

Original Article

# ChatGPT Insight and Opinion Regarding the Controversies in Neurogenic Thoracic Outlet Syndrome: A Case-Based Study

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## Keywords:

AI  
Artificial intelligence  
ChatGPT  
Duplex scanning  
Thoracic outlet syndrome

Received: July 5, 2023

Revised: July 15, 2023

Accepted: July 20, 2023

Published: July 25, 2023

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Citation: Salih AM, Mohammed NA, Mahmood YM, Hasan SJ, Namiq HS, Ghafour AK et al. ChatGPT Insight and Opinion Regarding the Controversies in Neurogenic Thoracic Outlet Syndrome; a Case Based-Study. Barw Medical Journal. 2023 Jul 25;1(3):2-4.

<https://doi.org/10.58742/bmj.v1i2.48>

## Abstract

### Introduction

There are several controversies regarding thoracic outlet syndrome. This manuscript evaluates the utility of ChatGPT in providing insights into the controversies surrounding neurogenic thoracic outlet syndrome (nTOS).

### Methods

The following questions were chatted with ChatGPT based on OpenAI's GPT-4 architecture, which was last updated in September 2021. What is your opinion regarding the psychological abnormalities in patients with nTOS? What is your opinion about the role of duplex ultrasound in the diagnosis of nTOS? In your opinion, which one is preferred? First rib resection or only scalenectomy for the surgical management of nTOS?

### Results

ChatGPT was accurate in addressing the psychiatric disorders associated with nTOS and the outcome of different types of surgical intervention while it failed to highlight the role of duplex scanning in this disease apart from ruling out another differential diagnosis.

### Conclusion

While ChatGPT offers valuable insights, it should be noted that its last update was in September 2021. Hence, some newer developments in the field may not be addressed. Nonetheless, a comprehensive approach to understanding and managing nTOS, combining both clinical expertise and technological advancements, is vital for the well-being of patients.

## 1. Introduction

Neurogenic thoracic outlet syndrome (nTOS) is a clinical entity that has sparked considerable debate and controversy among medical professionals for decades. It is a complex disorder that arises due to compression of the neurovascular structures as they pass from the neck into the thoracic outlet, between the first rib, the collarbone, and the scalene muscles. There are diverse controversial somatic and psychological symptoms [1,2].

One of the primary sources of contention surrounding TOS is its diagnosis. Due to diverse presentation, TOS can mimic several other conditions, leading to frequent misdiagnoses. This is compounded by the absence of a universally accepted diagnostic gold standard, which often results in over-reliance on clinical evaluations and inconsistent use of diagnostic tests. One of the controversies in the diagnosis nTOS is the role of duplex ultrasound (US) [2,3].

Treatment modalities for TOS also ignite controversies. While some experts advocate for surgical intervention, particularly in cases with clear vascular compromise, others believe in conservative approaches, including physical therapy and lifestyle modifications, especially for neurogenic cases. The long-term efficacy of surgery, its associated risks, and its superiority or equivalence to conservative measures are all topics of debate. Even debates exist regarding the type of surgical intervention, whether resecting the first rib or only the scalenus muscle is required [3,4,5].

Artificial Intelligence (AI) refers to the machine simulation of human-like intelligence, encompassing capabilities such as learning, reasoning, self-correction, and problem-solving. ChatGPT, stemming from OpenAI's GPT (Generative Pre-trained Transformer) architecture, is an advanced AI language model designed for conversational interactions. Because it is adept at generating coherent and contextually relevant text based on vast amounts of trained data, AI has a crucial role in several aspects of human life [6,7]. The aim of this study is to report and discuss the insight and opinion of ChatGPT regarding the most important controversies surrounding nTOS.

## 2. Methods

The following questions were chatted with ChatGPT based on OpenAI's GPT-4 architecture, which was last updated in September 2021.

- What is your opinion regarding the psychological abnormalities in patients with nTOS?
- What is your opinion about the role of duplex US in the diagnosis of nTOS?
- In your opinion, which one is preferred? First rib resection or only scalenectomy for the surgical management of nTOS?

The details of the responses were reported and compared.

## 3. Results

Human authors: What is your opinion regarding the psychological abnormalities in patients with nTOS?

ChatGPT: The psychological aspects of nTOS are multifaceted, but I can provide a more detailed breakdown of the key points:

- **Chronic Pain and Emotional Well-being:** Chronic pain, as seen in nTOS patients, can lead to various psychological issues. There is a well-established relationship between chronic pain and conditions like depression, anxiety, and decreased quality of life. Prolonged pain can impact sleep, social relationships, work, and daily routines, leading to feelings of helplessness, hopelessness, and a lowered mood.
- **Cognitive Effects:** Chronic pain, like that in nTOS, can also have cognitive implications. Patients might experience difficulties with memory, attention, and executive functions, further compounding the challenges they face in their daily lives.
- **Diagnostic Delays:** As mentioned previously, the path to diagnosing nTOS can be long and fraught with uncertainty. These delays can produce feelings of frustration and invalidation, especially if patients feel their pain is not being taken seriously or is being attributed purely to psychological causes.
- **Somatization:** In some instances, the stress and psychological burden of the illness can lead to somatization, where psychological distress manifests as physical symptoms. This can further complicate the clinical picture, making it harder to discern which symptoms are due to nTOS and which might be somatic expressions of emotional distress.
- **Fear-avoidance:** The pain and discomfort from nTOS can lead to fear-avoidance behaviors, where patients avoid certain activities because they fear they will cause pain or worsen their condition. Over time, this can lead to decreased physical activity, muscle atrophy, and increased disability.
- **Treatment Adherence:** Psychological distress can affect a patient's motivation and ability to adhere to prescribed treatments. For example, depression or anxiety might reduce a patient's willingness to participate in physical therapy or to consistently perform exercises at home.

**Stress Exacerbation:** Stress can intensify the symptoms of nTOS, creating a feedback loop where the physical symptoms cause psychological distress, and the resulting stress then worsens the physical symptoms.

In summary, while nTOS has a primary neurological component, its intersection with psychological well-being is undeniable and demands a comprehensive approach for effective management.

Human authors: What is your opinion about the role of duplex US in the diagnosis of nTOS? ChatGPT: Duplex US in the context of nTOS is mainly used to rule out the other forms of TOS – venous (vTOS) and arterial (aTOS) – which involve vascular compression.

Specific roles of duplex US in nTOS diagnosis include:

- **Exclusion of Vascular TOS:** Before confirming a diagnosis of nTOS, it is crucial to rule out the vascular forms. Duplex US can visualize the blood vessels in the thoracic outlet area and detect any vascular compression or abnormalities that could be causing the patient's symptoms.
- **Scalene Muscle Anomaly:** While the primary utility of duplex US is for vascular evaluation, in some cases, an anomaly or hypertrophy of the anterior scalene muscle might be visualized, which can contribute to nTOS.
- **Posture-Dependent Changes:** The compression in TOS often varies with arm position or postural changes. Dynamic testing during duplex US, by moving the patient's arm in different positions, can show transient vascular compression that might indicate a positional or dynamic component to the patient's symptoms, even if nTOS is the primary suspicion.
- **Supplementing Clinical Evaluation:** A patient's symptoms and physical examination findings are primary in diagnosing nTOS. Still, duplex US can offer additional objective data, especially if there is uncertainty or a need to rule out other conditions.

In summary, while duplex US is not the primary diagnostic tool for nTOS due to its focus on vascular structures, it plays an essential role in excluding vascular causes of TOS symptoms. It can provide supplemental information in the overall diagnostic evaluation of a patient suspected of having nTOS. However, the diagnosis of nTOS remains primarily clinical, often supplemented by electrodiagnostic studies and other imaging as needed.

Human authors: In your opinion, which one is preferred? First rib resection or only scalenectomy for the surgical management of nTOS?

ChatGPT: The statement addresses two surgical interventions for the management of nTOS: "first rib resection" and "scalenectomy".

- **First Rib Resection:** This surgical procedure involves the removal of the first rib. The goal of this procedure in the context of nTOS is to alleviate the compression on the brachial plexus by creating more space in the thoracic outlet. When conservative treatments for nTOS are unsuccessful, first rib resection is a commonly considered surgical approach. It has been used for many decades and is considered a standard procedure for certain cases of TOS.
- **Scalenectomy (Anterior Scalene Muscle Resection):** This procedure involves the removal or partial removal of the anterior scalene muscle, which can be a source of compression on the brachial plexus. By resecting the muscle, the goal is to alleviate the pressure on the nerve structures. Scalenectomy can be done alone or in conjunction with first rib resection.

When comparing the two:

- **Effectiveness:** Both procedures aim to relieve compression and can be effective. The choice often depends on the specifics of the compression and the surgeon's assessment. Some patients may have primary compression from the scalene muscle, while others may have bony compression from the first rib or a combination of both.
- **Surgical Approach and Recovery:** The surgical approach, potential complications, and recovery can vary between the two procedures. However, with any surgical intervention, risks exist, and post-operative care and physical therapy are typically essential for optimal recovery.
- **Decision-making:** The decision between first rib resection, scalenectomy, or a combination of both should be made on a case-by-case basis. Factors include the patient's anatomy, the location and cause of compression, the patient's symptoms, and the surgeon's expertise and preference.

In summary, both first rib resection and scalenectomy are established surgical options for managing nTOS. The best approach depends on the individual circumstances of the patient and the recommendation of the thoracic surgeon or specialist managing the case.

#### 4. Discussion

Chronic pain like what has been reported for nTOS is associated with some psychiatric diseases, especially major depressive disorder [8].

Romano et al. explored the relationship between chronic pain and depression by reviewing relevant literature and identifying issues in its conceptual and methodological approach. While the association between chronic pain and depression remains debated, the reviewed literature supports their correlation. There are multiple theories, including biological, psychodynamic, and behavioral cognitive models, explaining how these conditions might interplay [8]. ChatGPT reported the major psychiatric symptoms like depression, anxiety, decreased quality of life, feelings of helplessness and hopelessness, a lowered mood, difficulties with memory and attention, and feelings of frustration and invalidation, with many others, that are supposed to be related to TOS. These symptoms were caused by chronic pain and emotional well-being, diagnostic delays, somatization, fear avoidance, and stress exacerbation.

US is employed to identify signs of nTOS, both direct (visualizing the brachial plexus compression) and indirect (compression of specific vessels without clinical signs of vascular TOS). Aryani and colleagues introduced the "wedgesickle sign" through high-resolution US as a marker to spot fibromuscular bands causing TOS. This marker had a 95% success rate in identifying brachial plexus compression [9]. However, Leonhard et al. connected brachial plexus branching variations with nTOS, suggesting that US could help spot unusual anatomical patterns [10]. Dollinger et al. found a combined nerve and vascular US to be a reliable TOS diagnostic tool, particularly for identifying compression sites [11].

Contrarily, Pesser's study at the nTOS-center found high-resolution US less contributive to nTOS diagnosis but noted its potential value in specific cases [12]. Goeteyn et al. questioned US's role in diagnosing nTOS, emphasizing clinical judgment over US findings [13]. Research by Orlando et al. emphasized the diagnostic significance of US in spotting nTOS through identifying subclavian vein or artery compression [14]. Meanwhile, Chailloux et al. found duplex scanning only moderately effective in diagnosing nTOS, questioning its diagnostic impact [15].

Regarding the role of duplex scanning in the diagnosis of nTOS, ChatGPT stressed the importance of ultrasonography in excluding vascular TOS. This AI did not mention the direct and indirect signs of duplex scanning. This may be due to the fact that the role of duplex scanning in the diagnosis of nTOS was popularized mostly in the last two years, while the last update of ChatGPT belongs to September 2021.

Resection of both the first rib and scalenus muscles or either alone is regarded as an effective surgical management strategy [1,4,5]. ChatGPT was very accurate in this regard and recommended case-by-case decisions.

## 5. Conclusion

Overall, while ChatGPT offers valuable insights, it should be noted that its last update was in September 2021. Hence, some newer developments in the field may not be addressed. Nonetheless, a comprehensive approach to understanding and managing nTOS, combining both clinical expertise and technological advancements, is vital for the well-being of patients.

## Declarations

**Conflicts of interest:** The author(s) have no conflicts of interest to disclose.

**Ethical approval:** Not applicable

**Patient consent** (participation and publication): Not applicable.

**Funding:** The present study received no financial support.

**Acknowledgements:** None to be declared.

**Authors' contributions:** SHM, BAA, HMH and SHK participated in data collection; FHK and AMS designed the study; YMM, MK and FA participated in preparing the manuscript; KNAM, HSN, AKG, SJH, SKA and KFH critically revised the manuscript. All authors critically revised and approved the final version of the manuscript.

**Data availability statement:** Note applicable.

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