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Complications of TOS surgery: A Systematic Review and Meta-analysis

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Abstract

The thoracic outlet is defined as the interval from the supraclavicular fossa to the axilla that passes between the clavicle and the first rib. The thoracic outlet includes the subclavian artery, subclavian vein and trunks of the brachial plexus. Patients may experience symptoms related to compression of any one or various combinations of these structures. To review the clinical and radiological outcome after surgical treatment of neurogenic thoracic outlet syndrome**.** We searched for potentially eligible titles and on various electronic databases, MEDLINE (through PubMed), EMBASE, SCOPUS, Google Scholar, using appropriate keywords. The keywords used included: thoracic outlet syndrome - Transaxillary resection - The supraclavicular approach - The posterior approach - thoracic outlet decompression - anterior scalene muscle- brachial plexus- compression neuropathy-Treatment strategy. The study found that the complication rate for surgical complications was 22.5% for Trans Axillary First Rib Excision (TAFRE), 25.9% for Supraclavicular First Rib Excision (SCFRE), and 12.6% for Supraclavicular Release *(*SCR), with pleural injury/pneumothorax and temporary neurological injury being the most common. Wound infection rates were 0.68% for TAFRE, 0.26% for SCFRE, and 0.18% for SCR. One death was reported in the TAFRE and SCFRE groups, while no reoperation or death was reported in the SCR group. The study reveals that Rib-Sparing Scalenectomy (RSS) is a suitable surgical approach for treating neurogenic thoracic outlet syndrome, with better outcomes compared to First Rib Resection.

Keywords: Thoracic; RSS; TAFRE.

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1. Introduction

Thoracic outlet syndrome (TOS) is a heterogeneous group of disorders characterized by compression of, and/or damage to, the neurovascular structures at the thoracic outlet, i.e., the passage from the chest into the neck. One or more anatomic structures of the upper thoracic outlet may be affected (the brachial plexus, the subclavian artery, and/or the subclavian vein). There are a variety of causes for compression of, and damage to, these structures [1]**.** The thoracic outlet is defined as the interval from the supraclavicular fossa to the axilla that passes between the clavicle and the first rib. The classic distinction is between arterial (aTOS), venous (vTOS), and neurogenic thoracic outlet syndrome (nTOS). In large case series from the USA, for example, in a prospective analysis of outpatient cases at the University of South Florida, the percentage of nTOS was 82% [2]. The patients who underwent TOS surgery was 82–85% and whose TOS was classified by the uniform standards of the Society for Vascular Surgery had nTOS. The percentage of women among nTOS patients ranged from 59% to 95%. The accurate determination of the incidence and prevalence of nTOS presents a methodological challenge [3]**.** The aim of this study was to review clinical and radiological outcome after surgical treatment of neurogenic thoracic outlet syndrome.

2. Patients and Methods

This study a systematic review and meta-analysis was conducted in Orthopedic Surgery Department, Zagazig University Hospitals. We searched for potentially eligible titles on various electronic databases, MEDLINE (through PubMed), EMBASE, SCOPUS, and Google Scholar, using appropriate keywords. The keywords used included: thoracic outlet syndrome - Trans axillary resection - The supraclavicular approach - The posterior approach - thoracic outlet decompression - anterior scalene muscle- brachial plexus- compression neuropathy-Treatment strategy.

2.1. Inclusion criteria

All case reports, case series, and clinical studies in the form of full-text papers about operative management of nTOS in the English literature. All evidence levels included.

2.2. Exclusion criteria

The exclusion criteria were are unrelated, duplicated, unavailable full texts (abstract-only papers); and biomechanical studies, reports of patients who were younger than 18 years, venous thouracic outlet syndrome, arterial thoracic outlet syndrome and non-English literature.

2.3. Data extraction

We entitled data collection from included full-texts in a structured extraction excel sheet: Including: general information (author, title, type of publication, country of origin, etc.), study characteristics (e.g. aims of study, design, randomization techniques, quality assessment or risk of bias, etc.), participant characteristics (number of patients, age, gender, mechanism of injury, associated injuries, neurological deficits, etc.), intervention and treatment modalities, complications of surgery, follow-up time and outcomes.

2.4. Assessment of quality

It used checklists that are preferable over quality scores to determine the methodological quality of the studies.

2.5. Data analysis

The results of data analysis are shown in a forest plot and funnel plot. Administrative design: The study protocol was submitted for approval by Zagazig University Institutional Review Board (IRB).

3. Results and discussion

3.1. Result

Of 10 studies reviewed, 5 described SCFRR (812 patients), 3 described TAFRR (478 patients), and 2 described RSS (720 patients). Of the included studies, 4 were retrospective series, 6 were prospective series, and 0 was a randomized controlled trial. The National Institutes of Health Quality Assessment Tool for Case Series Studies was used for the evaluation of risk of bias for retrospective studies. Accordingly, all of these had "good "quality. This did not imply that these retrospective studies were high quality when compared to prospective studies. Age and follow-up time varied among studies and between groups (Table 1). The proportions of female participants vary across the studies. The gender distribution in these studies is crucial for understanding potential gender-related factors and biases that might impact the generalizability of their findings.the duration of symptoms vary across the studies and it is crucial in assessing the chronicity and potential impact on surgical outcomes in each study (Table 2). Few studies reported the interventions used to manage the complications, which is essential to grading and quantification of severity of surgical complications. Therefore, we did not perform a formal statistical analysis. According to the available data, the complication rate was 22.5% for TAFRE, 25.9% for SCFRE, and 12.6% for SCR. Pleural injury/pneumothorax and temporary neurological injury were the most frequently reported complications. The reported Wound infection rate was 0.68% for TAFRE, 0.26% for SCFRE and 0.18% for SCR. One death due to hemorrhage and 1 without apparent reason were reported in the TAFRE group (0.04%) and the SCFRE group (0.07%), respectively. Neither reoperation nor death was reported in the SCR group (Table 3).

- ***CBSQ scores***

The mean difference between preoperative and postoperative CBSQ scores could be calculated only for the SCFRR group: 34.99 (95% CI, 22.57, and 47.4). The difference between preoperative and postoperative values was statistically significant (P <.05). The 95% prediction interval calculated using SMD was −1.3 to 3.7.

- ***VAS scores***

The mean difference between preoperative and postoperative VAS scores was as follows: SCFRR 3.0 (95% CI, 2.1, and 3.8) and TAFRR 5.3 (95% CI, 3.6, and 6.9). Difference between the groups was statistically significant (P <.05). The 95% prediction interval calculated using the SMD was −1.4 to 4.3.

3.2. Discussion

Traditionally, nTOS is managed initially nonoperatively using physical therapy and muscle relaxant medications. Ultrasound-guided botulinum toxin injections and nerve blocks with local anesthesia have demonstrated efficacy for temporizing pain and for diagnostic purposes, particularly in predicting a patient's response to surgery. If nonsurgical approaches fail, surgical management for nTOS is used and may include decompression of the affected brachial plexus via scalenectomy alone or in combination with excision of the first rib or a cervical rib [13]. Many studies have included adolescent and elderly patients, but the exact distribution of ages often was not been reported. Therefore, we could not do a meta-analysis that separated outcomes by age groups, which could explain some of the heterogeneity in our results. In this systematic review and meta-analysis, weighted averages for age were 34.6, 40.5, and 33 years for SCFRR, TAFRR, and RSS, respectively. It is reasonable to speculate TAFRR's higher preoperative and postoperative DASH scores were due partly to an older patient population. [4] Reported that adolescent patients with an average age of 17.3 years had more favorable outcomes after SCFRR than adults with a thaverage age of 40.0 years.

Many studies varied in their time to follow-up after surgery, limiting our ability to compare all studies at an exact time. Although most studies reported outcomes within 1 to 2 years, believe that this method did not significantly hinder our results. This claim is supported by Pesser et al. [14] who reported outcomes at 3, 6, 12, and 24 months; their study found that patient outcome scores plateau after 6 months. Their reported outcome scores at 6 versus 24 months varied only slightly. Our study show that complication rate was 22.5% for the TAFRE, 25.9% for SCFRE, and 12.6% for SCR. Pleural injury/pneumothorax and temporary neurological injury were most frequently reported complications. The reported Wound infection rate was 0.68% for the TAFRE, 0.26% for SCFRE and 0.18% for SCR. One death due to hemorrhage and 1 without apparent reason reported in the TAFRE group (0.04%) and the SCFRE group (0.07%), respectively. Neither reoperation nor death was reported in the SCR group. Our study had similar findings with a higher rate of complications for TAFRR followed by the SCFRR and RSS.

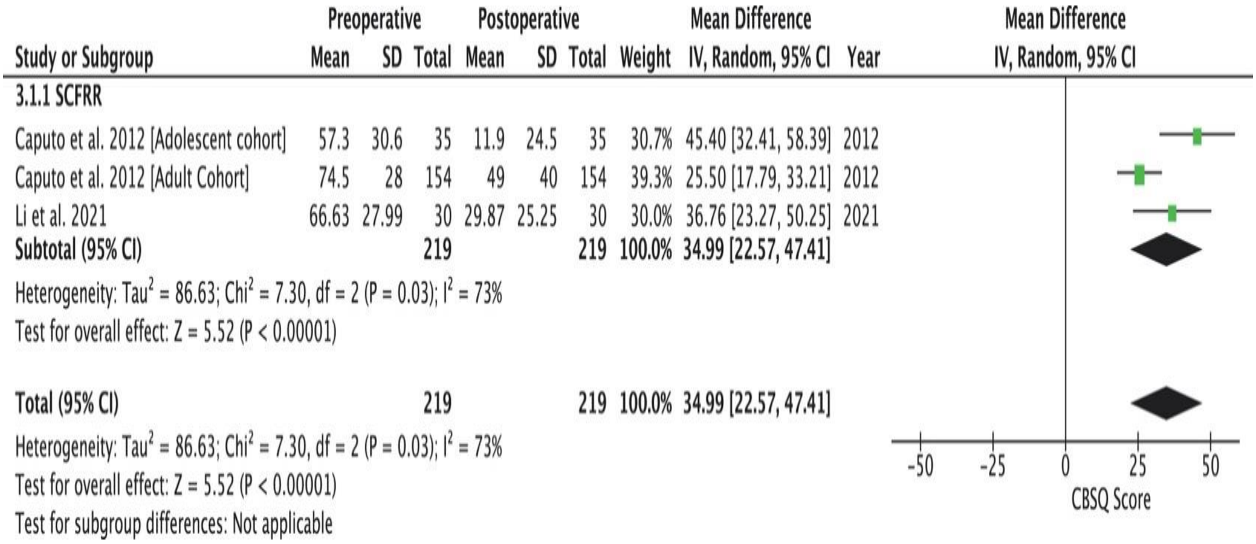

Figure (1): Forest plot showing preoperative, postoperative and interval change (mean difference) for CBSQ score in the SCFRR group: 34.99 (95% CI, 22.57, 47.4). Difference between preoperative and postoperative values was statistically significant (P <.05). The 95% prediction interval calculated using SMD was −1.3 to 3.7

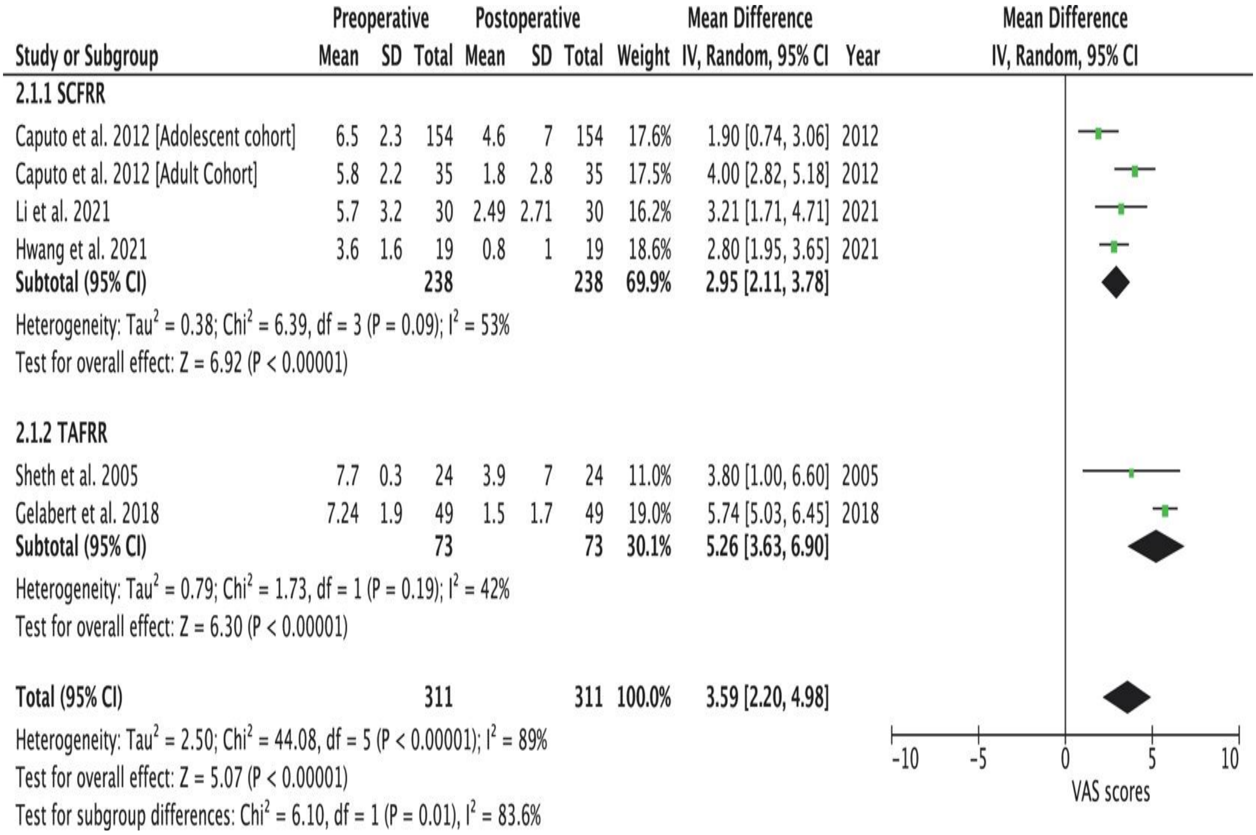

Figure (2): Forest plot showing preoperative, postoperative and interval change (mean difference) for VAS. Mean difference was as follows: SCFRR, 2.95 (95% CI, 2.11, and 3.78) and TAFRR 5.26 (95% CI, 3.6, and 6.9). The difference between groups was statistically significant (P <.05). The 95% prediction interval calculated using the SMD was −1.4 to 4.3.

Table (1): Demographics Based on Surgical Approach

Surgical Approach	NO. of participants	Age			Proportion of woman			Follow-up (months)		
		mean	SD	Range	mean	SD	Range	mean	SD	Range
(SCFRR) supraclavicular FRR with scalenectomy	812	34.6	5.1	17.3-40.6	77%	6%	54-84%	15.2	17.8	3-44.4
(TAFRR) transaxillary first rib resection with scalenectomy.	478	40.5	2	35-41.8	79%	2.8%	77-84%	28.3	9.2	15-44.7
RSS	720	33.0	3.2	29-53	76%	4.3%	71-100%	14.5	13.6	4.5-102

Table (2): Duration of symptoms and gender

NO.	Study ID	mean duration of Symptoms	females	
			No	%
1	**Caputo et al. [4]**	36 months	147/185	79%
2	**Al Hashel et al. [5]**	2.3 year	96/136	71%
3	**Ohman et al. [6]**	36 months	339/409	83%
4	**Gelabert et al. [7]**	27 months	36/54	67%
5	**Balderman et al. [8]**	3.4 year	219/282	78%
6	**Johnson e al. [9]**	31 months	132/165	80%
7	**Dua el al. [10]**	22 months	9/15	60%
8	**Lie et al et al. [11]**	25 months	19/24	79%
9	**Hawng et al. [12]**	1.8 year	14/17	82%
10	**Guarrderma et al.,2021**	18 months	329/473	70%

Table (3): Reported complications of TOS surgery

	TAFRE	**SCFRE**	**SCR**
NO. of participants receiving surgery	**2,662 patients**	**1,523 patients**	**539 patients**
Pleural opened/pneumothorax	383 patients	287 patients	**25** patients
Temporary Neurological injury	101 patients	16 patients	**27** patients
Permanent Neurological injury	21 patients	2 patients	**0**
Wound infection	18 (1 reoperation)	4 (2 reoperations)	**1** patient
Hemorrhage	8 (4 blood transfusions)	5 (2 reoperations)	**0**
Death	1 (due to hemorrhage)	1 (no apparent reason)	**0**
Total complications	**600**	**394**	**68**
No .of Studies included for complications data	20	10	**10**

Yin et al. [15] used Bayesian analysis to estimate the subjective probability of success following different surgical techniques, with the assumption that success and complete relief rate followed a binomial distribution. For patients undergoing FRR, our meta-analysis further showed that SCFRR had better outcomes compared to TAFRR when assessed through Derkash scores and postoperative complication rate. However, changes in DASH and Visual Analogue Scale (VAS) scores were significantly better for TAFRR compared to SCFRR. Our results are comparable to a retrospective review performed by Aboul Hos et al. [16] showing that SCFRR and TAFRR offered comparable outcomes for patients with nTOS. Traditionally, TAFRR was used to expose target anatomical structures adequately (i.e., the anterior aspect of first rib) and for improved appearance. In our systematic review and meta-analysis could do only a meta-analysis using the DASH score in patients undergoing RSS? Interestingly, our findings were that articles describing SCFRR and TAFRR reported validated surgical outcomes (i.e., CBSQ, DASH) more frequently. These findings indicate a need for future studies to report the outcomes for RSS using well-validated PROM, such as nTOS index Hwang et al. (12).

4. Conclusion

In conclusion, this systematic review and meta-analysis provides valuable insights into the clinical and radiological outcomes following surgical treatment of neurogenic thoracic outlet syndrome (nTOS). Our analysis highlights that while the differences in postoperative CBSQ scores between surgical approaches were not statistically significant, Specifically, RSS emerged as a sufficient approach for treating nTOS, potentially offering an effective solution with reduced morbidity compared to First Rib Resection (FRR). Among the FRR approaches, supraclavicular FRR (SCFRR) demonstrated better outcomes than trans-axillary FRR (TAFRR), particularly in terms of Derkash scores and postoperative complications. However, TAFRR showed better improvement in DASH and VAS scores compared to SCFRR.

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