

Article

# Infraclavicular first rib resection for decompression of venous thoracic outlet syndrome: a prospective cohort study

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**Abstract.** *Background:* McCleery syndrome is a form of venous thoracic outlet syndrome. This study aims to assess the technical success and the clinical outcome in term of symptoms resolution, complications and recurrence of the infraclavicular approach for decompression of venous thoracic outlet syndrome. *Methods:* A prospective cohort study at Alexandria University hospital run between August 2020 and January 2023 where patients presented with intermittent upper limb venous symptoms due to venous thoracic outlet syndrome were included to study. Only patients who had decompression via the infraclavicular approach were included in this article, data regarding the intervention and its outcome was collected and analysed to calculate the frequencies. *Results:* 15 patients (10 males) with mean age of 35 years (23 – 53 years) were recruited. All patients were diagnosed as McCleery syndrome. Eighty percent had right side presentation in the form of intermittent pain and swelling. Patients had first rib resection using the infra-clavicular approach with technical success of 100%. Complete resolution of symptoms was achieved in 100% of the study group after a secondary intervention. The symptoms resolution after the initial intervention was achieved in 93.3%. No perioperative complications or late recurrence were recorded. The mean follow-up duration was 8.6 months. *Conclusion:* Infraclavicular approach for first rib resection in venous thoracic outlet syndrome is safe and effective in the short term.

**Keywords:** Venous thoracic outlet syndrome, McCleery syndrome, pectoralis minor syndrome, first rib resection.

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## **Introduction**

Venous thoracic outlet syndrome (VTOS) consists of group of symptoms and signs that affect the upper limb of young active individuals whose activities involve repetitive overhead movement of the upper limb. The main pathology is compression of the axillary-subclavian vein mostly at the costoclavicular space or rarely under the pectoralis minor muscle producing venous pectoralis minor syndrome (VPMS). VTOS is a rare condition representing 3 % of all thoracic outlet syndromes. The main structures compressing the axillary-subclavian vein in the costo-clavicular space are the first rib (mainly the anterior half), the clavicle, the subclavius tendon and the costo-clavicular ligament.<sup>1,2</sup>

The most common presentations of VTOS include arm swelling (93% of patients), arm cyanosis (77% of patients), pain on exertion (66% of patients) and other symptoms and signs such as dilated veins over the shoulder or the chest wall (8% of patients). When the compression is intermittent and not associated with venous thrombosis, it is called McCleery syndrome. Patients who present with deep venous thrombosis (DVT) of the axillary-subclavian vein without evidence of secondary cause are called effort thrombosis or Paget- Schroetter syndrome (PSS).<sup>3</sup>

Decompression of the axillary-subclavian vein by first rib resection is an integral part in the management of VTOS. Different approaches have been described to achieve the decompression. In this article we focused on the infraclavicular approach.

## **Methods**

A prospective cohort study at Alexandria university hospital was conducted between August 2020 and January 2023 to assess the technical success and the clinical outcome in term of symptoms resolution, complications and recurrence of different interventions in patients with upper limb mechanical venous outflow obstruction. The study started after gaining approval from the ethics committee at Alexandria university in the 2020 July meeting. Patients aged more than 18 years old and presented with effort related upper limb venous complaint consistent with McCleery syndrome, Paget-Schroetter syndrome or post-thrombotic syndrome were all included in the original study however only the results of intervention in McCleery syndrome were included in this article. After confirmation of the diagnosis of McCleery syndrome by X-ray, dynamic venous doppler scan, magnetic

resonance venography (MRV), computerized tomography venography (CTV), diagnostic venogram or combined, patients were offered first rib resection via the infraclavicular approach. The data regarding interventions, its technical and clinical outcome were recorded prospectively and analysed by a statistician to calculate the frequencies.

## **Results**

Fifteen patients were recruited, 10 males (67 %) with a mean age of 35 years (range 23-53 years). Twelve patients (80%) had their presenting problem affecting the right upper limb. The main presenting complaint was intermittent pain or heaviness with or without arm swelling, cyanosis or venous collaterals over the shoulder. Hyperabduction of the arm was almost always associated with worsening of the pain. There was no previous history of deep venous thrombosis (DVT) or any history that can explain the cause of the symptoms e.g no previous trauma or fracture. Patients had X-ray of the thoracic outlet to rule out bony abnormalities and then dynamic venous and arterial doppler scan to rule out DVT and to detect signs of venous or arterial compression on abduction of the arm.

The patients had no DVT in their doppler scan. Instead, there were indirect signs of compression on abduction such as loss of phasic wave on respiration or increased velocity of blood flow in the arterial circulation. There was no confirmatory sign in the doppler scan for diagnosis of McCleery syndrome, hence patients were further investigated with cross sectional imaging (CTV/MRV) or direct upper limb venogram. Diagnosis of McCleery syndrome was confirmed if there was evidence of venous compression in the CTV, MRV or the venogram.

All patients were treated by decompression of the costoclavicular clavicular space by performing infraclavicular resection of the anterior half of the first rib with its associated subclavian tendon and costoclavicular ligament. All procedures were performed in a theatre with C-arm capability. On-table venogram was considered as an integral part of the operation where 18-gauge cannula was inserted in the basilic vein at the beginning of the operation. Venogram was done before and after the rib resection to confirm the complete decompression of the vein and to rule out any residual venous stenosis related to endoluminal web or fibrosis. Balloon venoplasty was required in two patients (13.3%) with residual stenosis more than 50%. All procedures successfully achieved decompression of the axillary-subclavian vein (100% technical success) with no per-operative complications.

All patients experienced complete resolution of symptoms except for one patient who reported early recurrence of less severe symptoms after 2 months, this patient underwent pectoralis minor resection which caused complete improvement of the recurrent symptoms.

All patients were advised to have physiotherapy to maintain the successful outcome. The average follow-up duration was 8.6 months (range 3-32 months). No late recurrence was reported during the follow up duration.

## Discussion

The diagnosis of VTOS is challenging particularly if it is not effort thrombosis. Good clinical skills are needed when reviewing these cases. The main factors involved in the subclavian vein compression at the costo-clavicular space are the costo-clavicular ligament, the subclavius muscle or tendon and the bony element from the clavicle or the 1<sup>st</sup> rib. The pectoralis minor muscle can also be a compressive agent in the sub-pectoral space. Most patients are active, and they move their arms repeatedly above the head. This repeated stress movement can cause injury to the intima leading to venous wall fibrosis. The luminal stenosis put the arm at high risk of DVT. Venous doppler ultrasound has been always the first modality to investigate venous diseases in the upper limb. However, it was non-conclusive in majority of cases, therefore CTV, MRV or venogram were almost always required. Indirect signs in the venous doppler scan can be in the form of loss of augmentation or respiratory phasic waves in the subclavian vein. The change in the flow velocity in the axillary artery with arm elevation can be the only sign of compression. When left untreated, McCleery syndrome progresses to DVT (effort thrombosis or Paget-Schroetter syndrome). Up to 75% of patients who progressed to DVT had long-term residual disabling symptoms.<sup>4,5</sup>

Treatment of McCleery syndrome is achieved by decompression of the costo-clavicular space and/or pectoralis minor space by performing 1<sup>st</sup> rib resection and/or pectoralis minor resection. In rare cases in which there is venous wall fibrosis, balloon dilatation is needed to improve the clinical outcome. Physical therapy after the intervention improves the clinical outcome and reduce the risk of recurrence.<sup>6</sup>

Direct comparison between different approaches to decompress the VTOS is lacking. Since the compressing agents are related to the anterior half of the 1<sup>st</sup> rib, infraclavicular resection of the anterior half of the rib with its associated subclavian tendon and costoclavicular ligament is sufficient to decompress the subclavian vein. Unlike the supraclavicular approach, the infraclavicular approaches keep the surgical dissection below the clavicle away from the brachial plexus and thoracic duct reducing the risk of injuring these structures. However, it remains a partial 1<sup>st</sup> rib resection. The supraclavicular approach allows complete resection of the 1<sup>st</sup> rib but with more risk of nerve or thoracic duct injury. Samoila and colleagues did a systematic review to investigate the long-term outcome of infra-clavicular approach in Paget-Schroetter syndrome (268 patients). The review found this approach offered excellent exposure to the subclavian vein, allowed open venous reconstruction using venous patch and had long term venous patency of 98.5% over follow up duration

that reached in some studies to 5 years. The freedom from reintervention was 89.9%.

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In this study the 1<sup>st</sup> rib resection was done using infraclavicular approach which allowed the operator to decompress the costo-calvicular space in all patients (technical success 100%), the clinical outcome matched the technical success where all patients at the end of follow up were symptoms free. However, one patient needed a second operation to remove the pectoralis minor muscle to achieve the 100% clinical success. This patient reported early recurrence of symptoms after 2 months of being symptoms free, the repeat venogram was inconclusive hence the decision to remove the pectoralis minor was made to get complete decompression of the venous thoracic outlet. Despite lack of radiological evidence of venous compression at the pectoralis minor muscle, the muscle resection restored the symptoms free status.

The results of this study match the current available evidence in terms of safety and efficacy of the infra-clavicular approach when used to decompress the thoracic outlet. In a systematic review and meta-analysis, the clinical improvement after surgical treatment of TOS was 90%.<sup>8</sup> In our study the clinical success was (100%). Despite the excellent outcome in our study, the number recruited remains small due to the rarity of these cases. The main limitation of the study was the rarity of the cases, only fifteen patients were recruited over 2.5 years in Alexandria university hospital, a hospital that serves more than five million population. Also, the diagnosis of intermittent compression in McCleery syndrome requires high index of suspicion, doppler ultrasound is not always conclusive and more invasive investigations such as diagnostic venogram done in neutral and hyperabduction position of the arm is usually required. The under diagnosis of McCleery syndrome can be a reason for the small number of the cases however more studies are required to reach this conclusion.

## **Conclusion**

VTOS is a rare disease, and an experienced physician is needed when reviewing and treating such cases due to lack of strong evidence in the literature that can guide the management of these cases. Infra-clavicular approach is safe and effective in decompressing the VTOS. VPMS is a possible cause of early recurrence after 1<sup>st</sup> rib resection in McCleery syndrome.

## **Conflicting interests**

None declared

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None declared

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