SHOULDER COMPLAINTS AFTER NECK DISSECTION; IS THE SPINAL ACCESSORY NERVE INVOLVED?

C.P. van Wilgen, PT ¹,², P.U. Dijkstra, PT, MT, PhD ¹,², B.F.A.M. van der Laan, MD, PhD ³, J.Th. Plukker, MD, PhD, ⁴
J.L.N. Roodenburg, DDS, MD, PhD ⁵

¹. Department of Oral and Maxillofacial Surgery, ². Department of Rehabilitation, ³. Department of Otorhinolaryngology, Head & Neck Surgery, ⁴. Department of Surgical Oncology, University Hospital Groningen.

Summary

The purpose of the current study was to investigate the relation between shoulder morbidity (pain and range of motion), and the function of the spinal accessory nerve after neck dissection. Identifying dysfunction of the nerve gives insight in the mechanisms of post-operative shoulder complaints. In total 112 patients after neck dissection (73 male/39 female), mean (SD) age 61 (13) years, participated in the study. The mean duration of follow up was 3 (2) years. Five patients had radical, 43 modified radical, 48 supraomohyoid, and 16 posterolateral neck dissection. Thirty-nine complained of shoulder pain of whom 20 (51%) had dysfunction of the spinal accessory nerve, and 19 (49%) did not. In total 29 patients (26%) had dysfunction of the spinal accessory nerve of whom 20 (69%) had shoulder pain. Shoulder pain was significantly related to dysfunction of the nerve (p < 0.001). Twenty-three patients had a difference in active range of motion in shoulder abduction of ≥ 40°, of whom 22 (96%) had dysfunction of the nerve. A difference in active shoulder abduction of ≥ 40° was significantly related to loss of function of the spinal accessory nerve (p < 0.001).

Conclusion: Shoulder pain after neck dissection can only be attributed to dysfunction of the spinal accessory nerve in about 50%. If patients experience shoulder pain after neck dissection examination of the trapezius muscle and active bilateral abduction of the shoulder should be made to find out if the spinal accessory nerve is involved.
Introduction

Neck dissections are either elective or therapeutic procedures in the treatment of cancer of head and neck. Ewing was one of the first to describe shoulder complaints after radical neck dissection. These complaints consisted of reduced range of motion, reduced strength in the trapezius muscle, pain, disfigurement, and disability in daily activities. In that study of 100 patients, 47% developed shoulder complaints after radical neck dissection. These were attributed to resection of the spinal accessory nerve. Other authors have described higher incidences after radical neck dissection, ranging from 47% to 100%. Resection of the nerve during radical neck dissection usually leads to loss of function of the trapezius muscle, but in some cases the muscle will function normally, because of the innervation by branches from the cervical plexus. Innervation from the cervical plexus may be through connections with the spinal accessory nerve, or through an independent double motor supply directly to the trapezius muscle. An independent double innervation by means of the nerve, and the cervical plexus is present in about 18% of patients. The trapezius muscle is innervated solely through the cervical plexus in 6% of patients. Krause stated that in about 25%, radical neck dissection will not lead to loss of function of the trapezius muscle if enough cervical branches are preserved. Because of the high incidence of shoulder complaints after radical neck dissection, modified and selective neck dissections with preservation of the spinal accessory nerve were developed. However, even with preservation of the nerve, shoulder complaints developed in 18% to 77% after modified radical neck dissection, and in 29% to 39% after selective dissection.

Shoulder complaints after nerve-preserving procedures were still attributed to dysfunction of the spinal accessory nerve. However, Cheng et al. in a small study described shoulder complaints after neck dissections with no dysfunction of the nerve. He described 5 patients after radical neck dissection who complained of shoulder pain, but only four had signs of loss of function of the trapezius muscle. Additionally in a group of 7 patients after selective neck dissection, 2 had pain with no signs of loss of function of the trapezius muscle.

On the other hand, loss of function of the trapezius muscle does not always affect the shoulder. Saunders et al. showed in a study of 100 patients after
radical and modified radical neck dissections that there was a weak relation between shoulder complaints (pain, ache, numbness, and weakness), and physical signs of loss function of the trapezius muscle (atrophy, shoulder drop, winging of the scapula, and reduced abduction). The purpose of the current study was to investigate the function of the spinal accessory nerve after neck dissections, and the relation between it’s function, shoulder pain, and range of motion of the shoulder.

Materials and methods
Patients who had a neck dissection done by the multidisciplinary Head and Neck Oncology Group of the University Hospital Groningen, during the period 1994 to 2000, were invited to participate in the study. A week before they visited the hospital for a regular follow-up appointment, all patients were sent a letter telling them about the study. During the appointment they were asked by the physician to participate in the study. After given written informed consent they were included in the study. Patients with bilateral neck dissection, recurrence of the tumour, or who were unable to understand Dutch were excluded. All patients had a follow up of at least 1 year after neck dissection. From the medical record, the following data were retrieved: date of operation, type of resection, type of neck dissection, whether the spinal accessory nerve or the cervical plexus or both were preserved, the type of reconstruction, stage and whether they had preoperative or postoperative radiotherapy. Neck dissections were classified as described by Robbins et al. In this classification lymph nodes of the neck are divided into 6 anatomical levels, and types of neck dissection are divided into: radical, modified radical, and four types of selective dissections. We also looked for extended posterolateral neck dissections in which parts of the trapezius muscle and the splenius muscle are sacrificed. Function of the spinal accessory nerve was assessed by examining the trapezius muscle. This examination included: visual and palpable signs of atrophy of the trapezius pars descendens muscle duringshrugging of the shoulders; visual signs of shoulder drop; and quantifying scapula posture by measuring the distance of the superior angle of the scapula to the spine. The side of the neck dissection was compared to the non-dissected side, and if there was a difference of 2 cm or more a change in scapula posture was recorded.

Chapter 5
If a patient had two or three signs of loss of function of the trapezius muscle we assumed that the spinal accessory nerve was malfunctioning as a consequence of the neck dissection. This may be caused by neurapraxia or neurotmesis.

Shoulder pain was evaluated by means of an interview. Beside pain in the shoulder on the dissected side we also recorded pain on the non-dissected side, and whether the patient had shoulder pain preoperatively. Shoulder pain was measured with a numbered visual analogue scale VAS from 0 to 10. They were asked to report their mean pain score over the last week.

Active abduction of the shoulder of the dissected and non-dissected sides were measured with an inclinometer. The patient stood with the back, heels, and buttocks against the wall, and were asked to abduct both arms to the maximum of their ability. Reduced abduction was assumed if the difference between the dissected and non-dissected side was $\geq 40^\circ$.

All patients were measured by the same observer. Statistical analyses were made using the statistical package for the social sciences 10.0 (SPSS Inc., Chicago) and Chi-square analysis, and Student’s t-test for independent samples. Probabilities of less than 0.05 were accepted as significant.

**Results**

In total 122 patients participated in the study, (41 female/ 81 male) mean age 61 (13) years, and mean follow-up of 3 (1-7) years. All patients with shoulder complaints before operation (n=7), and patients who could not remember whether they did or did not (n=2) were excluded from further analyses. Of the remaining 113; 5 underwent radical, 43 modified radical, 48 supraomohyoid, 16 posterolateral, and 1 lateral neck dissection. Before statistical analyses the patient with the lateral neck dissection was excluded. The spinal accessory nerve was dissected in all radical neck dissections, and in one modified radical, and one posterolateral neck dissection.
In total the records of 112 patients (73 male/39 female) mean age 61 (13) years were analysed. The mean (SD) follow-up was 3 (2) years. Their characteristics are summarised in Table 1.

Table 2 shows the relation between the type of neck dissection and the signs of dysfunction of the trapezius muscle. Thirty-nine patients (35%) complained of shoulder pain of whom 19 (49%) had no dysfunction of the nerve, and 20 (51%) did. Dysfunction was present in 29 patients, of whom 20 (69%) had shoulder pain. Shoulder pain was significantly associated with

Chapter 5
dysfunction of the nerve (Table 3). Sixteen (14 %) patients reported temporary shoulder complaints after neck dissection, that were no longer present at the time of the study. The cervical plexus was preserved in 30 patients (27%), sacrificed in 6 (5 %), partially sacrificed in 5 (4 %) and it was unknown in 71 (63 %) of the patients. From these data we could not analyse the contribution of the cervical plexus to the function of the trapezius muscle.

**Table 2** Assessment of trapezius muscle and scapula as signs of dysfunction of the spinal accessory nerve, in patients after radical, modified radical, posterolateral, and supraomohyoid neck dissection.

<table>
<thead>
<tr>
<th>Type of neck dissection</th>
<th>Number of patients</th>
<th>Atrophy of trapezius</th>
<th>Shoulder drop</th>
<th>Scapula distance &gt; 2 cm</th>
<th>Spinal accessory nerve dysfunction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radical</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5 (100)</td>
</tr>
<tr>
<td>Modified radical</td>
<td>43</td>
<td>12</td>
<td>13</td>
<td>10</td>
<td>12 (28)</td>
</tr>
<tr>
<td>Posterolateral</td>
<td>16</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>9 (56)</td>
</tr>
<tr>
<td>Supraomohyoid</td>
<td>48</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>3 (6)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>112</strong></td>
<td><strong>29 (26)</strong></td>
<td><strong>33 (29)</strong></td>
<td><strong>28 (25)</strong></td>
<td><strong>29 (26)</strong></td>
</tr>
</tbody>
</table>

Data are number of patients having each type of neck dissection who were affected. Percentages of totals are in parentheses.

*Two or three signs of loss of function of the trapezius muscle function present.

The mean (SD) VAS for patients with shoulder pain was 4.2 (2.3). Nine patients perceived shoulder pain on the non-dissected side (VAS 4.2 (2.6)). Active range of motion (abduction) was measured in 111 patients, and the mean (SD) active abduction on the operated side 146° (42°), was significantly less than on the non-operated side 162° (26°). There was a difference in active range of motion of ≥ 40° in 23 patients, which was significantly associated with dysfunction of the spinal accessory nerve (Table 3).
Table 3  Dysfunction of the spinal accessory nerve in relation to shoulder pain, and active range of motion (abduction) after neck dissection

<table>
<thead>
<tr>
<th></th>
<th>Number of patients</th>
<th>Dysfunction</th>
<th>No dysfunction</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder pain</td>
<td>39</td>
<td>20 (51)</td>
<td>19 (49)</td>
<td>0.001</td>
</tr>
<tr>
<td>No shoulder pain</td>
<td>73</td>
<td>9 (12)</td>
<td>64 (88)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>112</td>
<td>29 (26)</td>
<td>83 (74)</td>
<td>0.001</td>
</tr>
<tr>
<td>Difference ≥ 40°*</td>
<td>23</td>
<td>22 (96)</td>
<td>1 (4)</td>
<td></td>
</tr>
<tr>
<td>Difference &lt; 40°</td>
<td>88</td>
<td>7 (8)</td>
<td>81 (92)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>111#</td>
<td>29 (26)</td>
<td>82 (74)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Data are number (%) of patients. Percentages are row percentages.

* Difference in abduction between the dissected side and the non-dissected side

# One patient was not physically examined

Discussion

Dysfunction of the spinal accessory nerve occurs in all cases after neck dissection with resection of the nerve and in about 22 % when it is preserved. It may cause shoulder pain but such pain may also be present in 49 % of the cases without signs of dysfunction. Shoulder pain can be attributed to dysfunction of the spinal accessory nerve in only 51% of patients.

As well as by a physical examination the function of the nerve can also be investigated by an electromyography (EMG), which provides information about the extent of denervation. However there is a strong relation between EMG findings and the findings of physical examination of the shoulder girdle.15,16

The active range of motion of the shoulder girdle decreases after neck dissection, particularly if the nerve has been resected.17 A common way of evaluating the descending trapezius muscle is to elevate the shoulder girdle, but because the levator scapulae also elevates the shoulder girdle, this is not a valid method. A clinical interview, and simple physical examination several weeks after neck dissection is a useful way of accessing the function of the spinal accessory nerve and complaints about the shoulder. The physical examination after neck dissection should include bilateral active

Chapter 5
abduction and inspection of the shoulder girdle, looking for atrophy of the trapezius muscle, changed posture of the scapulae, and shoulder drop.

We assumed that the nerve was not functioning if two of three physical signs of dysfunction of the trapezius were present. Only one physical sign might be caused by postoperative immobilisation by pain, neck dissection, or the primary resection. We therefore arbitrarily choose two physical signs out of three. All patients who were known to have had the nerve resected had at least two signs of dysfunction.

Shoulder pain has been claimed to be a consequence of dysfunction of the accessory nerve, and although there is a significant relationship, only 51 % of the patients with shoulder pain had a dysfunctional nerve. Different tissues have been suggested to be responsible for shoulder pain, in patients with dysfunction of the spinal accessory nerve: a secondary frozen shoulder,18 a hypertrophic sternoclavicular joint,19 and over-stretching of the rhomboid and levator scapulae muscle.20 As well as these tissues, damage to or cutting of cutaneous sensory nerves causing deafferentation pain, or neuromas, may also cause shoulder pain.21 Why many patients have shoulder pain after neck dissection with a normal nerve function is unknown. Deafferentation pain, myofascial pain or neuromas may be the cause.20

Of the patients with a dysfunctional spinal accessory nerve 9 of 29 (31%) had no shoulder pain, and 7 had no major change in abduction. These findings of dysfunction without shoulder complaints are similar to the findings of Saunders et al.9 Patients in that study had atrophy of the trapezius, shoulder drop, and a changed position of the scapula but did not develop pain or a big reduction in the range of motion. Probably these patients managed to cope with the dysfunction, which makes them an interesting group for further investigation.

After neck dissection with preservation of the nerve, neurapraxia may result in a loss of function of the trapezius muscle. Several authors have hypothesised about the causes of this: traction during the operation, microtraumata or devascularisation of the nerve during, or as a consequence of the operation.22,23 The chance for microtraumata may be more likely because of the anatomical variations in the course of the nerve, particularly in the passage of the sternocleidomastoid muscle, which may lead to more extensive damage.12,22 Looking into the course of the nerve, the most important levels are II and V. At level V the C3 and C4 branches can be

Chapter 5
damaged by the surgeon, and preservation of level V is probably the main reason why supraomohyoid neck dissection cause less morbidity of the nerve. The prevalence of dysfunction in posterolateral neck dissections should be, according to the dissected level II and V, comparable to that in modified radical neck dissections, but in our study the incidence is considerably higher. A reason for this might be that posterolateral neck dissections are more likely to be done in combination with removal of large tumours in the larynx. In this study no extended posterolateral neck dissections, in which the trapezius muscle is partly dissected, were found.

The preservation of the cervical plexus may decrease the incidence of shoulder pain in 25 %. In our group all seven patients in whom the spinal accessory nerve was sacrificed lost function in the trapezius muscle. Of these seven, in one the cervical plexus was sacrificed, one was partly sacrificed, and in the others cases it was unknown. So no conclusions can be drawn about the function of the cervical plexus after neck dissection. It seems worthwhile to detect, and to preserve the branches of the cervical plexus, and to try to spare or damage these branches as little as possible. This sparing mainly consists the preparation of level V in which the branches of C3 and C4 are located.

Our retrospective study was based on observations at least a year after neck dissection. Because of the long follow up (mean 3 years), recall of pre-operative shoulder problems may have been biased, and missing data because of incomplete medical records resulted in little information about preservation of branches of the cervical plexus.

We were interested in long term outcome and did not include patients within a year after neck dissection. In the first year after operation psychological distress and risk of recurrence of the tumour are high, and may influence perception of shoulder pain. Shoulder pain may also recover during the first postoperative year. Fourteen percent of the patients in our group had temporary shoulder complaints, mostly after modified radical neck dissection, in the first year. If shoulder complaints are the result of neurapraxia of the spinal accessory nerve, regeneration might occur even after the first postoperative year. Regeneration has mainly been described after modified radical neck dissection. As well as regeneration, effective coping strategies, reducing heavy physical activities, physiotherapy, and changes in psychological factors may reduce pain and disability.
In this group nine patients (8%) had shoulder complaints on the unoperated side. According to epidemiological research in a western population this is a low percentage.\textsuperscript{27} Based on the results of this study we conclude that shoulder pain after neck dissection can only partly (51%) be attributed to neurotmesis or neurapraxia of the spinal accessory nerve. Further investigations into the causes of shoulder pain, with and without dysfunction of the nerve, is required, and is important for postoperative rehabilitation.
References


Chapter 5