COMPRESSION SYNDROMES

Conservative treatment of thoracic outlet syndrome (TOS): Creating an evidence-based strategy through critical research appraisal

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\textbf{KEYWORDS}
Thoracic outlet syndrome; Conservative treatment; Rehabilitation; Compression Syndromes

\textbf{Summary}
Thoracic outlet syndrome (TOS) is initially treated non-operatively. Upon failure or unsatisfactory improvement surgical treatment is contemplated. The purpose of this review is to critically appraise available primary research on non-operative treatment of TOS, explore the effectiveness of non-operative treatment approaches and propose an evidence-based treatment strategy.
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\textbf{Introduction}
Thoracic outlet syndrome (TOS) is a syndrome attributed to the narrowing of the spaces in the thoracic outlet, through which major nerves and vessels pass, resulting in compression of the brachial plexus or vessels.\textsuperscript{1} Common symptoms include pain on the side of the neck radiating to the ear and face (upper plexus TOS), or anterior/posterior shoulder pain radiating to the medial aspect of the upper extremity and ulnar nerve distribution paresthesia.\textsuperscript{1} Multiple or double crush syndromes may also occur as a result of compression in more than one site, such as the thoracic outlet, the cubital or carpal tunnel.\textsuperscript{2,3}

Treatment may be either operative or non-operative. The first non-operative treatment protocol for TOS was described by Peet et al.\textsuperscript{4} in 1956. Treatment consisted of massage, application of moist heat, strengthening of the shoulder elevators, pectoralis stretching, ergonomics and posture correction. 71 per cent of 55 patients improved. Twelve years later, Urschel et al.\textsuperscript{5} added active range of motion (ROM) exercises and cervical traction to the ‘Peet et al.’ protocol but only half of the 120 patients experienced symptomatic relief.

\textbf{Surgery and conservative treatment}
Surgery for TOS consists of decompression of the anterior shoulder region usually with resection of the first rib.
The approach can be either transaxillary or supraclavicular. The outcome of TOS is dependent on appropriate patient selection for surgery and identification of patients that can benefit from TOS surgery and lead to satisfactory results.

Current consensus suggests that surgery should follow after conservative treatment failure or/and vascular complications; therefore, it is underlined that conservative treatment is the first option in the treatment of TOS.

Methodology

The keywords used were ‘Thoracic outlet syndrome’ and ‘Conservative treatment’, or ‘Physiotherapy’ or ‘Physical Therapy’, or ‘Rehabilitation’ and the search was limited to clinical studies in the English and French languages published in the last 20 years. Case studies were not included. The databases used for the search strategy were Medline, CINAHL and EMBASE.

Results

Treatment administered in studies consisted of either multidisciplinary care, orthosis application plus exercise, or a combination of exercise physical modalities and/or other interventions as presented in Table 1.

Outcome criteria and measures ranged from subjective, such as satisfaction, to objectives such as ROM restoration and grip strength. Table 2 presents the outcome criteria used.

The results of the studies were favorable for non-operative treatment compared with control groups or surgery groups. Table 3 presents results and follow-ups of these studies.

Discussion

Considerations regarding primary research studies on the conservative treatment of TOS

In the studies retrieved, various methodological issues were traced mainly related to sample selection and differential diagnosis for inclusion of patients in the study.

Lindgren et al. report that in those patients that were satisfied with symptom relief (88%), there existed patients whose real cause of symptoms identified was other than TOS. Thus, the sample had been contaminated by patients presenting with other pathologic conditions. The effectiveness of treatment for TOS may have been different (less or more effective), had the patients presenting with other pathologies been excluded. In that case, the results would better reflect the population of patients presenting with TOS.

Twenty-six patients (81%) received psychologic assessment upon admission in the study by Maillis et al. but no exclusion of patients took place when psychological issues were identified. Psycho-emotional disturbances were noted in all patients in the non-surgical group with modest or no pain reduction. This finding might have undermined the validity of the study, since pain might be experienced whether psychological issues are present or not, but the severity of pain experienced and the ability to cope are closely linked with the patient’s subjective perception of pain, which is affected by psychological status. Therefore the study might have investigated the effect of conservative treatment on patients with TOS presenting with or without associated psychological issues.

All patients in the study by Kenny et al. presented with osteoarthritic changes in the cervical spine. It is supported in the study that osteoarthritis was an underlying cause for loss of tone of the shoulder muscles which resulted in the development of TOS. Still, this proposition is not supported by other research in this study, and is not generally a widely accepted cause leading to TOS. This criterion might have specified the results to a portion of the population presenting with underlying osteoarthritic changes, and might not reflect the usual patients with TOS.

It should be mentioned that in the sample of the study of Maillis et al. all patients were unemployed with the possibility of litigation pending. These elements could have influenced the outcome of the study and might have led to malingering in the pre- and post-study period, resulting in poor results.

A significant issue not addressed by Ghoussoub et al. is the effect of drop-outs on sample homogeneity. Immediately following completion of therapy sessions there were 56 participants, whereas after 6 months there were 17 less, after 1 year 32 and after 2 years only 15 participated. Drop-outs can potentially disrupt the homogeneity of the sample. In that way, the sample might not reflect the population intended. The statistical significance of the results is not provided and therefore it is unclear whether the results were significant despite the drop-outs.

The results by Maillis et al. proved that surgery or conservative treatment were both beneficial for approximately half of the patients. The results may imply that the treatment protocol used is not effective, since this study provided the most discouraging results for both treatment options of all the studies found.

The results could be attributed to the length of follow-up, amounting to up to 12–33 months, which is a lot longer than the follow-ups in the other studies. The longest follow-up was that of Maillis et al. which is the only study that was clearly more positive for patients than the control surgery group. Therefore the results could be attributed to the length of follow-up. Another consideration is that benefits of treatment might also have disappeared and it is also possible that compliance with exercise and general guidelines after discharge might have been significantly reduced in the sample.

Constructing an evidence-based rehabilitation strategy

Nakatsuchi et al. produced positive results regarding more objective outcome criteria than subjective satisfaction, such as pain and numbness. Still, the application of an orthosis for 2–3 years is probably not comfortable for patients and may severely restrict mobility, functional activities or even quality of life. Furthermore, no follow-up took place, thus results reflected maximum treatment effect and not long-term effectiveness. Nevertheless,
Table 1  Types of study, sample characteristics and treatment details of clinical studies on the conservative treatment of thoracic outlet syndrome.

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Treatment</th>
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| Ghoussoub et al.\textsuperscript{16} | Retropective study  
$n = 58$.  
88% of the sample were female | Conservative treatment protocol comprised stretching and strengthening of appropriate muscles, massage and respiratory exercise (15 sessions) |
| Landry et al.\textsuperscript{19} | Prospective clinical trial  
$n = 79$  
Allocation: treatment proposed by physician. Surgical treatment group $n = 15$, conservative treatment group, $n = 64$ | Conservative treatment (no further details) |
| Lindgren\textsuperscript{13} | Cohort/prospective study  
$n = 119$ (28 men, 91 women) | Physiotherapy and patient education for 3 months (SD: 2 months), mean number of treatments was 4 (SD = 2), and exercises were performed daily twice per day at home |
| Novak et al.\textsuperscript{17} | Cohort/prospective study  
$n = 42$, mean age was 38 years (20–67) and mean symptom duration time 38 months (range 4–240, SD: 39) | Treatment lasted a mean of 2 years and 3 months. Application of orthosis lasted until improvement took place. Exercise was also instructed according to Britt’s method. Orthosis was worn at all times except when bathing or sleeping |
| Nakatsuhi et al.\textsuperscript{14} | Prospective study  
$n = 86$ (74 females), 50 for follow-up, 43 women, 31.7-year-old mean age | Conservative treatment comprised physical modalities, stretching, exercise, trigger point injections, and application of a shoulder retraction harness versus surgical treatment |
| Maillis et al.\textsuperscript{18} | Prospective study  
$n = 86$ (74 females), 50 for follow-up, 43 women, 31.7-year-old mean age | Physiotherapy program which lasted 3 weeks. The physiotherapy program included progressive resisted shoulder elevation exercises |
| Kenny et al.\textsuperscript{15} | Prospective study  
$n = 8$ | |

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should the orthosis not affect functional activities or quality of life (e.g. use of a reasonably comfortable orthosis), then the orthosis could be applied along with an exercise program, at the physician’s and therapist’s discretion. It should be stated though that the use of an orthosis is supported by only one clinical trial, thus its use is not particularly evidence based.

In the remaining studies, protocols where similar and comprised exercises including shoulder elevation, stretching of muscles in the shoulder girdle, trigger point injections and patient education. Patient education can be considered essential, since the patient should be aware that part of the rehabilitation process includes decision making. The patient in that way is motivated to follow treatment and take control of his/her progress.

The interventions mentioned above can be implemented in the multidisciplinary approach as the physiotherapy component and thus result in a comprehensive treatment approach.

Lindgren, presented results showing general improvement (subjective satisfaction reached 88%, return to work 73%, ROM restoration in 8/10 patients over a mean of 11.4 days). Although the study is not an RCT, well-defined and rigorous inclusion criteria were used and no significant methodological issues were found. The sample size was larger than other studies on TOS, and although the power of the study is not mentioned, it is likely that positive results were not due to chance. Furthermore, the follow-up was 24.6 months, and so insight on long-term effectiveness is provided. Thus the multidisciplinary approach that was used in the study appears to be a promising option for treating TOS conservatively, since it has been found to provide subjectively significant results to patients.

The positive results of multidisciplinary rehabilitation are considered due to the fact that through multidisciplinary care the patient receives attention and services from a number of healthcare professionals (who could include an occupational therapist, nurse and psychologist) instead of a limited number or only one professional. Therefore, treatment should also include rehabilitation strategies that have been proven to be effective using objective outcome criteria.

It is stressed that a direct comparison of the results across studies can be misleading since numerous variables and confounding factors may influence results.

Table 2: Outcome criteria of clinical studies on the conservative treatment of thoracic outlet syndrome.

<table>
<thead>
<tr>
<th>Study</th>
<th>Outcome Criteria</th>
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<tbody>
<tr>
<td>Ghousoub et al.</td>
<td>Pain reduction (hands, arms, neck), hand, pinch/needle strength, shoulder strength, and shoulder movement.</td>
</tr>
<tr>
<td>Kenny et al.</td>
<td>Subjective symptom/pain relief</td>
</tr>
<tr>
<td>Nakatsuchi et al.</td>
<td>Subjective symptom/pain relief</td>
</tr>
<tr>
<td>Novak et al.</td>
<td>Work and recreational activities, symptom relief</td>
</tr>
<tr>
<td>Lindgren</td>
<td>Subjective symptom/pain relief</td>
</tr>
<tr>
<td>Landry et al.</td>
<td>Days off from work, symptom reduction, symptoms leading to at least a temporary inability to work, was an inclusion criterion.</td>
</tr>
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</tr>
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</table>

Conclusion and recommendations for future research

All studies produced positive results following conservative treatment, to a significant extent. Exercise, the combination of the use of an orthosis and exercise (active and passive approach) produced positive results as well as exercise included in a multidisciplinary team approach with patient education. A multidisciplinary approach including exercise as the main component appears to be the most effective strategy.

Future research should be randomly selected, allocated and homogeneous. Confounding variables such as occupational status, pending litigation and age could be controlled by matching or alternative methods.
Table 3  Follow-ups and results of clinical studies on the conservative treatment of thoracic outlet syndrome.

<table>
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<tr>
<th>Follow up</th>
<th>Results on completion of 15 sessions. 70% reported improvement and 71% satisfaction with results. After 6 months, 66% reported that they were still compliant with exercise, and 84% were satisfied and there was one recurrence of symptoms. After 1 year, 15% were still compliant and 81% were satisfied. After 2 years only 15 patients responded and 12 were satisfied (80%)</th>
<th>Ghoussoub et al.\textsuperscript{16}</th>
<th>Landry et al.\textsuperscript{19}</th>
<th>Lindgren\textsuperscript{13}</th>
<th>Novak et al.\textsuperscript{17}</th>
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<th>Maillis et al.\textsuperscript{18}</th>
<th>Kenny et al.\textsuperscript{15}</th>
</tr>
</thead>
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<tr>
<td>Follow up</td>
<td>Follow up was obtained right after treatment (completion of 15 sessions), 6 months, 1 and 2 years</td>
<td>Mean follow-up was 4, 2 years (range 2–7, 5 years) after the initial evaluation</td>
<td>Mean follow-up period after treatment was 1 year</td>
<td>Follow-up ranged from 6 months to 5 years and 9 months. Mean follow-up was 2 years and 3 months</td>
<td>Mean follow-up lasted 33 months (12–66 months) for operated patients, 25 months after second surgery, 3 years for conservatively treated patients</td>
<td>There was no follow-up. Treatment lasted 3 weeks and patients were evaluated at the end of the 3 weeks</td>
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<td>Results</td>
<td>Most patients (59 out of 79) returned to work after either treatment. Conservative treatment resulted in fewer days away from work ((p&lt;.04)). Most patients demonstrated a reduction in the intensity of symptoms in the long term, but the level of symptoms was not significantly reduced in either group. It was concluded that surgery did not significantly improve functional outcome</td>
<td>Subjective satisfaction reached 88%, frequency of return to work amounted to 73% and range of motion restoration was successful in 8 out of 10. Improvement in grip strength and Tinel’s sign was associated with patient satisfaction ((p&lt;.001)) and return to work ((p&lt;.001)). As a conclusion, treatment provided symptom relief</td>
<td>38 patients reported reduced neck and shoulder symptoms, improvement was significantly better when distal nerve compression was not present ((p&lt;.006)). Twenty-five patients reported improvement, 10 no improvement and 7 increase of the intensity symptoms. Twenty-four out of 42, provided feedback on work and recreational activities. 16/24 reported full activities while the remaining 8/24 reported restrictions. Poor outcomes were associated with obesity ((p&lt;.04)), worker’s compensation ((p&lt;.04)), associated carpal or cubital tunnel syndrome ((p&lt;.04))</td>
<td>In the follow-up, the orthosis was more effective for distal symptoms. Pain disappeared or improved in 67% of patients, numbness in 85%, sensory in 84%, and motor disturbance in 80%. Proximal symptoms relieved in 65%. Half of the patients with weak grip benefited from the orthosis. Ability to perform activities of daily living was excellent in 33%, good in 44%, fair in 12% and poor in 9%. There were no drop-outs, but for the follow-up only 50 out of 86 patients were sent a questionnaire</td>
<td>Only 47% of the operated patients reported very good pain relief and 20% of the conservatively treated patients. Improvement in conservatively treated patients was supported to be due to the use of the harness. Re-operation was deemed necessary for six patients</td>
<td>All patients improved, with a significant decrease ((p&lt;0.01)) in pain (hands, arms, neck), pins/needles, weakness in hands and/or arms. Cervical neck and shoulder movements were normal in all patients after treatment and blood pressure measurements were not significantly different. There were no drop-outs</td>
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Research could also focus on which therapeutic methods in conservative treatment are more effective so as to minimize treatment duration as much as possible, and researchers could also investigate which therapeutic strategies provide more long-term relief.

References