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Original article

Complications of first rib resection for thoracic outlet syndrome – A national registry study from Finland

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ABSTRACT

Many studies have described the frequency of short-term complications in patients undergoing first rib resection for thoracic outlet syndrome (TOS). The rate of long-term complications is less well known. 699 patients that had undergone first rib resection for TOS during 2004–2018 were identified from the Care Register for Healthcare in Finland. The prevalence of complications within 30 days and 1 year was analyzed. The prevalence of complications within 30 days was 9.8%, and complications occurred in 18.8% of the cases within 1 year. The rate of vascular and neural complications increased from 5.9% and 0.7% within 30 days to 10.3% and 2.7% within 1 year, respectively. Only a slight increase was seen in the rate of pneumo/chylothorax or infection. A follow-up of at least 1 year is prudent to detect all complications in patients undergoing first rib resection for TOS.

Level of evidence: III (Retrospective cohort study).

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Introduction

Operative treatment options for chronic thoracic outlet syndrome (TOS) after failed conservative treatment are open, mini-invasive or thoracoscopic first rib resection, scalenectomy or a combination of both [1,2]. Currently there is no randomized evidence to support the choice of the method of treatment and attempts to produce such evidence are complicated by a lack of universal diagnostic criteria [3]. Surgery for TOS seems to have increased during the past decade [4]. Possible perioperative complications of first rib resection include pneumothorax, subclavian vein or artery injury, brachial plexus injury (BPI), long thoracic nerve or intercostal nerve injury [5]. Iatrogenic brachial plexus injury is a catastrophic complication leading to causalgia, sensory deficits and weakness of hand muscles that can be the cause of severe depression or even suicide [6,7]. The rate of brachial plexus injury is variable with the most common site of injury of the brachial plexus being the T1 nerve root [8]. An early report of 668 operations for thoracic outlet syndrome operated between 1964 and 1987 reported the rate of brachial plexus injury

to be 2.6% [9]. The subspecialty training of the operating surgeon may play a role [9].

The rate of in-hospital complications is usually reported to be low with brachial plexus injury occurring in <1% and vascular complication in 1–2% of the cases [10]. Low rate of complications has been reported during the first postoperative month [9,11]. In a recent registry study of 1431 patients from the United States only 0.3% of patients experience nerve injury and 1.4% experienced bleeding requiring transfusion [12]. A large series of 770 operations reported no brachial plexus lesions [13]. The complication rate during the first postoperative month has been better studied than the long-term complication rate.

We conducted a comprehensive analysis of all complications that occurred during the initial year following first rib resection due to TOS using nationwide Finnish data.

Patients and methods

We analyzed all patients undergoing rib resection in Finland during 2004–2018 who were retrospectively recognized from the Care Register for Healthcare in Finland (CRHF): a national mandatory registry that includes all hospital admissions in Finland. The procedure was identified using the code GAE40 and

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Table 1
Diagnoses of benign and malign neoplasms warranting exclusion.

C40	Malignant neoplasm of bone and articular cartilage of limbs
C41	Malignant neoplasm of bone and articular cartilage of other and unspecified sites
C43	Malignant melanoma of skin
C44	Other and unspecified malignant neoplasm of skin
C47	Malignant neoplasm of other connective and soft tissue
C48	Malignant neoplasm of retroperitoneum and peritoneum
C49	Malignant neoplasm of other connective and soft tissue
C50	Malignant neoplasm of breast
C54	Malignant neoplasm of corpus uteri
C69	Malignant neoplasm of eye and adnexa
C73	Malignant neoplasm of thyroid gland
C81	Hodgkin lymphoma
C91	Lymphoid leukemia
D25.1	Leiomyoma of uterus
D48	Neoplasm of uncertain behavior of other and unspecified sites

the diagnosis was identified as G54.0. Data used to exclude cancers from the analysis was obtained from CRHF and the Finnish Cancer Registry. Mortality data was acquired from the national cause of death registry held by Statistics Finland. All patients with diagnosis of cancerous or non-cancerous tumors were excluded (Table 1). The 30 days and 1-year outcomes were all-cause mortality and reoperations (Table 2). The study was approved by the National Institute for Health and Welfare of Finland (permission no: THL/164/14.02.00/2021) and the Statistics Finland (TK-53-484-20). Patient consent was waived due to study design.

Statistical analysis

Differences between groups were studied by Pearson’s Chi squared test, Mann-Whitney U-test or Student’s T-test as appropriate. Binary logistic regression was used to identify predictors of complications. Event rates were described using the Kaplan-Maier curve. Results are given as mean, median, percentage, odds ratio (OR) with 95% CI, interquartile range (IQR) or SD as appropriate. P value <0.05 was inferred statistically significant. Analyses were conducted using SPSS version 27 (IBM).

Results

A total of 699 patients were included in the analysis. Of those patients, 40.5% (283) were male and 59.5% (416) were female. A complication within the first year was reported by 18.8% (111/699) of patients. The incidence of specific complications during the first 30 days after surgery and during the first year are shown in Table 3.

Table 2
Diagnostic codes (ICD-10) and procedure codes searched to determine complications.

Generic term	ICD-10 codes
Vascular injury	I72.1/I72.2/I74.9
Venous thromboembolism	I82.20/I82.80/I82.9
Neural complication	S14.3/S24.3/S44.3/T92.4
Pneumo./chylothorax	J93.0/J93.1/J93.9/J94.0/J94.2/S27.9/S27.2
Infection	T81.4
Chronic pain syndrome	M89.0
Other, unspecified	T81.1/T81.2/T81.8/T81.9/T88.8/T88.9

Generic term	Procedure code
Vascular injury	PAP07/PBA08/PBG08/PBG99/PBH08/PBH09/PBU99/PHC99/PHH99/PHJ99/PWA00
Venous thromboembolism	BPE09/BPE10/BPE11/PAE07/PAG07/PAH07/PBG08/PBG99/PBU99/PWA00/PWE00
Neural complication	ABC29/ABC29/ACA19/ACC58/ACC59
Pneumo-/chylothorax	GAA10/GAA40
Infection	QWA00/QWA10

Table 3
The incidence of adverse events among patients (N 699) undergoing first cervical rib resection for thoracic outlet syndrome during the first 30 days, and the first year.

Event	30 days	1 year
	% (N)	% (N)
Any complication	9.8 (58)	18.8 (111)
Vascular complication ^a	5.9 (35)	10.3 (61)
Venous thromboembolism	1.2 (7)	5.2 (31)
Neural complication	0.7 (4)	2.7 (16)
Pneumo./chylothorax	2.1 (12)	2.4 (14)
Infection	0.9 (5)	1.4 (9)
Chronic pain syndrome	-	0.8 (5)

^a Includes vascular injury, arterial thromboembolism, aneurysm. Excludes venous thromboembolism.

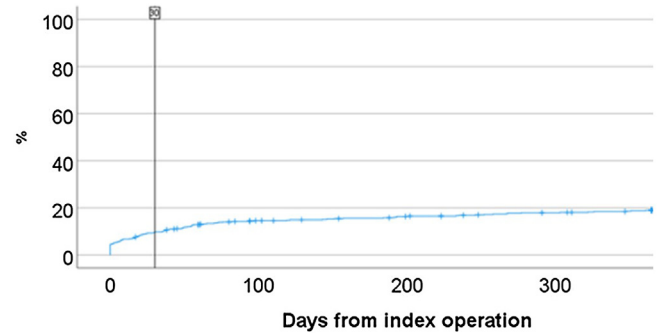


Fig. 1. Cumulative occurrence of complications after first thoracic rib resection for thoracic outlet syndrome.

Table 4
Comparison of patients with and without complications during the first 30 days.

Variable	All (N 699)	No complication (N 641)	Any complication (N 58)
Gender, Male	283	259	24
Age, mean ± SD	37.0 ± 12.5	36.8 ± 12.4	39.0 ± 13.3
CCI score, mean	0	0	0

SD, standard deviation; CCI, Charlson comorbidity index.

Fig. 1 shows the cumulative occurrence of complications after first rib resection for TOS. There were no deaths.

Charlson comorbidity index score was not associated with complications. Comparison of patients with and without complications during the first postoperative 30 days is given in Table 4.

Discussion

The main finding of this trial is that 1 out of 10 patients undergoing first rib resection undergo a clinically significant complication during the first post-operative month. This trend is similar to what is currently being reported in the literature [12,14]. What we found surprising was that up to 1 out of 6 patients develop a complication during the first postoperative year. Due to the devastating effect of many of these complications and their sequelae all patients considered for surgical treatment for TOS should receive adequate information regarding the risks related to this surgery. Our data shows a similar trend to the 8.6% complication rate during the first post-operative month that has been reported from the United States [12]. What we found interesting was that the complications almost doubled during the first post-operative year. There was a 2% increase in neural complications. Same increasing trend was seen in vascular complications such as venous thromboembolism, but no major increase in infection or pneumothorax occurred.

Although scalenectomy may be sufficient to alleviate symptoms in many cases, first rib resection remains a very common procedure for TOS patients [1–4,15]. Several recent studies have analyzed the complication rate of surgery on TOS during the first postoperative month, fewer studies have concentrated on the long-term prognosis [7,9,10,13]. Even studies with long-term follow-up do not necessarily report at what time point the complications were reported or have low attendance at follow-ups [2,7,16]. Most common complication is pneumothorax that can be present in up to ¼ cases if transaxillary approach is used [17].

Several factors may explain the delayed diagnosis of neural complications. Late complications may be caused by long term scar tissue formation and re-growth of rib ends. Traction injury of the brachial plexus is normally not detected during the procedure, and even sharp subtotal injuries may go undetected in case of poor visibility. In rare cases, an undetected Parsonage-Turner mono-neuritis of the brachial plexus may be the cause of persistent pain after brachial plexus surgery. The diagnosis of brachial plexus injury is notoriously difficult. Pain due to neural injury may be mistaken for post-operative pain. MRI imaging may be required for detection of insidious complications [18]. Electroneuromyography (ENMG) may be necessary to detect the injury or neuritis and may require the neurophysiologist to be well versed in the interpretation of ENMG in brachial plexus injuries. Sometimes even repeated ENMG examinations are needed. The significant incidence of neural complications diagnosed after the short-term postoperative follow-up period on the one hand suggests that early complications rates are an insufficient outcome measure and on the other hand gives a different outlook on success rates for surgical treatment of TOS. This is especially pertinent as patients and surgeons alike hope for good long term functional and symptomatic results.

This study has limitations. As in all registry studies, the risk of miscoding or the use of false codes exists. The registry data did not reveal if the operation was an open or a thoracoscopic procedure. The registry does not include the surgical subspecialty or the level of experience of the operating surgeon, so we cannot comment on the effect of training or subspecialty on complication rate [9]. The general diagnosis of TOS in the registry does not differentiate the subtypes of Willbourn classification (arterial, venous, neurogenic). No data was available regarding surgical approach (supra-/paracervical, transaxial or combined). The data on nerve injuries was unspecific and does not include the location of nerve injury within the brachial plexus or the type of nerve injury (axonotmesis or neurotmesis). The hospital registry does not include patient-rated outcome measures (PROMs) such as thoracic outlet syndrome index (TOSI) and we do not have data regarding how well the procedures ameliorated the neurogenic or vascular symptoms of TOS [19]. The observation infection or other complications after 30 days from the procedure does not necessarily mean that these complications developed a month after the procedure, but it can be considered that in some cases these complications give late symptoms or are noticed late. For statistics, we did use the Charlson comorbidity index that predicts 10-year survival for patients with a range of comorbidities [20].

Conclusion

In conclusion, at least one out of six patients undergoing first rib resection for thoracic outlet syndrome will experience a significant complication. Although most complications occur during the first few months after surgery, a follow-up period of six to twelve months is recommended for patients undergoing surgery for thoracic outlet syndrome to detect all possible adverse events and make better-informed decisions.

CRedit authorship contribution statement

All authors attest that they meet the current International Committee of Medical Journal Editors (ICMJE) criteria for Authorship.

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