

# Surgical management for thoracic outlet syndrome: A 5-year experience

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## RESUMEN

**Antecedentes.** El síndrome de salida torácica (SST) es una condición poco común causada por la compresión de las estructuras neurovasculares que pasan a través de la apertura torácica. Se puede clasificar en tres tipos de acuerdo con la compresión predominante, siendo neurogénica, venosa o arterial, dando un espectro clínico diferente. El diagnóstico se realiza mediante un examen minucioso y métodos de imagen. El estándar de oro diagnóstico es la resección de la primera costilla. **Objetivo.** Revisar la presentación, diagnóstico, manejo y complicaciones del tratamiento quirúrgico para el SST en un lapso de cinco años en el Hospital Médica Sur. **Material y métodos.** Estudio retrospectivo observacional de pacientes sometidos a manejo quirúrgico por SST en un periodo de cinco años, del 15 de junio 2010 al 16 de enero 2016. **Resultados.** Incluyó 28 pacientes sometidos a una resección transaxilar de primera costilla torácica como tratamiento para el síndrome de salida de tórax. De los 28 pacientes, 39.2% presentó componente nervioso, 35.7% componente arterial y sólo 25.1% componente venoso. 82.2% pacientes eran mujeres. La edad media fue 44 años. Los síntomas más frecuentes fueron parestesias (82.14%), dolor (75%), debilidad (46%), edema (35%) y cambios en la coloración de la extremidad (32%). **Conclusiones.** El SST es una patología de espectro clínico muy variado, el retraso en el diagnóstico lleva a una pérdida importante de recursos y persistencia de los síntomas. En nuestro centro se observó una demografía similar a la reportada en otros estudios, pero con una morbimortalidad menor.

**Palabras clave.** Síndrome de salida torácica/Cirugía. Síndrome de salida torácica/Fisiopatología. Costilla cervical. Costillas/cirugía.

## ABSTRACT

**Introduction.** Thoracic outlet syndrome (TOS) is an uncommon condition caused by the compression of the neurovascular structures passing through the thoracic inlet. It can be categorized into three distinct types, neurogenic, venous and arterial; each type having a different clinical spectrum. The diagnosis is made by a meticulous examination and confirmation by non-invasive imaging methods. The gold standard for diagnosis is the first rib resection (FRRS). **Objective.** To review clinical presentation, diagnosis, management and complications of the surgical treatment for TOS within five years of experience in a private hospital in Mexico City. **Material and methods.** This is an observational retrospective study of all consecutive patients who underwent surgical treatment for TOS over a period of five years, between June 15, 2010, and January 16, 2016. **Results.** Twenty-eight patients who underwent trans axillary resection of the first thoracic rib for treatment of thoracic outlet syndrome were included. Of the 28 patients, 39.2% had a neural component, 35.7% an arterial component, only 25.1% patients had a venous component. 82.2% of the patients were female. The average age at diagnosis was 44 years old. The symptoms most often presented were paresthesia (82.14%), pain (75%), weakness or paresis (46%), edema (35%) and discoloration of the affected limb (32%). **Conclusions.** TOS is a disease with a wide clinical spectrum of symptoms depending on the affected component. Delay in diagnosis leads to significant loss of health care resources and persistence of symptoms. Our center shows a similar demography to that reported in other studies, but with lower associated morbidity and mortality.

**Key words.** Thoracic outlet syndrome/surgery. Thoracic outlet syndrome/physiopathology. Cervical rib, ribs/surgery.

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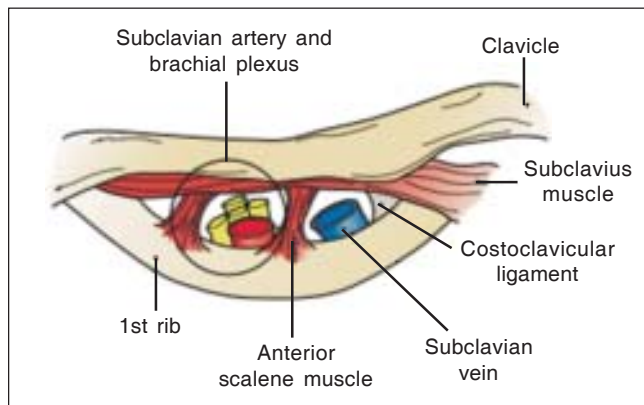
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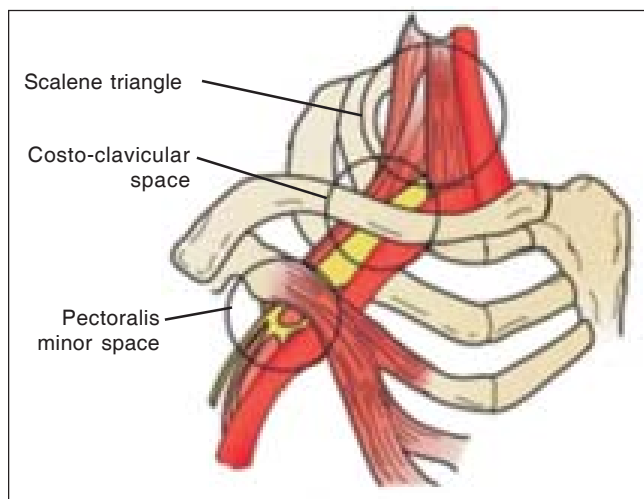
## BACKGROUND

The thoracic outlet syndrome (TOS) is an uncommon condition caused by the compression of the neurovascular structures passing through the thoracic inlet;<sup>1</sup> a compact anatomic space, enclosed by bone ligaments and muscles.<sup>1,4</sup> It can be categorized into three different types, resulting in a different clinical spectrum: neurogenic, venous and arterial; these according to the predominant compression of the roots of the brachial plexus, subclavian vein or subclavian artery<sup>2</sup> (Figure 1).

NTOS accounts for about 95% of TOS cases.<sup>3</sup> Symptoms include pain, weakness, numbness, and tingling of the upper extremity; however, it is often underdiagnosed because of the ambiguity of the symptomatology<sup>5</sup> (Figure 2).



**Figure 1.** Costoclavicular space.



**Figure 2.** Anatomy of the thoracic outlet area with the three major spaces.

On the other hand, VTOS occurs after a thrombosis and/or the intermittent compression of the subclavian vein, otherwise known as Paget-Schroetter syndrome and McCleery syndrome, respectively; patients with venous TOS often present an acute episode of pain, unilateral arm swelling, blue discoloration, and collateral veins.<sup>6</sup>

Furthermore, ATOS is the least frequent subtype (1-5% of all TOS cases); it is the most severe due to damage to the arterial wall, eventually causing distal embolization and limb-threatening secondary ischemia.<sup>7,8</sup>

The incidence of TOS is three times more frequent in women than in men.<sup>7</sup> Also, anatomic predispositions such as cervical ribs and extrinsic factors like chronic repetitive movements or trauma may result in TOS.<sup>9-11</sup>

The clinical integration of this syndrome and a complete physical examination are important, however, diagnosing TOS requires identification of a direct source of compression by an imaging method such as a simple computed tomography (CT) or with IV contrast, nerve conduction velocity test, a duplex ultrasound or a magnetic resonance imaging (MRI).<sup>12-14</sup>

The treatment depends solely on the type of TOS, however, many patients are able to get relief without surgical intervention, being surgical decompression procedures the resolution if less invasive treatments are not successful.<sup>15,16</sup>

FRRS is considered the optimal treatment of TOS patients who fail to respond to conservative management, bilateral FRRS has not yet been explicitly supported by the literature.<sup>16,17</sup>

The overall morbidity rate in published series ranges from 7 to 40%, with pleural entry and transient brachial plexus injury being most frequent.<sup>18</sup>

## OBJECTIVE

Review the presentation, diagnosis, management and complications of the surgical treatment for TOS within five years of experience in a private hospital in Mexico City.

## MATERIAL AND METHODS

This is a retrospective study of all consecutive patients who underwent surgical treatment for TOS over a period of five years, between June 15, 2010, and January 16, 2016.

The variables assessed were age, sex, symptoms onset, symptoms exhibited, affected side, type of affection (nervous, arterial or venous), imaging diagnosis method (angiography, MRI, duplex ultrasound, CT scan with IV

contrast and nerve conduction velocity test), time between the onset of symptoms and surgery, anatomical changes, surgical complications, mortality and length of hospital stay.

Clinical records and diagnostic images were reviewed from the archives of Medica Sur Hospital, performing later on a descriptive analysis. Patients with incomplete data were excluded. Every patient in the study had to have clinical diagnosis and corroboration by at least one imaging method; as well, their procedures must have been performed by one of three different vascular surgeons, all members of the Medica Sur medical society.

The diagnoses of the different types of TOS were performed depending on the clinical presentation, physical

examination maneuvers and ruling out any other cause of symptoms prior to the surgery.

## RESULTS

Between June 15th, 2010 and January 16th, 2016, a total of 28 patients underwent trans-axillary FRRS, secondary to thoracic outlet syndrome; all procedures were performed by one of three different vascular surgeons in Medica Sur Hospital in Mexico City, Mexico.

Of the 28 patients included, 11 (39.2%) had neural component, 10 (35.7%) arterial component and 7 (25.1%) venous component.

The average age was 44 years and the ages were between 22 and 61 years. Twenty-three (82.2%) of the 28 patients were female (Table 1).

The time between the onset of TOS symptoms and the surgery had an average of 30 months in general, being the group of patients with neural component the one with the longest interval, with an average of 47.18 months, followed by patients with arterial and venous component with an average of 19.2 months and 21.5 months respectively.

The symptoms presented by patients were paresthesia of the affected arm (82.14%), followed by pain (75%), weakness or paresis of the affected limb (46%), edema (35%) and changes in color of the extremity (32%) (Table 2).

The imaging test used the most to confirm the diagnosis was the duplex ultrasound used in 92% of patients, followed by angiography in 25% and nerve conduction velocity test in 21.4%.

At the time of surgery, 85.7% of the patients had neurological symptoms (paresthesia or paresis of the affected arm).

74% of the FRRS were performed on the right side, and only five of the 28 patients in the study (17.8%) had a first cervical rib. The average postoperative hospital stay was 4.7 days, being the overall morbidity presented in our

**Table 1.** Demographics and presentation.

Total, n = 28	n (%)
Age at Surgery, median (range), years	44.5 (22-61)
Female	23 (82.2)
Male	5 (17.8)
TOS subtype	
Neurogenic TOS	11 (39.2)
Arterial TOS	10 (35.7)
Venous TOS	7 (25)
Smokers	14 (50)
Onset symptom	
Paresthesia	12 (42)
Pain	11 (39.2)
Edema	4 (14.2)
Weakness	1 (3.5)
Diagnostic imaging	
Ultrasound	26 (92)
Angiography	7 (25)
Nerve conduction velocity	6 (21.4)
Magnetic resonance imaging (MRI)	5 (17.8)
Tomography	3 (10.7)

TOS: thoracic outlet syndrome.

**Table 2.** Clinical presentation.

Symptoms exhibited	Total n (%)	NTOS n (%)	ATOS n (%)	VTOS n (%)
Patients (n)	28	11	10	7
Edema	10 (35.7)	1 (9)	3 (30)	6 (85.7)
Changes in color	9 (32.14)	2 (18.1)	2 (20)	5 (71.4)
Pain	21 (75)	7 (63)	8 (80)	6 (85.7)
Paresthesia	23 (82.14)	10 (90.9)	10 (100)	3 (42.8)
Weakness	13 (46)	9 (81.8)	3 (30)	1 (14.2)
Paresthesia or weakness	24 (85.7)	10 (90.9)	10 (100)	4 (57.4)
Time of presentation, average months	30	47.18	21.5	19.2

**Table 3.** Surgical morbidity.

	NTOS n = 11	ATOS n = 10	VTOS n = 7	Total n = 28
Affected side				
Right	72.7%	80%	57.1%	20 (71.4)
Left	27.2%	20%	42.8%	8 (28.5)
Cervical Rib	60%	40%	0	5 (17.8)
Complications				
Pneumothorax	0	2	1	3 (10.7)
Hemothorax	1	0	0	1 (3.5)
Hematoma	0	0	0	0
Overall morbidity				14.2
Mortality	0	0	0	0
Postoperative hospital stay, average days	4.0	4.8	5.8	4.7

NTOS: neurogenic thoracic outlet syndrome. VTOS: venous thoracic outlet syndrome. ATOS: arterial thoracic outlet syndrome.

institution for this procedure 14.2%, being pneumothorax the most common complication with an incidence of 10.7%, however, no major complications or deaths were observed in this group of patients (Table 3).

## DISCUSSION

TOS is a rare disease often under-diagnosed because of the delay in the correct identification and therefore treatment of the syndrome, generally established after many other possible conditions were treated without favorable results. The misdiagnoses and their treatments lead to the loss of a large amount of economic resources; NTOS accounting for most health care costs in this group.

In the population analyzed in this study the most present symptom was weakness and numbness of the affected limb. In the venous thoracic outlet syndrome (VTOS) where we report the shortest time between the onset of symptoms and surgical treatment, we believe that the existence of edema, pain, and swelling of the affected arm is what led patients to seek specialized medical attention which sped the time of diagnosis and thus the treatment.

The management of this condition is very diverse and with different results because it depends mainly on the affected component (nervous, arterial or venous), that is why it is important to differentiate between these; being one of the most useful therapeutic options the FRRS.

In our institution we have observed the same demographics than the worldwide population, being women between 20 and 50 years the most affected. There is a preponderance of the right side, making believe in the

importance of occupational component of this disease and to a lesser extent the anatomical component such as the presence of a first cervical rib.

While there is great controversy over the selection of patients undergoing conservative or surgical management as a first option, multiple series indicate an improvement of symptoms in over 90% of cases posterior to a FRRS.

Although this procedure requires an extensive knowledge of the surgical technique due to the proximity of vascular structures and the pleural cavity on which it operates, our institution has a morbidity of 10.7% which is much lower than that reported in multiple series<sup>2,3</sup> for this process that ascends to 40%, likewise our hospital mortality was zero.

## CONCLUSION

In conclusion, TOS is a complex entity that represents a diagnostic challenge because of its wide spectrum of symptoms that are dependent on the affected component, and because of the lack of established criteria there is a significant delay in its diagnosis and management.

The treatment for this syndrome has evolved over time, currently being the FRRS the procedure that has shown excellent results in a high percentage of cases. Our center shows a similar demography to that reported in other studies, but with lower morbidity and mortality.<sup>2,3</sup>

## ABBREVIATIONS

- **ATOS:** arterial thoracic outlet syndrome.
- **CT:** computed tomography.

- **FRRS:** first rib resection.
- **MRI:** magnetic resonance imaging.
- **NTOS:** neurogenic thoracic outlet syndrome.
- **TOS:** thoracic outlet syndrome.
- **VTOS:** venous thoracic outlet syndrome.

#### REFERENCES

1. Grunebach H, Arnold MW, Lum YW. Thoracic outlet syndrome. *Vascular Medicine* 2015; 5: 493-5.
2. Urschel HC, Kourlis H. Thoracic outlet syndrome: a 50-year experience at Baylor University Medical Center. *Proc (Bayl Univ Med Cent)* 2007, 20: 125-35.
3. Marine L, Valdes F, Mertens R, Kramer A, Bergoing M, Urbina J. Arterial thoracic outlet syndrome: A 32-year experience. *Ann Vasc Surg* 2013; 27: 1007-13.
4. Hooper TL, Denton J, McGalliard MK, Brismee JM, Sizer PS Jr. Thoracic outlet syndrome: a controversial clinical condition. Part 1: anatomy, and clinical examination/diagnosis. *J Man Manip Ther* 2010; 18:74-83.
5. Brooke B, Freischlag JA. Contemporary management of thoracic outlet syndrome. *Curr Opin Cardiol* 2010; 25: 535-40.
6. Orlando MS, Likes KC, Mirza S, Cao Y, Cohen A, Lum YW, Reifsnnyder T, et al. A decade of excellent outcomes after surgical intervention in 583 patients with thoracic outlet syndrome. *J AM Coll Surg* 2015; 220: 934-9.
7. Sanders RJ, Hamond SL, Rao NM. Diagnosis of thoracic outlet syndrome. *J Vas Surg* 2007; 46: 601-4.
8. Patton GM. Arterial thoracic outlet syndrome. *Hand Clin* 2004; 20: 107-11.
9. Chang KZ, Likes K, Davis K, et al. The significance of cervical ribs in thoracic outlet syndrome. *J Vasc Surg* 2013; 57: 771-5.
10. Erikson BR, Go MR, Vaccaro PS. Cervical rib causing occlusion of the subclavian artery and thoracic outlet syndrome. *J Vasc Med Surg* 2015; 3: 202-5.
11. Peet RM, Henriksen JD, Anderson TP, Martin GM. Thoracic-outlet syndrome: evaluation of a therapeutic exercise program. *Proceedings of the staff meetings. Mayo Clinic* 1956; 31: 281-7.
12. Fugate MW, Rotellini-Coltvet L, Freischlag JA. Current management of thoracic outlet syndrome. *Curr Treat Options Cardiovasc Med* 2009; 11: 176-83.
13. Gelabert HA, Machleder HI. Diagnosis and management of arterial compression at the thoracic outlet. *Ann Vasc Surg* 1997; 11: 359-66.
14. Howard M, Lee C, Dellon AL. Documentation of brachial plexus compression (in the thoracic inlet) utilizing provocative neurosensory and muscular testing. *J Reconstr Microsurg* 2003; 19: 303-12.
15. Chang DC, Rotellini-Coltvet LA, Mukherjee D, et al. Surgical interventions for thoracic outlet syndrome improves patient's quality of life. *J Vasc Surg* 2009; 49: 630-5.
16. Rochlin DH, Orlando MS, Likes KC, Jacobs C, Freischlag JA. Bilateral first rib resection and scalenectomy is effective for treatment of thoracic outlet syndrome. *J Vasc Surg* 2014; 60: 185-90.
17. Povlsen B, Hansson T, Povlsen SD. Treatment for thoracic outlet syndrome. *Cochrane Database Syst Rev* 2014; 11
18. Davidovic LB, Kostic DM, Jakovljevic NS, Kuzmanovic IL, Simic TM. Vascular thoracic outlet syndrome. *World J Surg* 2003; 27: 545-50.