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Convergent Validity of Thoracic Outlet Syndrome Index (TOSI)

RESEARCH

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ABSTRACT

No disease-specific evaluation score for thoracic outlet syndrome (TOS) patients was available prior to the presentation of the Thoracic Outlet Syndrome Index (TOSI) score. Our aim was to assess the convergent validity of the TOSI when compared with the short form of Disabilities of the Arm, Shoulder and Hand (QDASH), the Cervical Brachial Symptom Questionnaire (CBSQ), and pain numeric rating scale (painNRS) after supraclavicular rib-sparing decompression for neurogenic TOS. The TOSI takes into account five domains important to TOS patients with 15 questions, whereas QDASH considers only four domains, and CBSQ and painNRS each has only one domain. Our 67 TOS patients, mean age 36.5 years at surgery, were evaluated clinically for a mean 13.2 years after rib-sparing surgery. They completed the QDASH, the CBSQ, the pain NRS, and the TOSI questionnaires. Correlations between TOSI total score and QDASH, CBSQ total scores, and the painNRS were strong: 0.67 for TOSI vs. QDASH; 0.75 for TOSI vs. CBSQ; and 0.65 for TOSI vs. painNRS. The TOSI demonstrated good convergent validity. It may thus become a valuable addition among tools for assessing the quality of life and functioning of those with neurogenic thoracic outlet syndrome as well as for improving comparability of results across varying settings in this field.

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INTRODUCTION

Thoracic outlet syndrome (TOS) is a disorder with a diverse pathology including symptoms related to the neck, shoulder, upper chest, head, and upper limb, impairing the patient's quality of life and ability to work. Patients may present with pain, weakness, numbness, and paraesthesia. Especially raising the arms provokes symptoms. Many general and region-specific outcome measures exist to evaluate the three main consequences of neurogenic thoracic outlet syndrome (NTOS), pain, limitations in activities of daily living, and reduced work capacity. The scales most commonly used focus separately on either pain or functional limitations. Such scales include the short form of the Disabilities of the Arm, Shoulder and Hand (QDASH) (Caputo et al. 2013; Glynn et al. 2012; Ransom et al. 2020), the Cervical Brachial Symptom Questionnaire (CBSQ) (Caputo et al. 2013; Glynn et al. 2012; Ransom et al. 2022; Rochlin et al. 2013), and the pain numeric rating scale (NRS) (Jensen & Karoly 1991). These scales can evaluate the outcome of both conservative and surgical treatment of TOS. The QDASH and the CBSQ have proven to be valid tools to quantify the limitations of functioning of the upper extremity and the overall quality of life of respondents (Beaton, Wright & Katz 2005). Problematic, however, is that there has never been any disease-specific evaluation score for TOS, and researchers have had to use multiple scores simultaneously to provide comprehensive information regarding severity of pain, limitations in functioning, and quality of life (Balderman et al. 2017; Bosma et al. 2010; Chang et al. 2009; Cordobes-Gual et al. 2008; Ransom et al. 2022; Rochlin et al. 2013; Weiss & Chang 2013). This makes comparison of results difficult.

To avoid needing to use several TOS-nonspecific scales simultaneously, the present research group developed the 15-item Thoracic Outlet Syndrome Index (TOSI) (Vastamäki et al. 2020). This index provides both face- and content validity as well as being an internally consistent tool to evaluate TOS patients' quality of life (QoL). Because the TOSI is a new scale, its correlation with other relevant scales (convergent validity) has never been subjected to study. The TOSI may allow comprehensive evaluation of the entire multidimensional spectrum of the TOS impact on patients' health: pain, limitation in function(ing), and quality of life. If found valid, the TOSI may help clinicians assess the functioning of TOS patients by means of a single score. Such assessments may lead to improved comparability of results across varying settings.

Our purpose was to assess the convergent validity of TOSI when compared with the QDASH, the CBSQ, and painNRS after supraclavicular rib-sparing decompression due to neurogenic TOS.

METHODS

Cross-sectional data on 67 consecutive patients undergoing surgery for NTOS between 1997 and 2011 came from patient records (Ruopsa et al. 2021). All the operations were performed by a single surgeon (M.V.) at a tertiary orthopaedic clinic. All the patients underwent a supraclavicular decompression scalenotomy without resection of the first rib, as described by Sanders (1996). A questionnaire containing the QDASH, the CBSQ, the pain NRS, and the TOSI went to the patients in 2019, a mean 13.2 (SD 4.6) years after surgery (***Figure 1***). The clinical routine follow-up appointments were with the same surgeon who performed the operations. The final follow up appointment was with the first author in 2021 (N.R.).

The TOSI, exploring the quality of life of patients with TOS, comprises 15 items organized in five subgroups: physical symptoms (items 1 to 7), sports/recreation (8, 9), work (10 to 13), lifestyle (14), and emotions (15) (Vastamäki et al. 2020). These items are scored on a Likert-like scale from zero to 10, where zero represents "no limitation" and 10 "worst possible limitation". The total score is the sum of the items' scores with a minimum of zero and maximum of 150 points. The QDASH is an 11-item questionnaire. Its items are measured on a Likert-like scale from zero to five, where zero represents "no limitation" and five "worst possible limitation". The total score ranges from zero point ("no symptoms, no difficulty") to 100 points ("unable to perform tasks due to severe difficulty") (Bosma et al. 2005). The 14-item CBSQ was originally developed to measure limitations of functioning among patients with cervicobrachial symptoms, neurogenic TOS, and related disorders (Jordan, Ahn & Gelabert 2007). CBSQ items

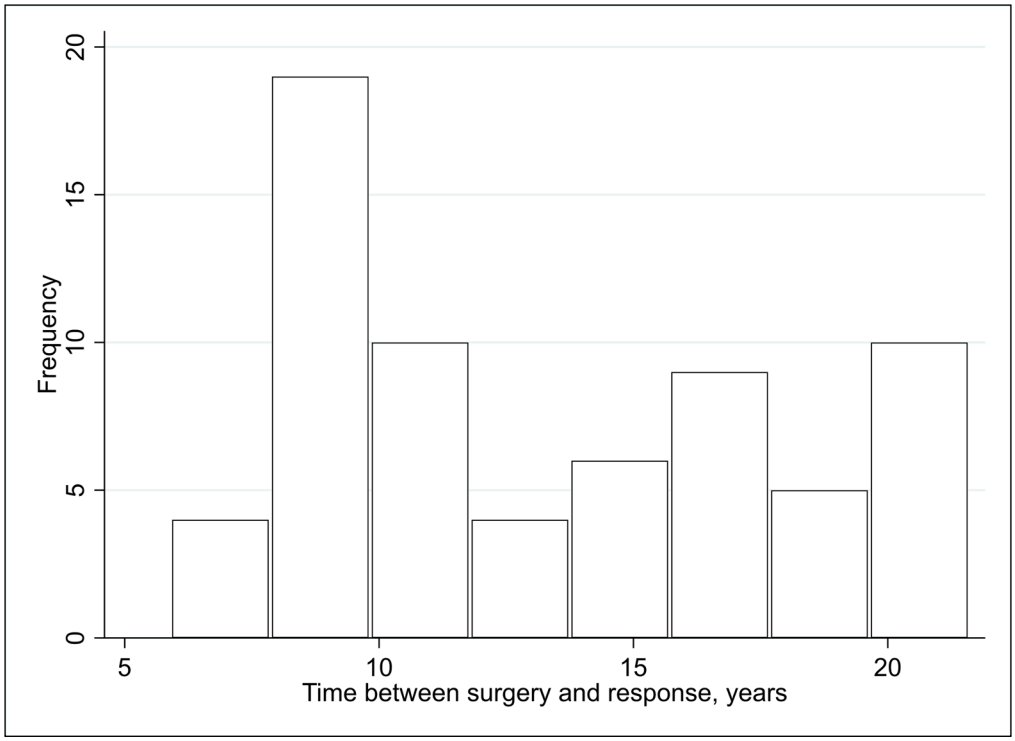

Figure 1 Frequency plot of time between surgery and response to the survey.

are measured on a Likert-like scale from zero to 10, where zero represents "no symptoms" and 10 "constant severe symptoms". The total score is the sum of items' scores with a minimum of zero and maximum of 140 points. PainNRS is an 11-point Likert-like scale from zero ("no pain") to 10 ("the worst possible pain") (***Table 1***).

The TOSI, QDASH, and CBSQ show many similarities, but are far from identical. TOSI and CBSQ include three and five questions about pain, but QDASH only one. The CBSQ has five questions about tingling and numbness, TOSI only two, and QDASH only one. Actually, CBSQ only measures pain and physical symptoms, completely ignoring coping at work or daily life activities, and omitting life style and emotions. QDASH, on the other hand, focuses on many activities in daily life that are not significantly affected by TOS.

Age was recorded at the time of surgery and at the time of response. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2). We calculated also BMI, because some authors have evaluated the influence of body weight on technical and functional outcomes of surgical treatment for NTOS (Maqbool et al. 2019; Mattox et al. 2016; Ohman et al. 2018). We also were interested in this topic (Ruopsa et al. 2021). Symptom duration we calculated as years from symptom onset until surgery (***Table 2***).

We compared the total scores of TOSI, QDASH, CBSQ, and painNRS by using the Spearman correlation coefficient with the Bonferroni correction for multiple correlations. A correlation of ≥0.70 was considered very strong, 0.40 to 0.69 strong, 0.30 to 0.39 moderate, 0.20 to 0.29 weak, and 0.01 to 0.19 as none or a negligible correlation (Lawshe 1975). The estimates were accompanied by 95% confidence intervals (95% CIs). All the analyses were with Stata/IC Statistical Software: Release 16, College Station (StataCorp LP, TX, USA).

RESULTS

PARTICIPANT CHARACTERISTICS

For neurogenic TOS, 67 patients, mean age 36.5 (SD 10.2) at surgery, 55 (82%) of them women, underwent surgery (***Table 2***). The mean follow-up was 13.2 (SD 4.6) years. The right side underwent surgery in 40 (60%) patients, the left side in 23 (34%), and both sides in 4 (6%). No re-operations were necessary. For questionnaire results, see ***Table 3***.

new scoring tool measures the same domains as do the older ones. Additionally, our intention was to show what novelty the new measure provides–that is, where the correlations were weak because of the lack of similar questions in earlier measures. As TOSI is a new instrument, there as yet exist no other studies concerning any correlation between it and other instruments to measure quality of life.

CBSQ and DASH have each served as a tool for evaluating quality of life for TOS patients (Cordobes-Gual et al. 2008; Rochlin et al. 2013). TOSI question 15 (Being worried about difficulty in working) correlated quite poorly with CBSQ or QDASH. In NTOS patients, work ability is often threatened, and this may, based on our 45 years` experience, cause mental stress which further complicates symptoms. Mental stress is very rarely mentioned in the TOS literature, however. We found only one mention concerning NTOS: "Patients with NTOS reported significantly lower aggregate mental health QoL than patients with vascular-only TOS" (Al Rstum et al. 2020). Similarly, TOSI question 12, on difficulty in working overall, correlates quite poorly with CBSQ and QDASH; CBSQ does not measure work capacity at all, and QDASH measures it by one question. TOSI adds to the old scales four questions on ability to work, questions 10, 12, 13, and 15.

TOSI question 6, tingling or numbness after rest, question 2, pain in axilla, thorax, neck, or cheek, and question 4, tingling or numbness, correlated poorly with QDASH, and so did TOSI question 6 with QDASH. All those symptoms are common in TOS. For evaluation of functioning and QoL, they are important. Apparently, TOSI was able to identify those symptoms better than did the other measures. The absence of these questions from the evaluation form most obviously causes the possibility of error. On the other hand, TOSI correlated strongly with painNRS. reflecting the fact that in TOS the main symptom is pain.

In both the CBSQ and TOSI, most items are meant to capture physical issues, and in the QDASH and TOSI to measure limitations of functioning. Higher correlations can thus be expected between these tests. Based on the correlation matrix in ***Table 5***, it seems that while the CBSQ could be replaced by the TOSI, the QDASH could still provide additional information on the functioning of those with TOS. In other words, the TOSI and the QDASH should probably be used concurrently. TOSI and pain NRS both typify issues with pain, so correlations between them are unsurprising.

We acknowledge some limitations. The generalizability of these results may be compromised by the retrospective design of our study, its small sample size, and its relatively small spectrum of variables available for analysis. A number of confounding factors may affect the strength of the correlations observed, one being the time interval between surgery and the questionnaire, and other problems occurring in patients' upper limbs. Recall bias may be likely, when patients had to complete questionnaires concerning their preoperative situation at follow-up. That over 80% of the patients were women, with most of them relatively young, may also distort any correlations with populations that have different gender- or age distributions. However, it must be remembered that TOS is a disease of young people everywhere, mostly of women, and is very rare in those over age 45.

In addition, this study sample was drawn from a specific population of patients after scalenotomy without rib resection. In theory, the TOSI may behave differently in other patient groups. In addition, the TOSI score has been validated only in Finnish. It is possible that the validation results in English, for example, may be different. And some TOSI questions may be too close to each other thus perhaps overemphasizing the issue in question such as question 5, Pain with arm overhead, and question 10, Difficulty in working arm overhead, as well as question 10, and question 12 "Difficulty in working overall". However, the difficulty of these activities is typical and very common in the TOS, so that over-representation of those items is unlikely.

Our Thoracic Outlet Syndrome Index TOSI appeared to correlate with other forms, so in the future it may not have been necessary to use many different forms to explore the QoL of TOS patients, because one would suffice. However, this single study is insufficient to show the usability of the form, meaning that further research is necessary**.**

CONCLUSIONS

The Thoracic Outlet Syndrome Index TOSI demonstrated good convergent validity and may become a valuable addition to the assessment of functioning and quality of life of individuals with neurogenic thoracic outlet syndrome.

INSTITUTIONAL REVIEW BOARD STATEMENT

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Helsinki University (protocol code 1755/2017, *07.02.2018*).

ETHICS AND CONSENT

Written informed consent was obtained from all subjects involved in the study.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

Conceptualization M.V., N.R., L.R., and H.V.; methodology, N.R., H.V., L.R., M.V. and M.S.; software, L.R. and M.S.; validation, N.R., H.V., L.R., M.V., and M.S.; formal analysis, N.R., L.R., M.V. and M.S; patient investigation, N.R. and H.V.; resources, L.R. and M.V.; data curation, N.R., H.V., L.R., M.V., and M.S.; writing—original draft preparation, N.R. and M.V.; writing—review and editing, N.R., H.V., L.R., M.V. and M.S.; visualization, L.R.; supervision, H.V., M.V., and L.R.; project administration, M.V.; funding acquisition, N.R., H.V., L.R., and M.V. All authors have read and agreed to the submitted version of the manuscript.

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