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Motor and sensory complications following neck dissection: a prospective telephone-interview study

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Main Article

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Abstract

Objectives. To clarify incidence, progression and effect on quality of life of shoulder/neck disability, oral asymmetry, neuropathic pain and numbness following neck dissection.

Methods. This prospective telephone-interview study delivered the Neck Dissection Impairment Index, Neuropathic Pain Questionnaire, House–Brackmann Scale and questions assessing numbness to patients before and three times after neck dissection.

Results. Mean Neck Dissection Impairment Index (6.43 *vs* 22.17; $p = 0.004$) and Neuropathic Pain Questionnaire scores (0.76 *vs* 2.30; $p = 0.004$), proportions of patients with oral asymmetry (3 per cent *vs* 33.3 per cent; $p = 0.016$), ear (5.9 per cent *vs* 46.7 per cent; $p = 0.002$), jaw (5.9 per cent *vs* 53.3 per cent; $p < 0.001$) and neck numbness (5.9 per cent *vs* 53.3 per cent; $p < 0.001$) each increased significantly from pre-operation versus 12 weeks after. Neuropathic pain diagnoses did not reach significance. No outcome returned to baseline and progression of each was illustrated over time.

Conclusion. The findings demonstrated that these complications are common and persist throughout short-term recovery. Screening to identify and manage complications could improve post-operative care.

Introduction

Head and neck cancer, which is the eighth most common cancer in the UK, has increased in incidence by one-third since the 1990s and five-year survival (26–67 per cent) is poor.[1] Management typically involves a combination of surgery, chemotherapy and radiotherapy; neck dissection represents a core element of the surgical management to prevent metastatic spread.[2] Refinement of this procedure over 130 years has reduced associated morbidity.[3] Although clinically significant neurological sequelae persist, some may be disease related, others iatrogenic. Neurological sequelae arise through spinal accessory nerve, marginal mandibular nerve, superficial cervical plexus and cervical nerve root damage. Clinical manifestations include shoulder and neck dysfunction,[4] salivary incompetence and aesthetic deformity (marginal mandibular nerve),[5] loss of sensation (cervical nerve roots)[6] and pain, including neuropathic pain specifically (superficial cervical plexus).[7] Hence, these structures are paramount to understanding morbidity arising after neck dissection.

Shoulder dysfunction, often attributed to spinal accessory nerve damage, is reportedly the second commonest complication after neck dissection.[8] Comparatively, neck dysfunction is neglected, which may be an oversight as research suggests 26 per cent of patients experience this.[9] The biomechanics of the neck and shoulder are strongly connected.[10] Unfortunately, shoulder range of motion tends to be investigated alone and the true extent of impairment to mobility may be overlooked. This potential neglect has translated into clinical practice as national guidelines only recommend post-operative physiotherapy for shoulder dysfunction,[11] but not neck dysfunction. Furthermore, shoulder dysfunction itself is oversimplified as this is not synonymous with spinal accessory nerve injury. For example, more than 50 per cent of patients experience shoulder dysfunction[9] but only 5.1 per cent of patients have an identified spinal accessory nerve injury after neck dissection.[8] It is essential that research assesses shoulder and neck mobility together and move away from focusing on individual nerve injuries.

Existing research relies on retrospective analyses of patient records, which are biased towards complications requiring acute intervention during the post-operative period. For example, marginal mandibular nerve injury incidence has been reported at only 4 per cent,[12] loss of sensation and neuropathic pain are seldom reported at all in retrospective analyses. van Wilgen *et al.*[13] actively screened for altered sensation reporting a 60 per cent incidence and Batstone *et al.*[14] did the same for marginal mandibular nerve injury reporting incidence at 23 per cent.

Furthermore, Gane *et al.*,[9] van Wilgen *et al.*[13] and Ramphul *et al.*[15] identified neuropathic pain incidence of 19–35 per cent through active screening in cross-sectional analyses. These neurological sequelae do not require acute intervention in hospital, hence are commonly not recorded in medical records. Existing research consequently underestimates the incidence of numbness, oral asymmetry and neuropathic pain. Prospective studies are needed to overcome these underestimates, and active screening is required to translate this evidence into improved post-operative care.

Symptom evolution during recovery is also under investigated, hampering understanding of patient experience and early intervention for post-operative complications. Cross-sectional analyses, whilst superior to existing retrospective studies, only provide a snapshot in time. Gane *et al.*[9] supported the need for prospective data as they identified that improvement in pain is positively correlated with time since surgery, however they conceded that serial measurements would provide better insight into how symptoms evolve. At a practical level, neuropathic pain may be misinterpreted as tumour recurrence, initiating unnecessary investigations and adding to patient burden.[7] Understanding neuropathic pain peaks and troughs during recovery could abate concerns about recurrence and promote early intervention. This approach should similarly be applied to oral asymmetry, numbness and shoulder dysfunction. Prospective research is essential to improve understanding of post-operative recovery, with serial measurements over time to characterise precisely how each of these main neurological sequelae progress during the follow-up period.

Understanding complications after neck dissection, independently of quality of life (QoL) assessment, is insufficient. Hence this study was designed to prospectively screen for neuropathic pain, sensory disturbance, neck and shoulder weakness and oral asymmetry, as well as their effects on patients' QoL. This serves to plug gaps in existing literature and improve understanding of patients' recovery after neck dissection. The objectives of the study were to understand the incidences of the above-mentioned complications of neck dissection as well as understand how they change over the post-operative recovery period.

Materials and methods

A longitudinal prospective design was used, with structured telephone interviews happening pre-operatively and at 1, 6 and 12 weeks post-operatively. All patients undergoing neck dissection surgery, over a six-month period (September 2021 to February 2022), and under the care of an ENT and maxillofacial surgery team at a UK tertiary centre were included in the study. Appropriate candidates were identified through advance review of the weekly theatre lists. All suitable candidates were contacted and offered the opportunity to participate in the study. The only exclusion criterion was lack of patient consent. Patient information leaflets were distributed and informed consent gained at the pre-operative telephone call. The standard approach at this institution is to preserve the accessory nerve, unless it is required to be sacrificed due to tumour invasion and to complete an oncologically sound procedure. The study was classed a service evaluation by the local research governance department, hence no formal ethical approval was deemed to be required.

Standardised, reliable and valid instruments were used to assess outcomes accurately and objectively. No suitable existing instrument was identified to measure numbness, hence the questions were constructed based on literature and through consultation with experts in the field. The following questionnaires discussed below were used.

The Neck Dissection Impairment Index[16]

This is a 10-item Likert-like scale assessing QoL following neck dissection surgery. Total standardised scores range from 0 to 100, based on response options scored 1–5 for "not at all" to "a lot." The scale was validated through comparison to existing QoL and shoulder motility measures.[16] Internal consistency is excellent ($\alpha = 0.95$) and test–retest reliability is adequate ($r = 0.91$).[16]

The adapted Neuropathic Pain Questionnaire[17]

The adapted Neuropathic Pain Questionnaire is a seven-item Yes/No scale which identifies the presence of neuropathic pain. The full Neuropathic Pain Questionnaire has acceptable internal reliability ($\alpha = 0.74$).[18] However, it requires physical examination, which was precluded by telephone interviews. The revised scale remains a valid tool and the altered diagnostic cut-off (3 or more for diagnosis) is supported.[19] Total scores range from zero to seven, with 'Yes' responses scored one and 'No' responses scored zero.

Numbness over the neck, jaw and ear

Numbness over the neck, jaw and ear was assessed with the question: 'On the side of your operation, do you have any numbness under your chin, on or around your ear or on your neck?' 'Yes' responses were recorded as one and 'No' as zero per area.

House–Brackman scale[20]

One item was used for oral asymmetry: 'Have you noticed any asymmetry in your lower lip when you smile with your teeth?' Participants were prompted to check in a mirror if unsure. 'Yes' responses were recorded as one and 'No' as zero.

Demographic data, operative details and post-operative complications

Demographic data, operative details and post-operative complications were retrieved from electronic patient records. Data was stored securely within NHS software and analysed using the Statistical Package for the Social Sciences version 28 (SPSS Inc., Chicago, IL, USA). Paired *t*-tests and McNemar's test (with Edwards correction) were applied to continuous and categorical outcomes respectively, comparing pre-operative (baseline) and 12-week post-operative scores. Total scores were also descriptively analysed and graphically displayed to explore trends over time in complication progression.

Results and analysis

Fifty-five eligible candidates were identified, of which two declined to participate, therefore 53 patients were enrolled in the study. Fourteen patients were lost to follow up, leaving a response rate of 71 per cent. Forty-four neck dissections (17 left, 17 right and five bilateral) were performed on 39 patients by 6 surgeons at the centre. The study cohort was heterogeneous in terms of tumour stage and the levels dissected. Spinal accessory nerve resection was undertaken in three cases (7 per cent). Nearly two-thirds (64 per

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Table 1. Demographics of all enrolled patients. There was minimal difference between the demographics of those patients included in the sample and those lost to follow up

Demographics of all enrolled participants	Included	Lost to follow up
Mean age (range)	63 (20–87)	61 (31–83)
Gender		
– Female	12	4
– Male	27	10
Primary Disease		
– Oropharyngeal squamous cell carcinoma (SCC)	20	6
– Hypopharyngeal/laryngeal SCC	5	5
– Papillary thyroid carcinoma	4	0
– Cutaneous SCC	3	0
– Parotid acinic cell carcinoma	2	0
– Spindle cell sarcoma	1	1
– Cutaneous SCC metastatic deposit within parotid	1	0
– Submandibular pleomorphic adenoma	1	0
– Salivary duct carcinoma	1	0
– Hürthle cell thyroid cancer	1	0
– Cancer of unknown primary	0	1
– Branchial cyst	0	1

cent) of patients received adjuvant radiotherapy during the three-month follow-up period. Demographic data and primary disease types are displayed in Table 1.

Effect of shoulder/neck dysfunction on QoL

Table 2 and Figure 1 demonstrate scores were highest after the first week (32.5), but decreased by week 12 (22.2). However, they remained higher than pre-operative baseline scores (6.4). Mean Neck Dissection Impairment Index scores at 12 weeks were significantly higher than pre-operation scores, with a moderate effect size ($t(24) = -2.86$, one-tailed $p = 0.004$, $d = 0.57$).

Oral asymmetry

As shown in Figure 2, the proportion of patients with oral asymmetry at baseline was only 3.0 per cent, before peaking at week 6 (44.3 per cent), then decreasing to one-third (33.3 per cent) by week 12. The number of patients reporting oral asymmetry at 12 weeks was significantly higher than pre-operation ($\chi^2(1) = 5.14$, exact two-tailed $p = 0.016$).

Neuropathic pain

The mean Neuropathic Pain Questionnaire score was representative of the number of neuropathic pain symptoms experienced. Figure 3 demonstrates how Neuropathic Pain Questionnaire scores increased from baseline (0.76) to week 1 (2.23), peaked at week 6 (2.83) then decreased by week 12 (2.30) without returning to baseline. Mean Neuropathic Pain Questionnaire scores at 12 weeks were significantly higher than at pre-operation, with a moderate effect of size ($t(24) = -2.92$, one-tailed $p = 0.004$, $d = 0.58$).

A similar trend was observed for the proportion of patients diagnosed with neuropathic pain (Figure 4). Diagnoses reached a peak at week 6 (60.0 per cent) then decreased by week 12 (40.0 per cent), without returning to baseline (14.7 per cent). The number of neuropathic pain diagnoses at 12 weeks was not significantly different than pre-operation ($\chi^2(1) = 3.27$, exact two-tailed $p = 0.065$).

Numbness

The percentage of patients experiencing numbness over the jaw, neck and ear increased from baseline to week 1, peaked at week 6, then decreased by week 12 without returning to baseline (Table 3). The individual trends for each anatomical area are shown in Figure 5. The number of patients with numbness over the jaw at 12 weeks was significantly higher than pre-operation ($\chi^2(1) = 11.08$, exact two-tailed $p < 0.001$). The number of patients with numbness over the ear at 12 weeks was also significantly higher than pre-operation ($\chi^2(1) = 8.10$, exact two-tailed $p = 0.002$). Similarly, the proportion of patients with numbness over the neck at 12 weeks was significantly higher than pre-operation ($\chi^2(1) = 10.08$, exact two-tailed $p < 0.001$). Overall, around half of patients still experienced jaw, neck or ear numbness at week 12.

Discussion

Our study has shown how neck dissection often results in significant and persistent short-term morbidity for patients. As hypothesised, shoulder/neck dysfunction, oral asymmetry, neuropathic pain symptoms and numbness each significantly increased post-operatively. The proportion of patients reaching diagnostic cutoff for neuropathic pain was greater at 12 weeks than pre-operatively though not significantly. Shoulder/neck dysfunction peaked at week one, declined by six weeks and remained somewhat stable at 12 weeks. All other outcomes peaked at six weeks and declined by 12 weeks, although not back to baseline.

Prior to our study, there have been very few prospective studies evaluating complications after neck dissection.[13,21] Two of these studies only assessed patients at two time points (pre- and post-operation)[13,21] and another study only assessed shoulder range of motion without evaluating QoL.[22] Our study has addressed this gap in research by quantifying multiple important complications over time and evaluating subjective patient-reported data with respect to QoL. Our study has paved the way for a multicentre, prospective study that assesses complications over a longer period of time.

Firstly, shoulder and neck function was found to be significantly affected. There was a significant increase in neck and shoulder dysfunction scores post-operatively. Although there was improvement between week one and week 12, many patients generally did not regain full shoulder/neck functionality during the time period assessed.

Through applying the Neck Dissection Impairment Index, we established how shoulder and neck dysfunction affected patient QoL in various domains. For example, the ability to perform day-to-day tasks such as washing, getting dressed, ability to work and participation in leisure activities. Whilst most patients report

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Table 2. Neck Dissection Impairment Index (NDII) Scores Over Time. Neck dissection impairment index scores indicate shoulder and neck disability related quality of life. The data shows these were most severe at week one and decreased to week 12 but did not return to baseline. SD = standard deviation; CI = confidence interval

	Neck Dissection Impairment Index (NDII) Scores Over Time			
	Time Point			
	Pre-operation	One Week	Six Weeks	Twelve Weeks
Mean NDII Score (SD)	6.43 (14.33)	32.50 (25.49)	24.25 (27.62)	22.17 (28.67)
95% CI	1.43–11.43	22.21–42.72	13.94–34.56	11.46–32.87

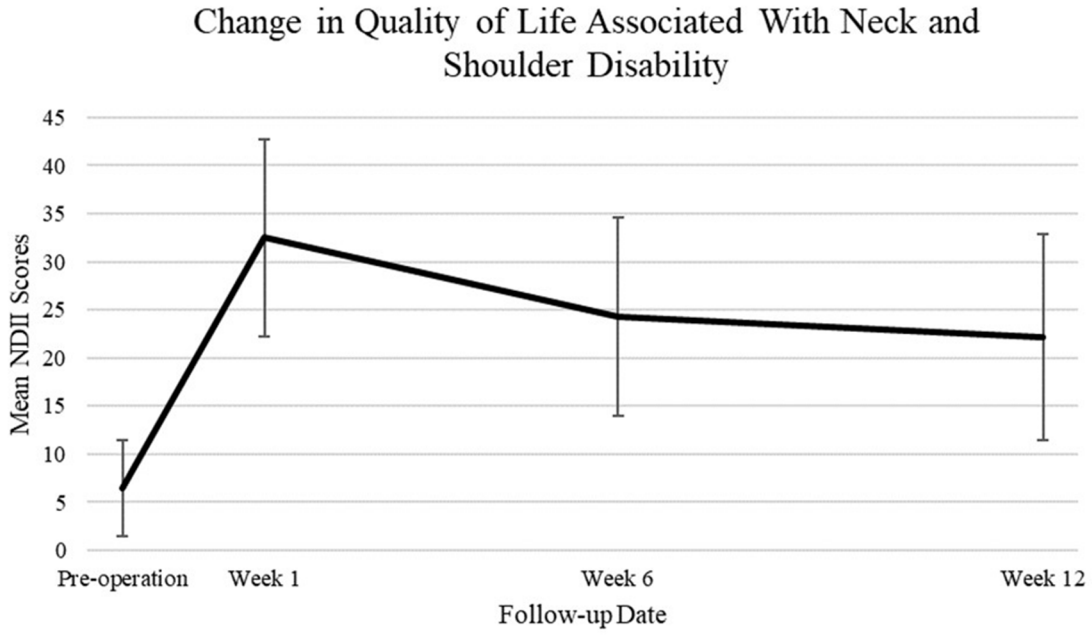


Figure 1. Change in quality of life (QoL) associated with neck and shoulder disability. Serial measurements illustrate how shoulder and neck disability changes during short-term recovery after neck dissection. NDII = Neck Dissection Impairment Index.

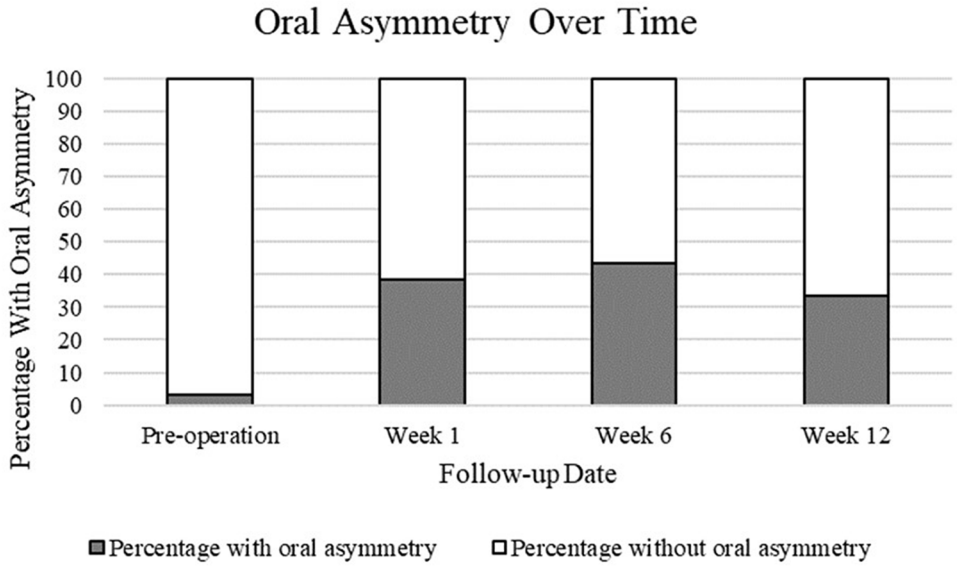


Figure 2. Change in proportion of patients experiencing oral asymmetry over time. The greatest proportion of patients experiencing oral asymmetry was at 6 weeks and this did not decrease to baseline by 12 weeks.

shoulder/neck dysfunction following neck dissection,[9,13] our pre-/post-test design facilitated exclusion of existing dysfunction to clearly measure the effect of surgery on this outcome. Furthermore, dysfunction cannot be fully investigated by identifying spinal

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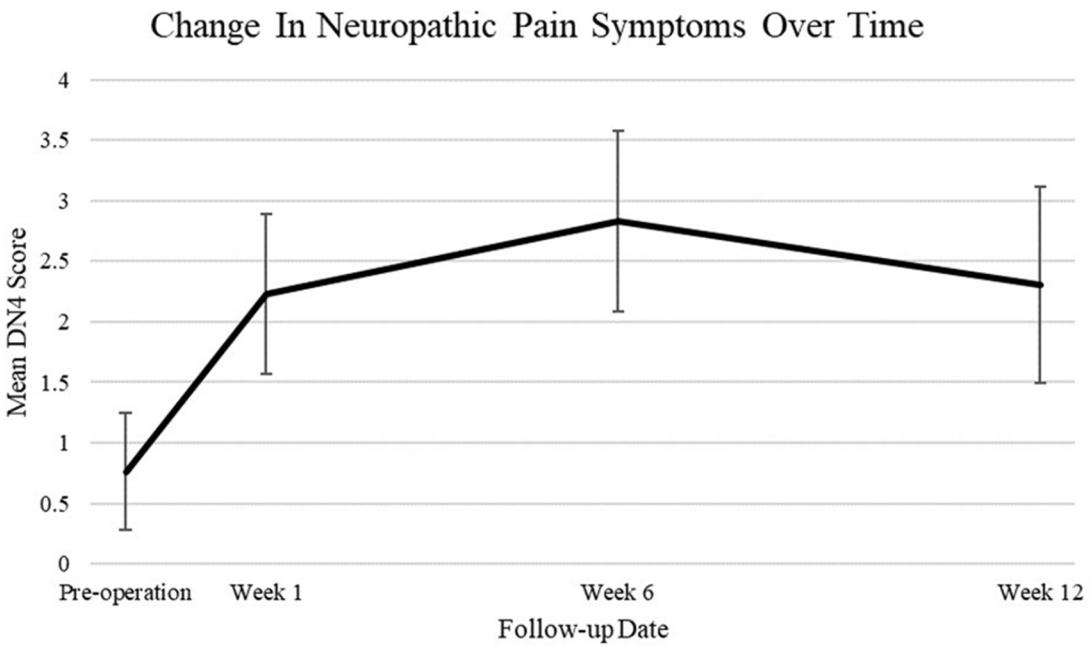


Figure 3. Change in neuropathic pain symptoms over time. The mean highest number of reported neuropathic pain symptoms was at six weeks after neck dissection and this did not decrease to baseline by 12 weeks. DN4 = Neuropathic Pain Questionnaire.

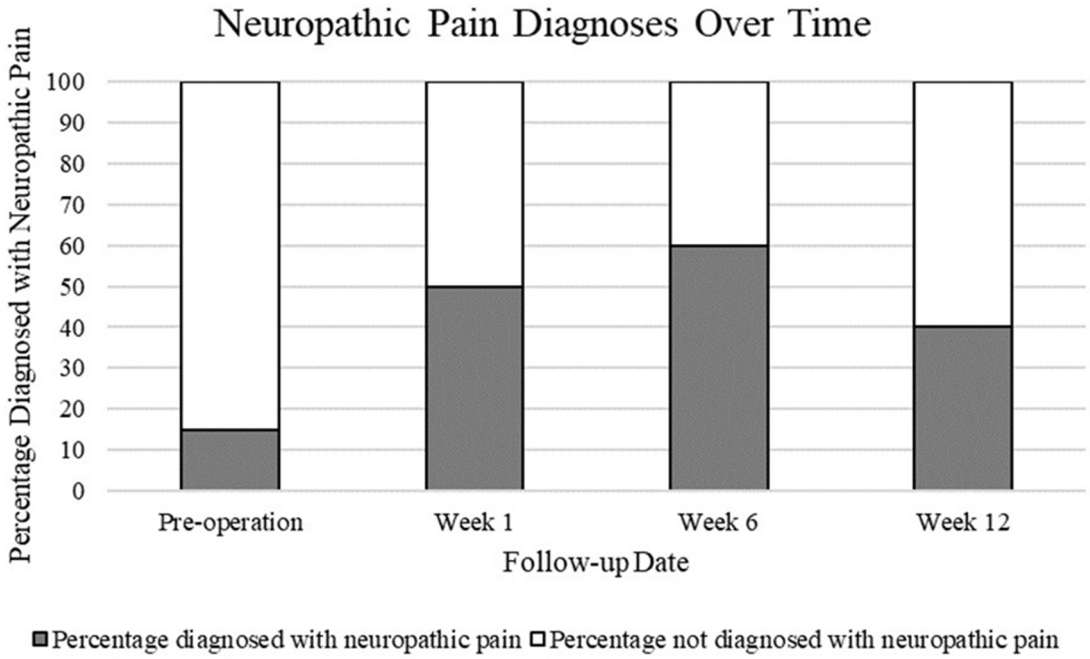


Figure 4. Change in proportion of patients diagnosed with neuropathic pain over time. Although patients may experience neuropathic pain symptoms (as seen in Figure 3), the Neuropathic Pain Questionnaire requires a threshold number of symptoms to be met for a diagnosis. Diagnoses mirrored change in reported symptoms over time, peaking at six weeks and not returning to baseline by 12 weeks.

accessory nerve injury, as this is not the only factor involved (for example, evidence shows the absence of spinal accessory nerve injury does not prevent shoulder pain).[13] Post neck-surgery syndrome shows why this is an over-simplification, because it explains there is a synergistic effect of damage to related structures in the neck during neck dissection, contributing to dysfunction of those which were not directly injured during the surgery.[23] This shows post-operative motor dysfunction is more complex than identifying isolated nerve injuries (both spinal accessory nerve and marginal mandibular nerve).

Our results therefore show more than the incidence of a biomechanical pathology, but also show it is a pathology of clinical significance to patients. Our results support existing literature, such as the study by Güldiken *et al.*[22] who also assessed shoulder impairment using the Neck Dissection Impairment Index and found shoulder abduction was significantly reduced in the first

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Table 3. Proportion of Patients Experiencing Numbness Over Time Over the Ear, Jaw and Neck. The greatest proportion of patients experiencing numbness was at 6 weeks across all 3 areas (most commonly over the jaw) and these did not decrease to baseline by 12 weeks

	Percentage of Patients Reporting Loss of Sensation Over Time Over the Ear, Jaw & Neck			
	Time Point			
	Pre-operation (%)	One Week (%)	Six Weeks (%)	Twelve Weeks (%)
Ear	5.9	65.4	73.3	46.7
Jaw	5.9	61.5	90.0	53.3
Neck	5.9	57.7	70.0	53.3

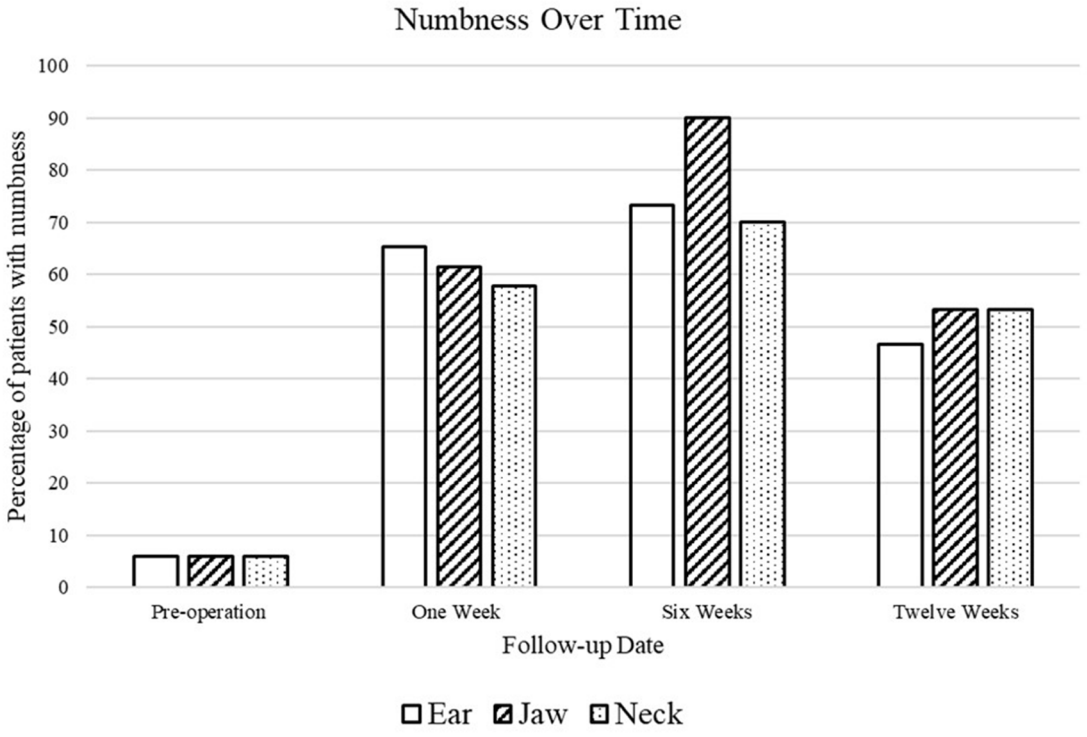


Figure 5. Proportion of patients experiencing numbness in ear, jaw and neck over time.

and third months following surgery. In terms of neck dysfunction, Gane *et al.*[9] and van Wilgen *et al.*[13] described significant patient morbidity due to neck pain, loss of sensation and decreased range of motion.

We found oral asymmetry to be a common complication following neck dissection, with around half of patients still experiencing asymmetry at week 12. Retrospective studies by Nason *et al.*,[24] Batstone *et al.*[14] and Anand *et al.*[25] reported lower rates of oral asymmetry following neck dissection (16 per cent, 23 per cent and 29 per cent, respectively). However, retrospective studies tend to underestimate the true incidence of complications,[24] which reflects a wider clinical issue of inadequate screening for complications. Our results specifically suggest this too, because although 38.5 per cent of patients reported oral asymmetry at week one, only two patients were recorded in patient records as having facial weakness post-operatively. Furthermore, although significant shoulder and neck disability was identified, many patients in the sample were discharged from physiotherapy before discharge, without onward referral. These findings indicate that opportunities to improve post-operative symptoms are potentially being missed due to lack of screening.

Our study applied no specific exclusion criteria other than refusal to participate, and included neck dissections for any indication, hence various levels were dissected. This difference shows our results are likely more representative of risk of oral asymmetry following neck dissection and explains the discordance with previous literature. Furthermore, previous studies reported marginal mandibular nerve injury rate to determine effect of neck dissection rather than patient-reported oral asymmetry; however, Batstone *et al.* found no significant association between marginal mandibular nerve injury and perceived asymmetry after neck dissection.[14] The fact that our results suggest a much higher proportion of patients perceive post-operative asymmetry compared to previous research, which identified isolated nerve injuries, is perhaps explained by post-neck dissection asymmetry arising due to damage to cervical branches of the facial nerve and platysma, as well as the marginal mandibular nerve.[26] This also highlights that patients perceive functional asymmetry even in the absence of objective marginal mandibular nerve injury. Patients' perception of their oromotor function may therefore involve more than the functionality of a single nerve, so that assessing subjective experience may better reflect effects of surgery on the patient.

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The number of neuropathic pain symptoms (burning, electric shocks, tingling, etc.) over the neck, jaw and ear significantly increased due to iatrogenic damage to the cutaneous branches of the cervical nerves. Interestingly, our study found that half of patients still experience some form of neuropathic pain at 12 weeks. This highlights how neuropathic pain following neck dissection is potentially far more prevalent than current research suggests.[9,15,27]

Our findings are arguably more representative given we included all neck dissection operations, irrespective of extent or indication. Identifying the presence of post-operative neuropathic pain is important because patients can experience significant distress and conventional analgesics (e.g. opioids) are often futile. Although double the pre-operation rate, the number of neuropathic pain diagnoses (in accordance with the Neuropathic Pain Questionnaire) after 12 weeks was not significantly increased compared to pre-operation. This is likely due to the modest sample size, which necessitated applying Edwards correction to the McNemar test,[28] thus inherently reducing statistical power.

Rates of post-operative numbness were similar to those reported in previous literature (around 50–60 per cent).[9,13,15,27,29] Our results confirm statistically that persistent cutaneous numbness is a common complication of neck dissection. As this can have significant negative effect on QoL,[30] it remains a key symptom influencing post-operative morbidity.

The strengths of our study include the prospective design incorporating multiple data-collection points, use of well-validated measures, inclusion of both subjective and objective data, and high response rate (71 per cent). The main limitations of this study are the relatively short follow-up period, modest sample size and small number of operating surgeons. Future larger studies with longer follow-up periods can further define the nature of complications by assessing if patient-reported outcomes eventually return to baseline or remain significantly different. Such studies can also stratify findings according to neck dissection type, use of adjuvant radiotherapy and primary operation type as these factors have been proven to affect complication rates.[8,31] However, this study has successfully provided much-needed prospective complications and QoL data, thus facilitating better understanding of complications after neck dissections and laying the foundation for ways to mitigate them.

An example of such mitigation approaches is physiotherapy. There is evidence that post-operative physiotherapy significantly improves shoulder function after neck dissection, even with only with one session.[32] Unfortunately, 11 per cent of UK centres provide no post-operative physiotherapy and another 11 per cent only offer it to those with 'severe dysfunction'.[33] Considering the commonness of complications identified in this study, better access to physiotherapy is a good starting point towards addressing at least one of them.[32]

- Head and neck cancer incidence is rising, and neck dissection is key in preventing metastatic spread
- Although 130 years of refinement of techniques has reduced associated morbidity, significant neurological sequelae persist
- Existing research frequently relies on retrospective analyses, which may not capture subtle complications including motor disturbance, sensory loss or neuropathic pain
- This prospective study identified oral asymmetry, numbness, and shoulder/neck motor dysfunction persist during short-term recovery and began to clarify progression over time
- This evidence begins to elucidate some previously neglected understanding of the effects of neck dissection, providing a starting point for multi-centre research which could improve post-operative care for this patient group

Conclusion

Neck and shoulder dysfunction, neuropathic pain, numbness and oral asymmetry are all common and important complications that persist during short-term recovery following neck dissection. Our findings have provided much-needed prospective data on complications and recovery after neck dissection over the short term. We recommend that the specific post-operative sequelae of neck dissection surgery we have evaluated form part of the routine post-operative assessment pathway. In this way, affected patients will be identified and these complications addressed, in an attempt to reduce post-operative morbidity and optimise QoL in head and neck surgery patients.

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