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RESEARCH ARTICLE

A NOVEL DIAGNOSTIC SCALE FOR DIAGNOSIS OF SURGICAL NEUROGENIC THORACIC OUTLET SYNDROME (TOS)

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ABSTRACT

Background: Diagnosing thoracic outlet syndrome **(**TOS) can be challenging because the symptoms vary greatly amongst patients with the disorder, thus lending to other conditions including a double crush syndrome. Adjunct diagnostic studies frequently confirm the diagnosis of VTOS (venous thoracic outlet syndrome) and ATOS (arterial thoracic outlet syndrome), but not of NTOS (neurogenic thoracic outlet syndrome), so a new diagnostic scale was applied for NTOS.
Aim of the study: evaluation of the new diagnostic scale for management of neurogenic thoracic outlet syndrome.
Patients and methods: the new diagnostic scale was applied on a forty patients with neurogenic thoracic outlet syndrome. They were selected from Al-Azhar University hospitals between Jan 2008 and December 2017.Conservative treatment was decided for all patients for one month, then surgery for the failed cases, then evaluation after 6 months for all the 40 patients.
Results: All patients scored below 5(30 patients= 75%) responded well to conservative treatment. While Patients scored 5 and 6(both are 10 patients =25%) had no response to conservative treatment. So, surgery was done.6 months follow up showed improvement of all the studied cases. So this suggested novel scale helped us to decide when to decide conservative treatment and when to do surgery.
Conclusion: This suggested novel scale helped us to decide when to decide conservative treatment and when to do surgery.

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INTRODUCTION

Thoracic outlet syndrome (TOS) is defined as "upper extremity symptoms due to neurovascular compression in the area of the neck above the first rib" (Sanders *et al.,* 2008). There are three basic forms of TOS as TOS complaints can be of arterial (approximately 5%), venous (51%) or neurogenic (95%) origin (Vanti *et al.,* 2007; Christo *et al.,* 2010; Thompson and Bartoli, 2005). A sub classification of NTOS (Neurogenic Thoracic Outlet Syndrome) includes "true" NTOS (also known as the "classic" form with objective findings), which accounts for only 1% of Neurogenic Cases, and "Disputed or Nonspecific" NTOS (also known as the "common" form, with chronic pain symptoms suggestive of brachial plexus compromise but without objective findings). The latter accounts for 99% of neurogenic cases (Braun *et al.,* 2006, Harold *et al.,* 2007; Atasoy, 1996).

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Diagnosing TOS can be challenging because the symptoms vary greatly amongst patients with the disorder, thus lending to other conditions including a double crush syndrome (Troy *et al.,* 2010). Adjunct diagnostic studies frequently confirm the diagnoses of VTOS (Venous thoracic outlet syndrome) and ATOS (arterial thoracic outlet syndrome), but not of NTOS (Nichols and Andrew, 2009). There will always be some errors in diagnosis, and surgery must be advised on a basis of exclusion and with great reservation (Wood *et al.,* 1988).

Little argument exists against the surgical treatment of a patient with severe compression or compromise of the subclavian vein or artery (Peek *et al.,* 2017). Likewise, patients with atrophy of the intrinsic muscles of the hand secondary to thoracic outlet syndrome with no distal sites of compression need surgical intervention (Mackinnon *et al.,* 2002). However, less severe cases are more controversial. So that, we will evaluate the validity of the new diagnostic score of neurogenic thoracic outlet syndrome .by application of it on 40 patients. The aim of the study is to find a clear plan for management of neurogenic

thoracic outlet syndrome (Conservative or Surgical Management).

Patients and Methods

The present study included forty patients with neurogenic thoracic outlet syndrome. They were selected from Al-Azhar University hospitals between Jan 2008 and December 2017. Patients diagnosed as NTOS **(**neurogenic thoracic outlet syndrome) are included in this study and

Patients with the diagnosis of VTOS (Venous Thoracic Outlet Syndrome) and ATOS (Arterial Thoracic Outlet Syndrome) are excluded from this study. Written consent was obtained from all patients. Clinical evaluation included a detailed history and physical examination. At the initial consultation, the patient's symptoms were recorded and a complete clinical examination of the neck, shoulder, and upper extremity was performed. The following procedures were used routinely for the diagnosis of thoracic outlet syndrome:

Clinical

- **Routine Clinical evaluation:** inspection, palpation, auscultation in the supraclavicular fossa with the arm in the neutral position and up into the abducted and externally rotated position, and muscle strength test.

- **Provocative clinical tests:** three classic maneuvers: *Adson or Scalene Test*, This maneuver tightens the anterior and middle scalene muscles, *Costoclavicular Test (military position)*, This maneuver narrows the costoclavicular space by approximating the clavicle to the first rib and thus tends to compress the neurovascular bundle and *Hyperabduction Test*, the components of the neurovascular bundle are pulled around the pectoralis minor tendon, the coracoid process, and the head of the humorous.

- Provocative stimulation and anesthetic blocks of the anterior scalene muscle.

Electrophysiologic tests

Somatosensory evoked potential recording across the brachial plexus.

Anatomic studies plain radiograph and magnetic resonance imaging

Summation of the previous data was done according to the new diagnostic scale for diagnosis of neurogenic TOS, in which the true neurogenic thoracic outlet syndrome can be postulated as 6 points, 3 points forclinical examination (1 for provocative tests and 2 for scalene block test), 1 point for nerve conduction velocity, and 2 points for anatomic studies. It is necessary to be at least 5 points to diagnose surgical neurogenic TOS (Hasan *et al.,* 2013). Following the application of this scale on patients presented by symptoms of thoracic outlet syndrome and after ensuring the diagnosis, we started medical treatment for all patients for one month.

Scale application as a case presentation

20 years old female patient presented by right upper limb Paresthesia and right claw hand.

Addson's test was positive (the patient scored 1) and scalene block test was positive (the patient scored 2), nerve conduction velocity showed evidence of an old standing incomplete lesion (axonotemesis) affecting the right lower trunk of the brachial plexus (the patient scored 1) and MRI brachial plexus and x-ray cervical showed bilateral cervical ribs and thinning of the right subclavian artery more than left (the patient scored 2), the total sum of patient's score was 6. We tried medical treatment with no response. So, we decided surgery. Follow-up was obtained by standard visits with the clinician for all patients.

We observed the response for medical treatment and number of patients responded for medical treatment and who will need surgery. Then after surgery, the surgical results were gathered and analyzed in 6-month time increments, with an additional time point at 2 months after surgery. Scalenotomy was our chosen technique for surgical intervention for surgical neurogenic thoracic outlet syndrome. So, clinical follow up was decided for all patients in our study as the radiological picture (eg: cervical rib) mayn't change postoperative.

RESULTS

In the present study, females represent 85% of all studied cases and males represent 15%; age ranged from 17 to 58 years with a mean of 38.05±8.85 years. The most common presenting symptom was paresthesia reported in 75%, followed by lack of power in 55% and finally pain at rest in 50%; symptoms were unilateral in 65% and bilateral in 35%; plexus compression was in upper plexus in 10.0% and lower plexus in 90.0% (Table 1).

DISCUSSION

Thoracic outlet syndrome (TOS) refers to compression of the neurovascular structures at the superior aperture of the thorax (Huang and Zager, 2004). So it is a misnomer as it is thoracic inlet not thoracic outlet (Vanti *et al.,* 2007). Regarding the diagnosis of true TOS, it is complementary by triad of

- Clinical examination which is the main stone including anterior scalene muscle block,
- Nerve conduction velocity assessment,
- Anatomical diagnostic studies like MRI cervical spine, MRI angiography and others. Diagnosing TOS can be challenging because the symptoms vary greatly amongst patients with the disorder, thus lending to other conditions including a double crush syndrome (Troy *et al.,* 2010).

Adjunct diagnostic studies frequently confirm the diagnoses of VTOS (venous thoracic outlet syndrome) and ATOS (arterial thoracic outlet syndrome, but not of NTOS (Nichols, Andrew, 2009). There will always be some errors in diagnosis, and surgery must be advised on a basis of exclusion and with great reservation (Wood *et al.,* 1988). Little argument exists against the surgical treatment of a patient with severe compression or compromise of the subclavian vein or artery (Peek *et al.,* 2017). Likewise, patients with atrophy of the intrinsic muscles of the hand secondary to thoracic outlet syndrome with no distal sites of compression need surgical intervention (Mackinnon *et al.,* 2002). However, less severe cases are more controversial. Christo *et al.* (2010) stated that: Anterior scalene block may serve as a reliable diagnostic test by temporarily blocking or paralyzing the muscle in spasm and reducing symptoms of TOS.

1. Patient presented by claw hand.

2. X-ray cervical showing bilateral cervical ribs.

3. Angiography showing thinning of the right subclavian artery.

4. Intraoperative picture after scalenotomy

Figure 1. Application of the novel scale on a patient

Table 1. Demographic characteristics and clinical presentations of the studied cases

	Values
Sex (M/F) (no, %)	10 (15%)/30 (85%)
Age (mean ± SD): range	38.05±8.85: 17- 58
Symptoms	
Paresthesia	30 (75%)
Lack of power	22 (55.0%)
Pain at rest	20 (50.0%)
Laterality	
Unilateral	26 (65.0%)
Bilateral	14 (35.0%)
Plexus compression	
Lower	36 (90.0%)
Upper	4 (10.0%)

Table 2. Showing NTOS grade of the studied cases and who response to medical treatment and who need surgery

Score	No of patients	Response to medical treatment	Patients improved at 6 months follow up
1	6 (15%)	Positive	6
2	10 (25%)	Positive	10
3	4 (10%)	Positive	4
4	10 (25%)	Positive	10
5	7 (17.5%)	No response so surgery was done.	7
6	3 (7.5%)	No response so surgery was done	3

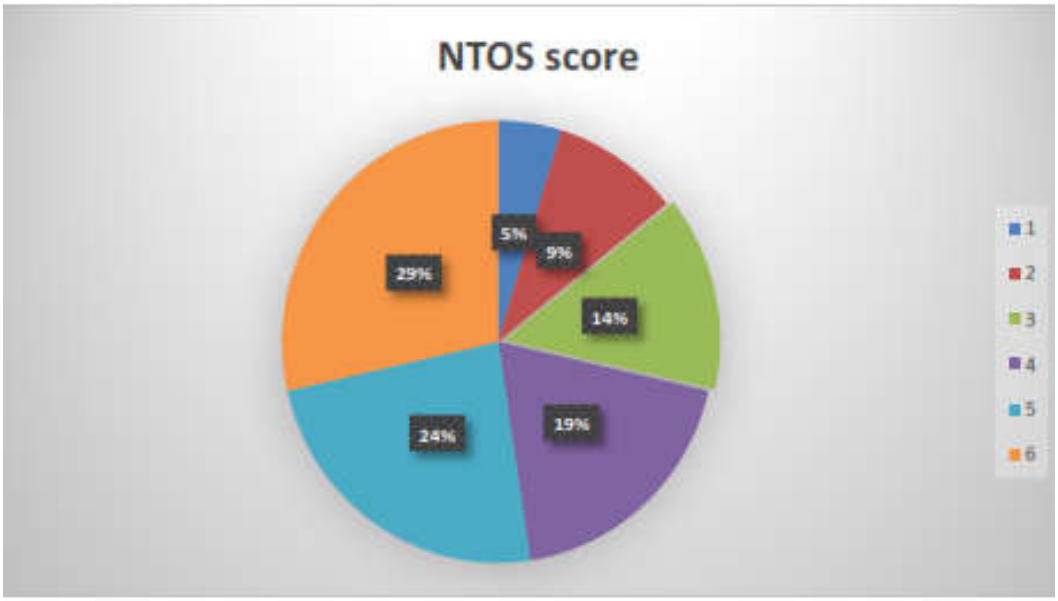

Figure 2. Chart showing NTOS grade of the studied cases

Two points among 6 of the scale were given to Scalene muscle blocks as it useful to confirm the diagnosis of NTOS, with a good response being highly correlated with a good response to surgery (Sanders *et al.,* 2008; Braun *et al.,* 2006). Although, Harold and Harry (2007) stated that The primary objective test for thoracic outlet peripheral nerve compression is the nerve conduction velocity (NCV), we give it one point only among six points of the scale because many deny Harold and Harry statement as the results of conventional EMG / NC studies are usually negative or nonspecific in patients with neurogenic TOS. This is probably due to two causes; the first is the extremely proximal location of brachial plexus nerve root compression, where it may be technically difficult to obtain accurate NC readings. The second is the nerve compression in neurogenic TOS is typically intermittent, only rarely causing the type of permanent changes in motor nerve function that are most easily detected by EMG / NC studies, for that the diagnosis of TOS is complementary by triad of clinical examination which is the main stone and scalene muscle block test., nerve conduction velocity assessment, and anatomical diagnostic studies like MRI cervical spine, MRI angiography and others.) By applying our suggested novel scale on our patients, we found that number of patients scored 1 was 6 patients, some of them have only positive provocative test, and patients scored 2 was 10 and patients scored 3 was 4 and patients scored 4 was 10 patients and patients scored 5 was 7 and patients scored 6 was 3. Regarding the gender and age:, females represent 85% of all studied cases and males represent 15%; age ranged from 17 to 58 years with a mean of 38.05±8.85 years. While, Bhattacharya et al. (14) reported that, females: males represent 62:8 with a mean age of 37 years. Several reasons for the preponderance of female patients have been postulated, including relative underdevelopment of the muscles inserting around the shoulder girdle or relatively lower

origin of the brachial plexus with frequent contributions from the second thoracic nerve root (Stoney *et al.,* 1976). Regarding symptoms, the most common presenting symptom was paresthesia reported in 75%, followed by lack of power in 55% and finally pain at rest in 50%; symptoms were unilateral in 65% and bilateral in 35%; plexus compression was in upper plexus in 10.0% and lower plexus in 90.0%. These results are comparable to those reported by Balci *et al.* (2003) who reported that, the most frequent symptom was paresthesia in the arms and hands (72.3%). Twenty-six (53%) patients complained that their symptoms were aggravated when lifting objects above the head or when placing the arms in an exaggerated hyperabduction position. C8-T1/ulnar nerve (lower plexus) compression was present in 36 patients, and C5-C7/median nerve (upper plexus) compression was present in 6. Therefore, the lower plexus in 85.7% and the upper plexus in 14.3% of patients were compressed in neurologic cases. In addition, Bhattacharya *et al.* (2003) who reported that, 71% of the cases presented with neurological symptoms, females/male represent 62/8 and mean age was 37 years. Furthermore, it is in agreement with Terzis and Kokkalis (2010) who reported that; mean age was 36.9±11.5 (range, 21–55 years), about two thirds of the patients presented with neurologic symptoms (weakness was found in

88% of the cases, and decrease of sensation was revealed in 68% of cases) and positive electrophysiological signs (65% of the cases). We suggested to start conservative treatment for all patients in our study for one month. All patients scored below 5 responded well to conservative treatment. Patients scored 5 and 6 had no response to conservative treatment. So, we decided surgery. 6 months follow up showed improvement of the clinical picture of all the studied cases. Scoring for diagnosing the surgical neurogenic thoracic outlet syndrome is fast and easily applicable to all physicians involved in treatment of it. Some limitations can, however, weaken the accuracy of the new score; low number of patients involved in the study, and the follow up period wasn't sufficient for long-term follow up. The study was performed in a single center, and no more patients were included. Validation of the new score in another prospective patient material, especially in another surgical unit, would make the score more reliable for clinical use.

Conclusions

This suggested novel scale helped us to decide when to decide conservative treatment and when to do surgery.

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