure due to infrequent pediatric shoulder arthroscopy cases, with high risk for axillary nerve injury due to its proximity to the subscapularis.

Lastly, we recommend arthroscopic subscapularis release in specific patients with internal rotation shoulder contracture in the early stages of development for better life quality, better mobility, and performance.

CONCLUSION

Arthroscopic subscapularis release alone without tendon transfer for internal rotation shoulder contracture in OBPP was minimally invasive procedure and showed promising results in the younger age groups. It addressed the primary pathology, associated with the capsuloligamentous structures. This procedure preserved the subscapularis and, at the same time, active internal rotation So, it prevented subsequent glenohumeral instability and later deformity.

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تحرير وتر العضلة تحت الكتفية لعلاج تقلص مفصل الكتف في وضع التقريب و الدوران للداخل الناتج عن شلل الضفيرة العصبية العضدية أثناء الولادة بإستخدام المنظار الجراحي

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خلفية البحث: الأطفال المصابون بشلل الضفيرة العضدية الذي لم يتم حله كثيرًا ما يصابون بتقلص دوراني داخلي معطل للكتف. تتوفر العديد من الخيارات الجراحية، بما في ذلك إجراءات الأنسجة الرخوة مثل تحرير العضلات و / أو عمليات النقل، وعمليات العظام مثل قطع العظم العضدي لتصحيح هذا التشوه.

الهدف من البحث: تقييم النتائج التي تم الحصول عليها لعلاج تقلص مفصل الكتف في وضع التقريب و الدوران للداخل الناتج عن شلل الضفيرة العصبية العضدية أثناء الولادة بإستخدام المنظار الجراحي.

المرضى وطرق البحث: كانت هذه دراسة إستطلاعية أجريت في قسم جراحة العظام بمستشفيات جامعة الأزهر (مستشفي الحسين وسيد جلال)، وشملت 10 مرضى تقلص كتف ثانوي لشلل الضفيرة العصبية العضدية الحادث أثناء الولادة و كانت هذه الدراسة من شهر يناير 2020 حتي شهر أغسطس 2021.

نتيجة البحث: كان متوسط الدوران الخارجي السلبي 72.3 درجة (40 درجة - 90 درجة) وكان متوسط الدوران الخارجي النشط 72.9 درجة (20 درجة - 90 درجة) في نهاية المتابعة. تحسن متوسط درجة ماليت العالمية من 11.6 ± 1.07 (تتراوح من (10 إلى 13) قبل الجراحة إلى

17.5 ± 2.22 (مـــن 13 إلـــى 20) بعـــد الجراحـــة. كانـــت هنـــاك فـــروق ذات دلالـــة إحصـــائية بـــين متوســـط متوســـط الـــدوران الســـلبي ودرجـــة ماليـــت قبـــل وبعـــد الجراحـــة. وكانـــت نتيجـــة متوســـط الـــدوران الخـــارجي الســـلبي و متوســـط الـــدوران الخـــارجي النشـــط ودرجـــة ماليـــت أعلـــى بـــين المجموعـــة المصـــابة بإصـــابة جزئيـــة مـــن الإصـــابة الكاملـــة ولكـــن مـــع عـــدم وجـــود فـــروق ذات دلالـــة إحصـــائية و لـــم تكـــن هنـــاك مضـــاعفات أثنـــاء العمليـــة أو بعـــد العملية الجراحية.

الاســـتنتاج: يعـــد تحريـــر الجـــزء الســـفلي المعـــزول إجـــراءً ســـهلاً وفعـــالاً وآمنًـــا عنـــد الأطفـــال الصـــغار الـــذين يعـــانون مـــن التقريـــب الكتفـــي - تقلـــص الـــدوران الـــداخلي بســـبب شـــلل الضـــفيرة العصـــبية العضـــدية الحـــادث أثنـــاء الـــولادة و يحســـن التبعيـــد والـــدوران الخـــارجي ولكـــن لـــيس لـــه تـــأثير إحصـــائي كبيـــر على الدوران الداخلي.

الكلمـــات الدالـــة: شـــلل الضـــفيرة العصـــبية العضـــدية، تقلـــص مفصـــل الكتـــف في وضع التقريب و الدوران، تحرير تحت الكتف، المنظار الجراحي.