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van Wilgen, C.P.; Dijkstra, Pieter U. ; van der Laan, Bernard F.A.M.; Plukker, John T.H.M.; Roodenburg, Johannes

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MORBIDITY OF THE NECK AFTER HEAD AND NECK CANCER THERAPY

C. Paul van Wilgen, PhD,[1,2] Pieter U. Dijkstra, PhD,[1,2] Berend F. A. M. van der Laan, PhD,[3] John T. Plukker, PhD,[4] Jan L. N. Roodenburg, PhD[1]

[1] Department of Oral and Maxillofacial Surgery, University Hospital Groningen, PO Box 30.001, 9700 RB Groningen, The Netherlands. E-mail: c.p.van.wilgen@rev.azg.nl
[2] Department of Rehabilitation, University Hospital Groningen, Groningen, The Netherlands
[3] Department of Otorhinolaryngology, Head & Neck Surgery, University Hospital Groningen, Groningen, The Netherlands
[4] Department of Surgical Oncology, University Hospital Groningen, Groningen, The Netherlands

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Abstract: *Background.* Studies on morbidity of the neck after head and neck cancer therapy are scarcely described.

Methods. Patients who underwent surgery, including neck dissection, with and without radiation therapy at least 1 year before the study were asked to participate. We assessed neck pain, loss of sensation, range of motion of the cervical spine, and shoulder pain.

Results. Of the 220 patients who were invited, 153 (70%) participated in the study. Neck pain was present in 33% of the patients (n = 51), and shoulder pain was present in 37% of the patients (n = 57). Neuropathic pain of the neck was present in 32% (n = 49); myofascial pain, in 46% (n = 70); and joint pain, in 24% (n = 37). Loss of sensation of the neck was present in 65% (n = 99) and was related to type of neck dissection and radiation therapy. Range of motion of the neck was significantly decreased because of the neck dissection and/or radiation therapy in lateral flexion away from the operated side.

Conclusions. The occurrences of morbidity of the neck after cancer therapy were considerable and consisted of neck pain, loss of sensation, and decreased range of motion. © 2004 Wiley Periodicals, Inc. *Head Neck* **26:** 785–791, 2004

Correspondence to: C. P. van Wilgen

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Head and neck tumors account for 10% of all new cancer diagnoses in The Netherlands.[1] The treatment of head and neck tumors consists of surgery, radiation therapy, or both. During surgery, often an elective or therapeutic neck dissection is performed. As a result of head and neck cancer therapy, morbidity of the neck and shoulder regions may occur. This morbidity manifests itself through pain, loss of sensation, disfigurement, reduced range of motion of the shoulder, and changes in quality of life.[2–5]

Morbidity of the neck itself has been described in only a small number of studies. Neck tightness was reported in 71% of the cases, together with shoulder discomfort in 53% of the cases, having a substantial negative effect on quality of life. This was reported by Shah et al[6] in a retrospective study of 51 patients after different types of neck dissection. Head and neck pain was reported by Chaplin et al[2] in 25% of 93 patients after neck dissection, radiation therapy, or both. In a study of 25 patients with persistent neck pain after neck dissection, Sist et al[7] described two types of neck pain: neuropathic pain (100%) and myofascial pain (72%). In contrast to these studies, Talmi et al[8] described three groups of patients (n = 88) after radical and modified radical neck dissection and claimed that pain in the neck after neck dissection was uncommon.

The results of previous studies regarding the presence of neck pain after head and neck cancer therapy are conflicting. It is unclear whether the type of neck dissection has any relationship with the occurrence of neck pain. The exact cause of neck pain after neck dissection was unclear. Besides neuropathic pain, other causes have been described: sternoclavicular joint pain caused by subluxation[9] or hypertrophy[10] and myofascial pain in head and neck muscles.[11]

Loss of sensation after selective neck dissection was related to sacrificing the sensory cervical root branches. For the analyses of loss of sensation, Saffold et al[12] divided the neck into eight regions including regions A through F (described herein). Region A is the lower half of the external ear, extending from the root of the helix to the tip of the lobule; region B, the midface, including the face above a line drawn between the oral commissure and the angle of mandible; and region C, the lower face, extending from below this line (region B) to the inferior border of the mandible. The neck is divided into upper and lower portions by a horizontal line at the level of the thyroid prominence. Region D is the upper posterior neck behind the anterior border of the sternocleidomastoideus; region E, the upper anterolateral neck, extending from the anterior border of the sternocleidomastoideus to a vertical line drawn from the facial notch of the mandible; and region F, the lower posterior neck behind the anterior border of the sternocleidomastoideus. Saffold et al also included two central regions over the larynx.

In the study by Saffold et al, after neck dissection in which the sensory cervical root branches were sacrificed, significantly more sensory deficits were present than in neck dissections in which the sensory cervical root branches were preserved.[12] Loss of sensation after neck dissection, including dissection of the sensory nerve branches, was reported most frequently in regions D, E, and F. However, loss of sensation in the neck could also be related to radiation therapy.[13] To the best of our knowledge, no other studies have adequately evaluated the loss of sensation after neck dissection.

Haribhakti et al[14] described impairment of neck movement after neck dissection and additional reconstruction. They found no differences in patients with or without a pectoralis major myocutaneous flap. Both Schuller et al and Haribhakti et al used questionnaires, without a physical examination or measure of range of motion. Studies measuring the range of motion of the cervical spine after neck dissection were not available.

The aim of our study was to analyze neck morbidity, including neck pain and loss of sensation and range of motion of the neck after head and neck cancer therapy, and to study the relationship between morbidity and type of neck dissection, number of dissected levels, radiation therapy, and shoulder pain.

MATERIALS AND METHODS

Patients who underwent a neck dissection with or without radiation therapy, performed by the multidisciplinary Head and Neck Oncology Group of the University Hospital Groningen from 1994 to 2000, were asked to participate. They were informed about the study by a personal letter, which was sent 1 week before they visited the hospital for an appointment as part of standard postoperative care. Patients who had a recurrence of the tumor or who could not understand Dutch were excluded. All patients were at least 1 year after surgery. From the medical records, we retrieved the date of surgery, type of surgery, type of neck dissection, preserved and/or sacrificed structures, preoperative or postoperative radiation therapy, and type of reconstruction.

Types of neck dissections were recorded in accordance with the classification of Robbins et al[15]: radical neck dissection, modified radical neck dissection, and four types of selective neck dissections. In this classification, lymph nodes in the neck are divided into six anatomic levels. Sensory cervical root branches were not preserved during surgery. Neck dissections were performed by use of the upper McFee incision for the dissection of levels 1, 2, and 3 and the lower McFee incision for the dissection of levels 4, 5, and 6. For the analyses of pain and sensation, we categorized the patients into two groups: patients who underwent dissection of only the upper areas 1, 2, and 3 (all supraomohyoid neck dissections) and patients who underwent dissection of the upper and lower areas 1 to 6 (all other neck dissections). A lower McFee incision was always performed in combination with an upper McFee incision.[14]

Table 1. Neck pain, hyperesthesia, and allodynia in relation to radiation therapy, total of levels dissected during neck dissection, and shoulder pain (n = 153).

		Radiation therapy		Levels dissected		Shoulder pain	
	Frequency	Yes (n = 107)	No (n = 46)	Upper* (n = 72)	Upper + lower† (n = 81)	Yes (n = 57)	No (n = 96)
Neck pain	Yes 51 (33%)	41 (38%)	10 (22%)	21 (29%)	30 (37%)	34 (60%)	17 (18%)
	No 102 (67%)	66 (62%)	36 (78%)	51 (71%)	51 (63%)	23 (40%)	79 (82%)
			$p < .046$		n.s		$p < 0.01$
Hyperpathia	Yes 49 (32%)	36 (33%)	13 (28%)	23 (32%)	26% (32%)	23 (40%)	26 (27%)
	No 104 (68%)	71 (66%)	33 (72%)	49 (68%)	55% (68%)	34 (60%)	70 (73%)
			$p < .064$		n.s.		n.s.
Allodynia	Yes 20 (13%)	15 (33%)	5 (11%)	9 (13%)	11 (14%)	13 (23%)	7 (7%)
	No 133 (87%)	92 (66%)	41 (89%)	63 (88%)	70 (86%)	44 (77%)	89 (93%)
			$p < .056$		n.s.		$p < 0.01$

Abbreviation: n.s., not significant.
Note. Percentages refer to column percentages.
**Upper McFee are all supraomohyoid neck dissections.*
†Upper and lower McFee are radical, modified radical, and posterolateral neck dissections.

We asked patients with neck pain for their average pain intensity over the previous week. Pain was measured by a numbered (0−10) visual analog scale (VAS). Allodynia was defined as an abnormal evoked pain tested with a nonpainful stimulus.[16] Allodynia was elicited by touching the neck and cheek gently with a fingertip several times. When a patient reported pain, allodynia was assumed to be present. Hyperpathia was defined as an abnormally painful reaction to a painful stimulus compared with the reaction on an unoperated or radiated body part.[16] Hyperpathia was tested with a pin prick. To get patients acquainted with the procedure, the nonirradiated cheek or upper arm was tested first. Hyperpathia was present if pain was felt more intensely in the neck, or cheek, at the side of the neck dissection compared with the control region. Myofascial pain was tested by palpating the trapezius muscle, the levator scapula, rhomboid muscles, and the pectoral muscle.[17] Myofascial pain was present if the same spot was reported as painful at least

Table 2. Myofascial pain and pain of the sternoclavicular joint and acromioclavicular joint related to radiation therapy, number of dissected areas, and shoulder pain.

		Radiation therapy		Levels dissected		Shoulder pain	
Location of pain	Pain on the operated side (n = 153)	Yes (n = 107)	No (n = 46)	Upper* (n = 72)	Upper + lower† (n = 81)	Yes (n = 57)	No (n = 96)
Myofascial pain							
Trapezius par desc.	54 (35%)	39 (37%)	15 (33%)	24 (33%)	30 (38%)	33 (58%)	21 (22%)
			n.s.		n.s.		$p < .01$
Levator scapulae	70 (46%)	54 (50%)	16 (35%)	26 (36%)	44 (54%)	48 (84%)	22 (23%)
			n.s.		$p < .05$		$p < .01$
Rhomboideus	47 (31%)	34 (32%)	13 (28%)	19 (26%)	28 (35%)	38 (68%)	9 (9%)
			n.s.		n.s.		$p < .01$
Pectoralis major	11 (7%)	8 (8%)	3 (7%)	3 (4%)	8 (10%)	8 (14%)	3 (3%)
			n.s.		n.s.		$p < .05$
Joint pain							
Sternoclavicular joint	24 (16%)	18 (17%)	6 (13%)	10 (14%)	14 (17%)	16 (28%)	8 (8%)
			n.s.		n.s.		$p < .01$
Acromioclavicular joint	37 (24%)	27 (25%)	10 (22%)	13 (18%)	24 (30%)	26 (46%)	11 (12%)
			n.s.		n.s.		$p < .01$

Abbreviation: n.s., not significant.
Note. For statistical analyses chi-square test was used. Percentages are column percentages.
**Upper McFee are all supraomohyoid neck dissections.*
†Upper and lower McFee are radical, modified radical, and posterolateral neck dissections.

Table 3. Frequencies and percentages of regions with loss of sensation after four types of neck dissection.

Region	SOHND (*n* = 72)	PLND (*n* = 22)	MRND (*n* = 54)	RND (*n* = 5)	Loss of sensation, total group (*n* = 153)
A	10 (14%)	12 (55%)	32 (59%)	5 (100%)	59 (38%)
B	6 (8%)	2 (9%)	5 (9%)	2 (40%)	15 (10%)
C	6 (8%)	1 (5%)	9 (17%)	2 (40%)	18 (12%)
D	6 (8%)	9 (41%)	28 (52%)	4 (80%)	47 (31%)
E	20 (28%)	18 (82%)	43 (80%)	5 (100%)	86 (56%)
F	3 (4%)	13 (59%)	31 (57%)	5 (100%)	52 (34%)

Abbreviations: SOHND, Supraomohyoid neck disection; PLND, posterolateral neck dissection; MRND, modified radical neck dissection; RND, radical neck dissection.
Clinical note: supraomohyoid neck dissection has a lower degree of loss of sensation in almost all regions.

two times during palpation. If muscles could not be palpated properly (for instance, in case of severe trapezius muscle atrophy), the muscle was reported as not painful. Myofascial pain could be distinguished from allodynia or hyperpathia. Allodynia and hyperpathia were sensations tested by stimulating the skin, whereas myofascial pain was investigated by systematically palpating the muscles and looking for taught bands, trigger points, and pain.[17] Furthermore, the sternoclavicular joint and acromioclavicular joint were tested for pain by means of a "joint play" test.[18]

Because it was difficult in some cases to distinguish between neck pain and shoulder pain, we also assessed shoulder pain. Patients were asked whether they had shoulder pain, and their average pain intensity over the previous week was assessed with a numbered VAS (0–10). Patients who had undergone bilateral surgery were assessed on the (most) painful side, or if pain was not present, on the dominant side.[12] Loss of sensation was assessed in six distinct regions (regions A through F, defined by Saffold et al and described in the Introduction) related to the anatomic regions of the sensory cervical root branches.[12] Saffold et al described eight regions; we did not use the two central regions over the larynx. Patients were examined for sense of touch, with a wisp of cotton or pin prick. Patients were first acquainted with the nature of the stimulus by applying it to an unoperated and nonirradiated body part as mentioned previously. Patients were asked to respond each time they felt the wisp of cotton or pin. All regions were touched at least five times; when more than 50% of the attempts were not felt or reported incorrectly, loss of sensation was assumed. To analyze loss of sensation, we calculated the number of anatomic regions with loss of sensation. Range of motion was measured by means of a cervical measurement system. This system consisted of a helmet with two inclinometers and a compass.[19] All motions of the cervical spine (rotation to both sides, lateral flexion to both sides, extension, and forward flexion) were measured actively while the patient was seated.

For statistical analyses, we used SPSS 10.0. Descriptive statistics, chi-square test, 95% confidence interval calculation, and linear regression (method stepwise forward) were performed.

RESULTS

In total, 220 patients were invited, of which 153 patients (70%) participated in this study. The study population had 102 male and 51 female patients (mean age, 61.3 years; SD, 11.9). The mean follow-up was 3.0 years (SD, 1.7). Unilateral neck dissection was performed in 121 patients, and bilateral neck dissection was performed in 32 patients. The following type of neck dissections were performed: 72 supraomohyoid neck dissections, 22 posterolateral neck dissections, 54 modified radical neck dissections, and five radical neck dissections. In seven patients, the spinal accessory nerve was sacrificed. In all supraomohyoid neck dissections, the upper McFee incision was used; for all others, the upper and lower McFee incisions were used. Radiation therapy was given to 107 patients (90 postoperative, 21 preoperative, and four preoperative and

Table 4. Results of linear regression of analysis to predict the number of regions with loss of sensation, as a result of head and neck cancer therapy.

Variable	ß	95% CI interval for ß	*R* square
Levels dissected	0.9	(0.6 to 1.1)	
Radiation therapy	1.2	(0.7 to 1.7)	
Constant	−2.5	(−3.3 to −1.5)	.39

Note. In the regression analysis, the following variables were entered stepwise, number of levels dissected (level 1–6) and radiation therapy (yes/no), age, sex, and follow-up.

Table 5. Active range of motion of the cervical spine in degrees and standard deviation, classified by age, in patients (n = 153) after radical, modified radical, or selective neck dissection.

Age, y	No. of patients	Rotation away from operated side	Rotation to operated side	Lateral flexion away from operated side	Lateral flexion to operated side	Flexion	Extension
≤40	n = 6	70° (15)	74° (16)	35° (12)	35° (11)	66° (11)	53° (10)
40–49	n = 15	61° (21)	70° (14)	31° (13)	35° (12)	69° (15)	50° (17)
50–59	n = 51	61° (15)	60° (14)	26° (9)	29° (8)	52° (13)	49° (15)
60–69	n = 48	59° (13)	59° (13)	24° (10)	29° (10)	52° (11)	47° (15)
70–79	n = 23	58° (7)	55° (10)	23° (8)	27° (8)	53° (12)	48° (11)
≥80	n = 10	52° (14)	52° (10)	19° (7)	20° (10)	45° (9)	37° (21)

postoperative). Fifty-one patients (33%) experienced neck pain, of which 20 (39%) had allodynia in the neck, and 49 (96%) experienced hyperpathia; the mean intensity of neck pain was 3.5 (SD, 2.3). Of the patients who underwent unilateral surgery, four (3%) had neck pain on the nonsurgical side; the mean pain intensity was 2 (SD, 2.1). Neck pain was significantly related to radiation therapy but not to the number of levels dissected (Table 1). Shoulder pain, on the surgical side, was present in 57 patients (37%); the mean pain intensity was 3.7 (SD, 2.3). Shoulder pain was significantly related to neck pain and allodynia ($p < .01$) (Table 1). Myofascial pain in the levator scapulae muscle and trapezius pars descendens muscle was found most frequently (Table 2). Myofascial pain was present significantly more on the surgical side ($p < .05$). With regard to the patients who underwent unilateral surgery, in the nonsurgical side myofascial pain was present in 10 patients (8%) in the levator scapulae, 11 (9%) in the trapezius muscle, and in six (5%) in the rhomboid muscles. Myofascial pain was significantly related to the number of levels dissected for the levator scapulae ($p < .05$) but not for other muscles (Table 2). Myofascial pain was not related to radiation therapy (Table 2). Pain was present at the sternoclavicular joint in 24 patients (16%) and in the acromioclavicular joint in 37 patients (24%). Pain was significantly more frequently present on the surgical side ($p < .01$). On the nonsurgical side, the sternoclavicular joint was painful in five patients (4%), and the acromioclavicular joint was painful in six patients (5%). Joint pain was not significantly related to the number of levels dissected or radiation therapy (Table 2). Shoulder pain was closely related to myogenic pain and joint pain (Table 2).

Ninety-nine patients (65%) experienced loss of sensation. This loss was most frequently observed in area E (upper anterolateral neck), area A (the lower half external ear), and area F (lower posterior neck) (Table 3). Loss of sensation was significantly related to the number of levels dissected and radiation therapy (Table 4). Age and follow-up were not significantly related to loss of sensation.

The descriptive statistics of range of motion of the cervical spine for different age groups are

Table 6. Linear regression to predict range of motion of the cervical spine after head and neck cancer therapy.

Variable				
Dependent	Independent	ß	95% CI of ß	R square
Active lateroflexion to the operated side	Age	−0.3	(−0.4 to −0.1)	
	Constant	44.0	(34.4 to 35.6)	.12
Active lateral flexion away from operated side	Age	−0.3	(−0.4 to −0.1)	
	Levels dissected	−2.7	(−4.8 to −0.5)	
	Radiation therapy	−7.9	(−15.7 to −0.3)	
	Constant	59.4	(44.0 to 74.8)	.22
Active rotation to the operated side	Age	−0.4	(−0.6 to −0.2)	
	Constant	83.5	(69.2 to 97.8)	.13
Active flexion	Age	−0.4	(−0.6 to −0.2)	
	Constant	79.4	(65.8 to 93.0)	.14

Note. In the regression analyses, the following variables were entered stepwise; age, number of levels dissected during neck dissection, and radiation therapy (yes/no).
In the other movements of the cervical spine no significant influence of age, neck dissection, or radiation therapy was found.

presented in Table 5. To analyze the relationship between active range of motion and the number of levels dissected and radiation therapy, we performed a linear regression (stepwise forward). Lateral flexion away from the dissected side was significantly related to age (β: −0.3), number of levels dissected (β: −2.7), and radiation therapy (β: −7.9). Active lateroflexion toward the surgical side, active rotation toward the surgical side, and active flexion were only significantly related to age (Table 6). The sternocleidomastoid muscle was sacrificed in 22 patients. No significant relationship was found between sacrificing the sternocleidomastoid muscle and a reduced range of motion of the neck, although rotation away from the surgical side was an average of 10° less in patients for whom the sternocleidomastoid muscle was sacrificed.

DISCUSSION

Neck pain (33%) and loss of sensation (65%) were important aspects of neck morbidity after head and neck cancer therapy. Contrary to Talmi et al,[8] we found neck pain in 33% of the patients. Similar to the results of Sist et al,[7] we found that neuropathic pain, hyperpathia (96%), and allodynia (39%) were present in most patients with neck pain. In daily life, patients experienced neuropathic pain during shaving or when they were exposed to wind or low temperatures. Neck pain was significantly related to radiation therapy. Although the difference was not significant, hyperpathia ($p < .064$) and allodynia of the neck ($p < .056$) seemed to be present more frequently after radiation therapy, suggesting a trend.

Myofascial pain was most frequently present in the levator scapulae (46%). This percentage is higher than the percentage of patients that reported neck pain (33%). Several patients did not experience myofascial pain spontaneously but only during palpation, and myofascial pain was often felt as shoulder pain. Myofascial pain in the levator scapulae was related to the number of dissected levels. For the other types of myofascial pain, no relationship was found with the number of levels dissected. Myofascial pain was strongly related to shoulder pain.

Postoperative myofascial shoulder pain may be associated with postoperative shoulder drop as a consequence of spinal accessory nerve dysfunction.[20] But in this group, in approximately 50% of the patients with shoulder pain, the spinal accessory nerve was functioning normally.[21] In these cases, myofascial shoulder pain could not be attributed to spinal accessory nerve dysfunction. So shoulder pain with an intact spinal accessory nerve should be attributed to other causes, such as psychological factors.[22] The relationship between shoulder pain and neck pain is significant, probably because most of the tested structures span both neck and shoulder region. It seems, however, that neck pain was associated more with neuropathic pain and shoulder pain more with myofascial pain.

Loss of sensation was seen most in areas E, A, and F. These findings were similar to the findings described by Saffold et al.[12] Many patients in our study group mentioned recovery of loss of sensation in the first postoperative year; after this first year, loss of sensation was not related to follow-up. Loss of sensation was not likely to recover more than 1 year after surgery. The assessment of loss of sensation could be influenced by reconstruction in the surgical area. In our population, however, reconstruction did not significantly influence loss of sensation. Range of motion of the cervical spine was affected by radiation therapy and the number of dissected levels in lateral flexion away from the surgical side. Scars and radiation therapy could cause fibroses of tissues in the neck. Movements for which elasticity of soft tissues is needed seem to be especially affected. Other movements were not significantly related to radiation therapy or the number of levels dissected. Therefore, we conclude that the effects of neck dissection and radiation therapy on range of motion of the neck are limited. In the literature, normative data of range of motion of the cervical spine of similar patients assessed with the same type of inclinometer were not available.

In patients with a sacrificed sternocleidomastoid muscle, a nonsignificant mean reduction of 10° in active rotation away from the surgical side was found. The difficulty in analyzing the influence of sacrificing the sternocleidomastoid muscle on neck range of motion was that we only had a small group, and almost all (81%) underwent a radical or modified radical neck dissection.

In this study, 220 patients were invited to participate. Participation in the study was high (70%). Reasons for not participating were lack of time, lack of interest, or a belief that the investigation was too strenuous. Participation might have been higher in patients perceiving pain and or loss of sensation. Therefore, incidences described in this study may be an overestimation of the incidence of neck morbidity in the total population after head and neck cancer therapy.

The implications for the clinical practice for patients after head and neck cancer therapy are that in the management of neck pain, a distinction should be made between different types of pain. Neuropathic pain should be treated differently than myofascial pain. Neuropathic pain may be prevented by standard adequate perioperative pain management.[23] Furthermore, patients can be informed, before head and neck cancer therapy, about the chances of loss of sensation and reduced range of motion. It is important to inform patients, both preoperative and postoperative, about possible morbidity after therapy. Especially in patients who fear tumor recurrence, education about pain and the source of pain can be of great value, because these patients have an increased body perception.[24] Furthermore, standard exercises to preserve range of motion of the neck may be important, although so far no studies have been performed to analyze the effects of exercises on range of motion of the neck in these patients.

On the basis of our results, we conclude that neck pain after head and neck cancer therapy was present in 33% of the patients and is explained primarily by neuropathic pain. Neck pain is closely related to shoulder pain. Shoulder pain is present in 37% of the patients and is related to myofascial pain. Loss of sensation was present in 65% of the patients and was related to the number of dissected levels and radiation therapy. Range of motion, the lateral flexion away from the surgical side, was decreased significantly by surgery, radiation therapy, or both.

REFERENCES

1. Netherlands Cancer Registry. Head and Neck tumours in the Netherlands 1989–1995. Utrecht: Association of comprehensive cancer centres; 1998.
2. Chaplin JM, Morton RP. A prospective, longitudinal study of pain in head and neck cancer patients. Head Neck 1999; 21:531–537.
3. Dijkstra PU, van Wilgen CP, Buijs RP, et al. Incidence of shoulder pain after neck dissection: a clinical explorative study for risk factors. Head Neck 2001;23:947–953.
4. Kuntz AL, Weymuller-EA J. Impact of neck dissection on quality of life. Laryngoscope 1999;109:1334–1338.
5. Morton RP. Evolution of quality of life assessment in head and neck cancer. J Laryngol Otol 1995;109: 1029–1035.
6. Shah S, Har-El G, Rosenfeld RM. Short-term and long-term quality of life after neck dissection. Head Neck 2001; 23:954–961.
7. Sist T, Miner M, Lema M. Characteristics of postradical neck pain syndrome: a report of 25 cases. J Pain Symptom Manage 1999;18:95–102.
8. Talmi YP, Horowitz Z, Pfeffer MR, et al. Pain in the neck after neck dissection. Otolaryngol Head Neck Surg 2000; 123:302–306.
9. Krause HR. Shoulder-arm-syndrome after radical neck dissection: its relation with the innervation of the trapezius muscle. Int J Oral Maxillofac Surg 1992;21:276–279.
10. Cantlon GE, Gluckman JL. Sternoclavicular joint hypertrophy following radical neck dissection. Head Neck Surg 1983;5:218–221.
11. Remmler D, Byers R, Scheetz J, et al. A prospective study of shoulder disability resulting from radical and modified neck dissections. Head Neck Surg 1986;8:280–286.
12. Saffold SH, Wax MK, Nguyen A, et al. Sensory changes associated with selective neck dissection. Arch Otolaryngol Head Neck Surg 2000;126:425–428.
13. Schuller DE, Reiches NA, Hamaker RC, et al. Analysis of disability resulting from treatment including radical neck dissection or modified neck dissection. Head Neck Surg 1983;6:551–558.
14. Haribhakti VV, Kavarana NM, Tibrewala AN. Oral cavity reconstruction: an objective assessment of function. Head Neck 1993;15:119–124.
15. Robbins KT, Medina JE, Wolfe GT, Levine PA, Sessions RB, Pruet CW. Standardizing neck dissection terminology. Official report of the Academy's Committee for Head and Neck Surgery and Oncology. Arch Otolaryngol Head Neck Surg 1991;117:601–605.
16. Merskey H, Bogduk N. Classification of chronic pain, 2nd ed. Seattle: IASP Press; 1994.
17. Travell JG, Simons DG. Myofascial pain and dysfunction. Baltimore: Williams and Wilkins; 1982.
18. Frisch H. Systematic musculoskeletal examination. Berlin: Springer-Verlag; 1995. p 280.
19. Mellin G, Olenius P, Setala H. Comparison between three different inclinometers. Physiotherapy 1994;80: 612–614.
20. Nori S, Soo KC, Green RF, Strong EW, Miodownik S. Utilization of intraoperative electroneurography to understand the innervation of the trapezius muscle. Muscle Nerve 1997;20:279–285.
21. Van Wilgen CP, Dijkstra PU, van der Laan BFAM, Plukker JT, Roodenburg JLN. Shoulder complaints after neck dissection is the spinal accessory nerve involved? Br J Oral Maxillofacial Surg 2003;41:7–11.
22. Zaza C, Baine N. Cancer pain and psychological factors: a critical review of the literature. J Pain Sympt Management 2002;5:526–542.
23. McQuay HJ, Moore RA. Pre-emptive analgesia: a systematic review of clinical studies: 1950–94. In: McQuay HJ, editor. An evidence based resource for pain relief. Oxford: Oxford University Press; 1998. p 164–171.
24. Jones C, Humphris G, Dixon R, Hatcher MB. Fear of cancer recurrence—a literature review and proposed cognitive formulation to explain exacerbation of recurrence fears. Psycho-Oncology 1997;6:95–105.