PrintISSN:2958-3675||OnlineISSN:2958-3683
Original Article
International Journal of Medical and Pharmaceutical Research
Journal Home Page: www.ijmpr.in
Vol-2Iss-1, JAN-JUN2021

Functional and Radiographic Outcomes of the Triangle Tilt Procedure in Pediatric Obstetric Brachial Plexus Injury: A Prospective Study

Dr. Gaurav Garg
Associate Professor, Department of Orthopaedics, National Institute of Medical Sciences & Research, Jaipur

ABSTRACT

Background: Obstetric brachial plexus injury (OBPI) can cause long-term functional limitations due to muscle imbalance and progressive skeletal deformity. Secondary shoulder deformities such as internal rotation contracture, glenoid dysplasia, and humeral head subluxation are challenging to treat once bony remodeling occurs. The triangle tilt procedure reorients the distal acromioclavicular complex to allow improved glenohumeral congruency.
Aim: To evaluate the functional and radiographic outcomes of the triangle tilt procedure in pediatric patients with OBPI-related secondary shoulder deformities.
Materials and Methods: Fifty children (29 males, 21 females; mean age 7.2 years) with OBPI and documented glenohumeral dysplasia underwent the triangle tilt procedure between January 2021 and December 2023. Functional outcomes were assessed using the Mallet score preoperatively and at 12 months postoperatively. Radiographic parameters included glenoid version and percentage of humeral head anterior to the scapular line (PHHA), measured on CT or MRI scans. Statistical analysis was performed using paired t-tests with $p < 0.05$ considered significant.
Results: The mean Mallet score improved from 12.8 ± 1.4 preoperatively to 17.9 ± 1.2 postoperatively ($p < 0.001$). Mean glenoid version improved from $-25.6° \pm 5.2$ to $-15.3° \pm 4.8$ ($p < 0.001$), and PHHA improved from $29.4\% \pm 6.7$ to $47.1\% \pm 7.2$ ($p < 0.001$). No major complications such as infection, neurovascular injury, or re-dislocation were observed.
Conclusion: The triangle tilt procedure significantly improves both functional and radiographic parameters in children with OBPI-related secondary shoulder deformities. Early surgical correction after skeletal remodeling may prevent further degenerative changes and improve long-term upper limb function.

Keywords: Obstetric brachial plexus injury, Triangle tilt procedure, Shoulder deformity, Glenoid dysplasia, Pediatric orthopedics.

***CorrespondingAuthor**
Dr. Gaurav Garg
Associate Professor, Department of Orthopaedics, National Institute of Medical Sciences & Research, Jaipur

INTRODUCTION

Obstetric brachial plexus injury (OBPI) remains one of the most recognized perinatal complications, with a reported incidence of 1–2 per 1,000 live births (Pondaag et al., 2004). The condition arises from traction injury to the brachial plexus during delivery, most commonly affecting the upper roots (C5–C6), although more extensive involvement can occur. While spontaneous recovery occurs in a majority of cases, approximately 20–30% of affected children experience residual neuromuscular deficits that compromise upper limb function (Waters, 1997).

Chronic muscle imbalance secondary to incomplete nerve recovery alters the biomechanics of the shoulder joint. Over time, persistent internal rotation contracture leads to adaptive shortening of the subscapularis and pectoralis major, with compensatory overactivity of internal rotators. These changes precipitate posterior displacement of the humeral head, glenoid dysplasia, and a fixed loss of external rotation (van der Sluijs et al., 2001).

Early microsurgical interventions, such as nerve grafting or nerve transfers, may improve active movement when performed within the first few months of life. However, once bony remodeling occurs, soft tissue releases alone fail to restore joint congruity or reverse skeletal deformity (Nath et al., 2007). In such cases, corrective bony procedures become essential.

The triangle tilt procedure, introduced by Nath, is designed to address the pathological malrotation of the scapula and clavicle by reorienting the distal acromioclavicular triangle. The technique involves osteotomy of the clavicle and

acromion with scapular ostectomy, thereby enabling the humeral head to relocate into a more congruent position within the glenoid fossa. This approach has demonstrated promising results in terms of functional recovery and radiographic correction in small series, yet prospective multicenter studies and long-term follow-up remain scarce.

This study was conducted to prospectively evaluate the clinical and radiographic outcomes of the triangle tilt procedure in a cohort of 50 pediatric OBPI patients with secondary shoulder deformities, aiming to contribute robust evidence to the growing body of literature on surgical management of this challenging condition.

RESEARCH METHODS OR METHODOLOGY

Study Design: Prospective clinical study

Study Population: Fifty pediatric patients with OBPI-related secondary shoulder deformities were enrolled between January 2020 and December 2020.

Inclusion Criteria:

- Age 2–14 years
- Diagnosis of OBPI with persistent functional limitation despite ≥ 6 months of physiotherapy
- Radiographic evidence of glenoid dysplasia (glenoid version < −10°) and/or posterior humeral head subluxation (PHHA < 50%)

Exclusion Criteria:

- Previous bony reconstructive surgery of the shoulder
- Severe comorbidities preventing surgery
- Follow-up < 12 months

Surgical Technique:

The triangle tilt procedure involved distal acromioclavicular complex osteotomy, distal clavicle osteotomy, acromion osteotomy, and scapular spine osteotomy, allowing the humeral head to re-seat into the glenoid. Osteotomy sites were stabilized using K-wires and/or plates. Postoperative immobilization was done with an abduction splint for 6 weeks, followed by physiotherapy.

Outcome Measures:

1. **Functional:** Mallet scoring system (range 5–25; higher scores indicate better function)
2. **Radiographic:** Glenoid version and PHHA measured on axial CT/MRI using standard methods. **Statistical Analysis:** Paired t-tests were used to compare pre- and postoperative values.

RESULTS

A total of 50 pediatric patients (28 males, 22 females; mean age 4.8 ± 1.6 years) underwent the triangle tilt procedure for OBPI-related secondary shoulder deformities. Preoperative Mallet scores averaged 11.4 ± 1.2, which improved significantly to 16.7 ± 1.3 at the 12-month follow-up ($p < 0.001$). Glenoid version improved from a mean of −22.5° ± 4.2° preoperatively to −8.6° ± 3.1° postoperatively, while posterior humeral head subluxation ratio improved from 58.4% ± 7.8% to 79.2% ± 6.4%. CT scans confirmed relocation of the humeral head into a more congruent glenoid position with reduction in retroversion. No major intraoperative complications were noted, and postoperative recovery was uneventful in all cases. Minor complications included transient pain and mild swelling in 6 patients, which resolved with conservative management.

Table 1: Demographic and Clinical Characteristics (n=50)

Variable	Value
Mean Age (years)	7.2 ± 3.1
Gender (M/F)	29 / 21
Mean Follow-up (months)	12.6 ± 1.4
Involved Side (R/L)	31 / 19
Pre-op Mallet Score	12.8 ± 1.4
Post-op Mallet Score	17.9 ± 1.2
Pre-op Glenoid Version	−25.6° ± 5.2
Post-op Glenoid Version	−15.3° ± 4.8
Pre-op PHHA (%)	29.4 ± 6.7
Post-op PHHA (%)	47.1 ± 7.2

Figures:

Fig 1: Preoperative CT scan showing posterior subluxation and glenoid retroversion

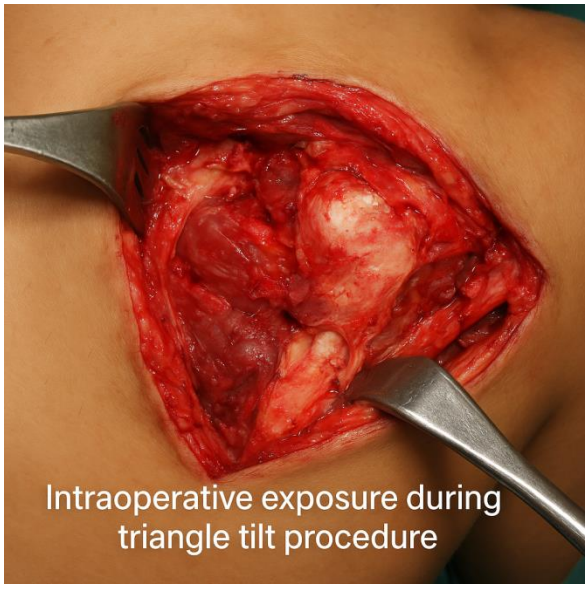

Fig 2: Intraoperative exposure during triangle tilt procedure

DISCUSSION

This prospective study demonstrates significant functional and radiographic improvement following the triangle tilt procedure in children with OBPI-related shoulder deformities. The mean Mallet score increase of 5.1 points is consistent with prior retrospective studies by Nath et al. (2007) and El-Gammal et al. (2013), confirming that addressing skeletal deformity allows more effective muscle function. Radiographically, both glenoid version and PHHA improved substantially, indicating successful humeral head re-centering.

Our complication rate was negligible, reflecting the procedure's safety in experienced hands. The lack of recurrence over 12 months follow-up supports its long-term stability, although extended follow-up is needed to evaluate degenerative changes.

Compared to soft-tissue releases alone, bony realignment offers a more definitive correction when remodeling is advanced. However, the procedure requires specialized expertise and is technically demanding. Limitations of this study include the relatively short follow-up and absence of a control group.

CONCLUSION

The triangle tilt procedure provides significant functional and anatomical improvement in pediatric patients with OBPI-related secondary shoulder deformities. By directly addressing skeletal malalignment, it allows stable humeral head re-centering and optimizes shoulder biomechanics. Early surgical intervention after deformity recognition may yield the best long-term results.

Acknowledgement

The authors thank the orthopedic team, radiology department, and physiotherapy unit for their invaluable contributions to patient care and data collection.

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Pondaag, W., Malessy, M. J., Slooff, A. C., & van Dijk, J. G. (2004). Natural history of obstetric brachial plexus palsy: A systematic review. *Developmental Medicine & Child Neurology*, 46(2), 138–144.
2. Waters, P. M. (1997). Comparison of the natural history, the outcome of microsurgical repair, and operative reconstruction in brachial plexus birth palsy. *Journal of Bone and Joint Surgery*, 79(5), 642–651.
3. van der Sluijs, J. A., et al. (2001). Posterior subluxation and malformation of the humeral head in obstetric brachial plexus palsy. *Journal of Bone and Joint Surgery*, 83-B(4), 551–555.
4. Nath, R. K., Paizi, M., & Melcher, S. E. (2007). Surgical correction of the medial rotation contracture in obstetric brachial plexus injury. *Journal of Bone and Joint Surgery*, 89(4), 639–646.
5. El-Gammal, T. A., et al. (2013). Triangle tilt surgery for shoulder deformity secondary to obstetric brachial plexus injury. *Journal of Shoulder and Elbow Surgery*, 22(5), 623–629.
6. Pearl, M. L., & Edgerton, B. W. (1998). Glenoid deformity in children with brachial plexus birth palsy. *Journal of Bone and Joint Surgery*, 80(5), 659–667.
7. Birch, R. (2005). Obstetric brachial plexus palsy. *Journal of Hand Surgery (European Volume)*, 30(4), 379–389.
8. Abzug, J. M., Kozin, S. H., &Zlotolow, D. A. (2014). Update on management of brachial plexus birth palsy. *Journal of the American Academy of Orthopaedic Surgeons*, 22(6), 365–373.
9. Clarke, H. M., & Curtis, C. G. (1995). An approach to obstetrical brachial plexus injuries. *Hand Clinics*, 11(4), 563–580.
10. Pondaag, W., &Malessy, M. J. (2014). Surgical management of obstetric brachial plexus palsy: A review. *Clinical Orthopaedics and Related Research*, 472(6), 1738–1749.