ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

# Effectiveness of Spinal Accessory Nerve Preservation in Modified Neck Dissections.

**Vladimir Popovski[1], Alberto Benedetti[1], Danica Popovic-Monevska[1], Goran Pacnevski[1], Aleksandar Iliev[1], Aleksandar Stamatoski[1]*, and Julia Zhivadinovik[2].**

[1]Clinic for Maxillofacial Surgery, St Cyril and Methodius University, Skopje, R. Macedonia.
[2]Institute of Anatomy, Medical Faculty, St Cyril and Methodius University, Skopje, R. Macedonia.

**ABSTRACT**

The spinal accessory nerve (SAN) is frequently encountered during neck surgery, resulting in the "shoulder syndrome". The modified neck dissection (MND) with preservation of the SAN minimizes the functional deformity associated with section of the eleventh nerve. The cross-sectional demonstration analysis was created through the medical records retrospectively of 165 consecutive patients with attention to ultrasound and MRI preoperative findings, type of neck dissection, type of identification and dissection of spinal accessory nerve and postoperative morbidity and survival rate. For exact preoperative planning ultrasound and MRI are superior for determining the positioning of the eleventh nerve. The mean distance between the greater auricular point and the SAN was 0.90cm. Average length of the trunk from Erb's point until the penetration in the trapezius muscle was around 5.1cm, ranging from 4.8 to 5.4cm. The diversity in the course from the posterior border of the sternocleidomastoid muscle and posterior neck triangle were confirmed in 15%. The frequency of postoperative morbidity of SAN was 46.7% for radical neck dissections, 28.3% for selective neck dissections and 8.3% for MND. MND has similar regional control rates to more comprehensive operations in appropriately selected patients and significantly reduces the risk of functional disability.

**Keywords:** posterior neck triangle, spinal accessory nerve, ultrasound, neck metastases, modified neck dissection

***Corresponding author**

## INTRODUCTION

Identification of spinal accessory nerve even in the correct anatomical position is not always easy during different types of neck dissections. The surgical anatomy of the spinal accessory nerve has been properly acknowledged in the literature [1-4] with evidence of significant variations. The eleventh cranial nerve topography consists of two parts, cranial part and the main cervical part. The nerve descends in the neck through jugular foramen and near the jugular vein exits in the posterior neck triangle and supplies the sternocleidomastoid and trapezius muscles. These muscles have the functions of: elevation of the shoulder by the trapezius, rotation and tilting of the head toward and away from the side of the contracting sternocleidomastoid muscle and flexion of the neck by both sternocleidomastoid muscles. This cervical part is associated by motor or sensory contributions from the upper cervical nerves. These functions are decreased or absent by weakness or paralysis. When the lesion is nuclear or infranuclear, there is associated muscle atrophy and fasciculations [5-7].

On the other hand neck dissection is a principal technique for the diagnosis (staging) and the treatment of cervical lymph node metastasis in patients with head and neck cancer. In modified neck dissections when indications are raised, a very important part is preservation of the spinal accessory nerve, together with internal jugular vein and sternocleidomastoid muscle [8-10]. The pain and dysfunction associated with a loss of innervation on spinal accessory nerve has motivated surgeons to modify the classic neck dissection. The modified neck dissection with preservation of the spinal accessory nerve is based on desire to minimize the functional deformity associated with section of that nerve, combined with the recognition that in many situations the nerve intimately involved in the neck disease and its preservation does not compromise the oncological effectiveness of the more limited procedure [4, 11-14].

Since the introduction of functional neck dissection, various modifications have been made to reduce the adverse effects of radical neck dissection and have contributed to improve the quality of life and to prevent permanent sequelae and medico-legal actions following neck dissection [4]. Proficient knowledge of posterior neck anatomy is crucial to avoid its accidental injury during selective or modified neck dissection in almost any extensive surgery of the posterior neck. Reasonable speed and safety in identifying and preserving important anatomical structures are of fundamental importance and for this type of neck dissection, special attention must be paid to refined identification of the spinal accessory nerve.

## MATERIAL AND METHODS

Surgical study of operative alteration of the spinal accessory nerve, and trapezius muscle function of patients who underwent distinctive neck surgery was performed. This study was done not only to document the indispensability of the trapezius muscle to shoulder-strap stability, but also to clarify the role of the eleventh cranial nerve preservation. The cross-sectional demonstration analysis was created on own clinical material from the University Clinic for Maxillofacial Surgery in Skopje, where in the last five year period, neck dissections were performed in 165 patients, from whom 59 were treated with radical neck dissection, 20 with modified neck dissection and in 83 cases with adequate type of selective neck dissection. Neck dissection with a curative intent was done in 80 patients with squamous cell carcinoma of the upper aerodigestive tract (naso- and oro-pharynx), in 26 patients with skin squamous cell carcinoma, 17 with salivary gland carcinoma, 11 with malignant melanoma and 31 with hidden primary. **(Tab.1, Tab. 2)**

**Table 1: Type of neck dissection**

| Type of Neck Dissections | 2007 | 2008 | 2009 | 2010 | 2011 | Total |
|---|---|---|---|---|---|---|
| Classical Radical Neck Dissection | 12 | 11 | 18 | 11 | 7 | 59 |
| Modified Neck Dissection | 2 | 2 | 3 | 5 | 8 | 20 |
| Selective Neck Dissection | 11 | 7 | 18 | 12 | 21 | 69 |
| Billateral: Radical + Selective ND | 2 | 3 | 5 | 4 | 4 | 18 |
| Total | 27 | 23 | 44 | 32 | 40 | 165 |

**Table 2: Distribution of patients according to primary site disease**

| Timing of neck dissection | Primary site | Number of patients |
|---|---|---|
| Primary treatment | Oropharynx (lower lip, tongue, sublingual, jaws, pharynx) | 69 |
| | Nasopharynx | 11 |
| | Skin cancer | 26 |
| | Hidden primary | 31 |
| Secondary treatment | Salivary carcinoma | 17 |
| | Malignant melanoma | 11 |
| | Total | 165 |

We have evaluated entirely records for this study in 20 patients with modified neck dissection and 40 patients with selective neck dissections, comparing preoperative diagnostic work-up, intraoperative findings and relationship of the dissected and preserved eleventh nerve with tumor mases and postoperative complications. T1-weighted high-resolution isotropic volume examination for the preoperative assessment of head and neck cancer, by comparison with spin-echo, T1-weighted sequences and the pathology specimen. Bland-Altman plots were used to assess measurement agreement.

In the selected cases, the intraoperative mapping study was done to obtain the exact anatomical data by drawing the exposed accessory nerve in life size during the modified neck dissection. Measurements were made at the end of the procedure by using a caliper. After the completeness of lymph node and metastases removal from the posterior neck triangle, evaluation was performed over extensive exposure of the spinal accessory nerve. Towards the end of the dissection, the correct location of the nerve was corroborated by enlarging the exposure to confirm the position and integrity of the preserved nerve.

The dissections and clinical observations corroborate that the trapezius is a key part of a "muscle continuum" that stabilizes the shoulder. Clinical and electrophysiological evaluations of the trapezius and sternocleidomastoid muscles and neurologic evaluations were performed in 3 to 6 months postoperatively.

## RESULTS

Intraoperatively we found significant variances in the positioning of the spinal accessory nerve. Particular attention was created about identification of spinal accessory nerve positioning and relationship with the internal jugular vein. Our findings confirmed that the spinal accessory nerve almost always crosses the internal jugular vein anteriorly in the upper neck, with exclusion in 4 cases (6.7%) with posterior crossing at the level of posterior belly of the digastric muscle and one case with rare anomaly where accessory nerve passing through the fenestrated internal jugular vein was observed. In 20 cases we have measured the distance from jugular foramen (skull base) to crossing of internal jugular vein with mean value of 2.34 cm. **(Fig.1)**

The diversity in the course from the posterior border of the sternocleidomastoid muscle and posterior neck triangle were confirmed in 9 cases (15%), predominantly at the level of entering the posterior neck triangle. Hypoplastic nerve was apparent in 8.3% (5 cases), generally after removal of neck masses with greater proportions. Hiperplastic nerve was evident in only 3.3% (2 cases). In almost every case we found that spinal accessory nerve was with typical coiled appearance in its course through the posterior cervical triangle of the neck . **(Fig. 2)**

The mean distance between the greater auricular point and the spinal accessory nerve was 0.90 cm. Average length of the trunk from Erb's point until the penetration in the trapezius muscle was around 5.1 cm, ranging from 4.8 to 5.4 cm. The most significant elongation was found in cases after meticolous preparation of spinal accessory nerve – usually after complete removal of neck metastases at level III - V. There were 4-8 lymph nodes in the spinal accessory nerve chain **(Fig. 3)**.

Fig-1

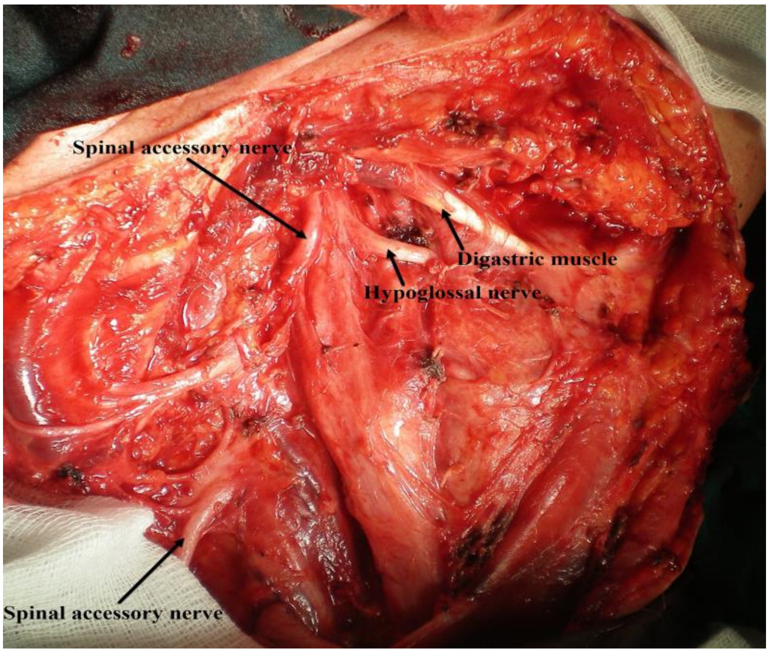
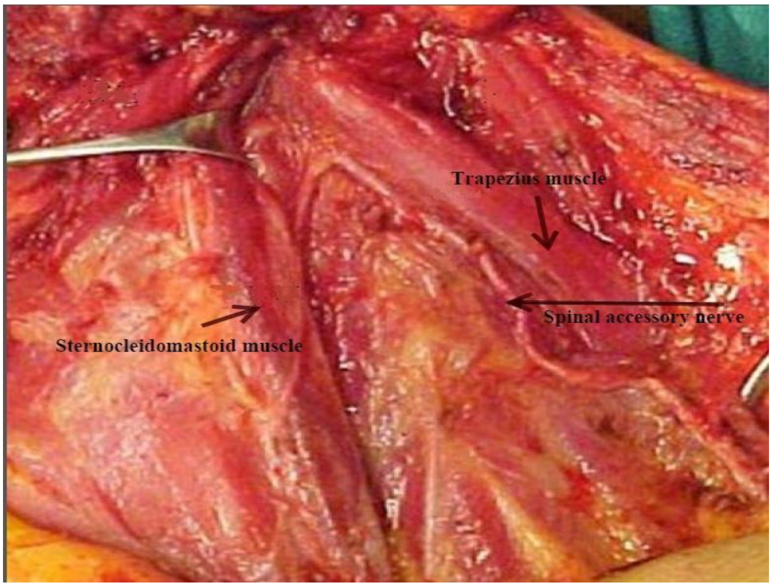
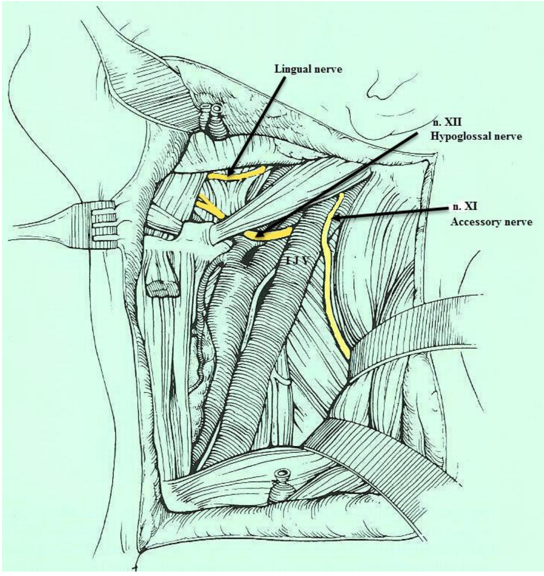



Fig-2



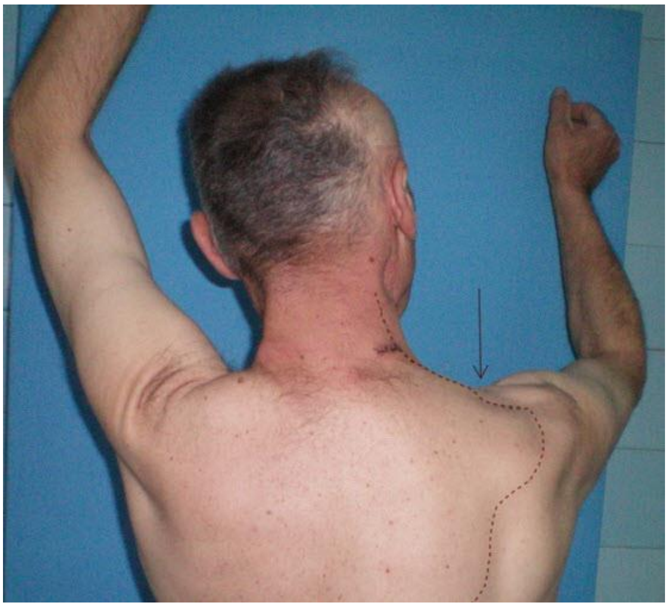

Measurements of abduction and the electromyographic measurements ( monopolar needle electrode) of the study group in 3 to 6 months postoperatively were found to be superior to those of the control group, although the difference between the groups was not significant. Damage to motor unit averagely recorded at ranges between 320-540 mV. The mean number of dissected lymph nodes was significantly higher in the study group than in the control group. The frequency of postoperative morbidity of the spinal accessory nerve was the highest in radical neck dissections (46.7%) in 28 cases. There was a reduced dysfunction in 17 cases with selective neck dissection (28.3%) comparing to preoperative values, while shoulder drop and scapular winging was confirmed in only 5 cases (8.3%) of modified neck dissection. The most significant was correlation after rafical neck dissection and modified neck dissection including levels IIb and V. **(Fig. 4)**

**Fig-3**




Patients who underwent supraomohyoid selective neck dissection that involved minimal dissection of the spinal accessory nerve had minimal loss of shoulder function and usually, normal electromyograms in 16 weeks that documented less injury to the spinal accessory nerve. Again, these patients had improvement with the time.

**Fig-4**



**DISCUSSION**

The main therapeutic dilemma for the therapy of metastatic carcinoma from the head and neck malignancy remains a choice of the type of neck dissection. The probability of metastases to the neck from various sites in the upper aerodigestive tract has been outlined [10, 15], so there are data from (the basis of) much of the literature on the technique and indications for functional modifications of the classical radical neck dissection. Conley and Schuller [10], confirmed a large percentage of metastases (42%) in close proximity to the spinal accessory nerve where it comes to lie near the internal jugular vein. Ballantyne, Shah and Bocca's group [10] gave strong support to MRND emphasizing that in many situations SAN is not intimately involved in the neck disease and its preservation does not comprise the oncologic effectiveness of the more limited procedure. These and other investigations have designated to the introduction of modified neck dissections.

Beneficial surgical intervention in case of posterior neck metastases depends on suitable exposure and preservation of spinal accessory nerve. This induces a consistent understanding of the anatomy of the posterior neck triangle for doing surgery safely, including the sufficient knowledge of extra cranial anatomy of spinal accessory nerve variations [11, 16-18].

Patten and Hillei [19] indicate that adhesive capsulitis is a principal component of the eleventh nerve syndrome that can significantly compound the morbidity of a neck dissection even when the accessory nerve recovers.

Our findings support results in previous literature that the spinal accessory nerve is located anterior to the internal jugular vein in the majority of the cases, however, it is imperative for the surgeon to be mindful to the anatomic variability and possible posterior crossing of the internal jugular vein by the spinal accessory nerve in the neck to avoid injury to the internal jugular vein during the dissection of the nerve. Since the great auricular nerve (Erb's point) represents a constantly identifiable landmark, it allows simple and reliable identification of the course of the spinal accessory nerve. Across the posterior triangle the nerve was running superficially with either straight (78%) or coiled (22%) pathway. The accessory nerve and the phrenic nerve were similar in the anatomic evidences and the number of motor nerve fibers. On ultrasound evaluation the accessory nerve exited the posterior border of sternocleidomastoid at a mean of 6.5 (5.0-8.5) cm below the mastoid process and penetrated the anterior border of trapezius 5.5 (3.0-7.0) cm above the clavicle with mean caliber of $0.75 \pm 0.10$ mm.

The most common complication of neck dissection is shoulder pain and dysfunction due to manipulation of spinal accessory nerve, resulting in trapezius muscle atrophy mainly in procedures involving the posterior neck triangle [18].

Lee and al. [20] show that twenty-two of 25 (88%) patients had shoulder pain, but the average pain score was low ($2.3\pm 1.3$).

Kuntz and Weymuller [21] reported that modified radical neck dissection group of patients reported greater shoulder disability in 6 months compared with the selective neck dissections group, but for 12 months, there was no difference between the two groups of patients.

Giordano and al. [22] analyzed shoulder function after selective and superselective neck dissections, and the subjective test show no significant differences between the two groups even if, when sublevel IIB is spared.

The findings of Cheng and al. [23] in their prospective study with subjective evaluation of shoulder pain and objective evaluation of shoulder muscle strength suggested that patients who underwent selective neck dissection had the least damage to spinal accessory nerve function and the least shoulder disability after neck dissection.

Capiello and al. [24] compare the results of clinical and electrophysiological investigations of shoulder function in patients affected by head and neck carcinoma, and a high number of abnormalities was found on electrophysiological testing, only a limited number of patients, mostly in group B (received a selective neck dissection involving clearance of levels II-V), displayed shoulder function disability affecting daily activities.

In a study by Remmler and al. [25] results indicate that modified nerve sparing dissections are followed on the average by a significant, but temporary and reversible phase of shoulder disfunction. By comparison, radical neck dissection is followed by profound and permanent trapezius muscle weakness and denervation [25].

Birinci and al. [26] showed a prospective, double-blind clinical trial where the shoulder function deterioration was statistically significantly less for patients with insignificant intraoperative neuromonitoring changes than patients with significant intraoperative neuromonitoring changes ($P < 0.05$).

Chepeha and al. [27] concluded that the patients receiving modified radical neck dissection had significantly worse shoulder function than patients with selective neck dissection (p = 0.0007).

van Wilgen and al. [28] reported that after modified radical neck dissection 33.3% of the patients experienced shoulder complaints, after postero-lateral neck dissection 66.7%, and after supraomohyoid neck dissection 20% of the patients experienced shoulder complaints. Wilgen and al. [28] indicate that type of neck dissection was significantly (P < 0.001) related to shoulder complaints.

Selcuk and al. [29] showed that patients who underwent anterolateral neck dissection, the goniometric results were better than in the functional neck dissection group.

Our study indicates that there may be a functional disability associated with any type of neck dissection in which the spinal accessory is dissected out and placed in some degree of traction. Significantly lower risk of functional disability in the modified neck dissections and confirmation that the modified neck dissection is as effective as the radical neck dissection for controlling neck disease, extend the indications for modified or selective neck dissections as more logical approach to surgical treatment of cervical neck disease. If there is no functional advantage, all other arguments for modified neck dissections become inappropriate.

The results of this study show that, on the average, neck dissection patients with their spinal accessory nerve preserved have less pain in their shoulders, less functional disability, and stronger results on their physical examination than those with their spinal accessory nerve sacrificed without any difference in their local control and survival rate. This is of pronounced importance because any inadvertent injury of the spinal accessory nerve during surgical procedures is a cause of significant morbidity with medicolegal repercussions. The findings in this work are consistent to some of previous reported studies regarding the spinal accessory nerve preservation [1, 3, 9]. This study has the advantage that it originated from existing operative findings rather than cadaver dissections and, as a result, incorporated functional information and the postoperative significance of damage to some of the muscle functions.

## CONCLUSIONS

We can validate that the spinal accessory nerve injury is potentially preventable in most cases of neck surgery. Surface anatomical landmarks are not always reliable guide to the position and course of the nerve in the posterior triangle. Within modified neck dissections, identification of spinal accessory nerve over established landmarks is unconditionally reliant on the exact preoperative mapping of the nerve with imaging diagnostics but the sophisticated further eleventh nerve dissection and preservation depends on the inclusive surgical knowledge. Modified neck dissection has similar regional control rates to more comprehensive operations in appropriately selected patients and significantly reduces the risk of functional disability.

## ACKNOWLEDGEMENT

The presented study has been carried with interdisciplinary assistance of all authors.

## REFERENCES

[1] Chen DT, Chen PR, Wen IS, Wu HP, Yang PK, Lee CF, et al. J Otolaryngol Head Neck Surg 2009; 38: 337-339.
[2] Durazzo MD, Furlan JC, Teixeira GV, Friguglietti CU, Kulcsar MA, Magalhães RP, Ferraz AR et al. Clin Anat 2009 ; 22: 471-475.
[3] Lloyd S. J Laryngol Otol 2007; 121: 1118-1125.
[4] Shah J, Patel S. Head and Neck surgery and oncology. III rd ed. Mosby – Edinburgh, London, New York, Toronto 2003; 353 – 394.
[5] Saman M, Etebari P, Pakdaman MN, Urken ML. Surg Radiol Anat 2011; 33: 175-179.
[6] Tubbs RS, Stetler W, Louis RG Jr, Gupta AA, Loukas M, Kelly DR, et al. J Neurosurg Spine 2010; 12: 22-24.
[7] Veyseller B, Aksoy F, Ozturan O, Acar H, Ertaş B, Bayraktar FG, et al. J Otolaryngol Head Neck Surg 2010; 39: 403-409.
[8] Aravind R, Kathiresan N. J Surg Oncol 2008; 98: 200-201.

[9] Popovski V. Sec Biol Med Sci MASA 2007; 28: 113-127.
[10] Thawley SE, Panje WR, Batsakis JG. Comprehensive Management of Head and Neck Tumors. 1999; Vol. II. W.B. Saunders Company, Philadelphia; p.1147-1172.
[11] Boström D, Dahlin LB. Scand J Plast Reconstr Surg Hand Surg 2007; 41: 82-87.
[12] Hashimoto Y, Otsuki N, Morimoto K, Saito M, Nibu K. Surg Radiol Anat 2012; 34: 373-375.
[13] Lima LP, Amar A, Lehn CN. Braz J Otorhinolaryngol 2011; 77: 259-262
[14] Salgarelli AC, Landini B, Bellini P, Multinu A, Consolo U, Collini M. Oral Maxillofac Surg 2009; 13: 69-72.
[15] Cummings CW, Fredrickson JM at all. 1993; Otolaryngology – Head and neck surgery. II nd ed. Mosby – Year Book, St. Louis-Baltimore-Boston. Vol.II, p.1043-1078.
[16] Skinner SA. J Clin Neurophysiol 2011; 28: 587-98.
[17] Lee SH, Lee JK, Jin SM, Kim JH, Park IS, Chu HR, et al, Otolaryngol Head Neck Surg 2009; 141: 639-644. Epub 2009 Sep 18.
[18] Watkins JP, Williams GB, Mascioli AA, Wan JY, Samant S. Head Neck 2011; 33: 615-619.
[19] Patten C, Hillel AD. Arch Otolaryngol Head Neck Surg 1993; 119: 215–220.
[20] Lee CH, Huang NC, Chen HC, Chen MK. Acta Otorhinolaryngol Ital 2013 Apr; 33: 93–96.
[21] Kuntz AL, Weymuller EA. 1999; 109: 1334–1338.
[22] Giordano L, Sarandria D, Fabiano B, Del Carro U, Bussi M. Acta Otorhinolaryngol Ital 2012; 32: 376–379.
[23] Cheng PT, Hao SP, Lin YH, Yeh AR. Ann Otol Rhinol Laryngol 2000; 109: 761-766.
[24] Cappiello J, Piazza C, Giudice M, De Maria G, Nicolai P. Laryngoscope 2005; 115: 259-263.
[25] Remmler D, Byers R, Scheetz J, et al. Head Neck Surg 1986; 8: 280–286.
[26] Birinci Y, Genc A, Ecevit MC, Erdag TK, Guneri EA, Oztura I, et al. Otolaryngol Head Neck Surg 2014; 151: 253-259.
[27] Chepeha DB, Taylor RJ, Chepeha JC, Teknos TN, Bradford CR, Sharma PK, et al. Head Neck 2002; 24: 432-436.
[28] van Wilgen CP, Dijkstra PU, van der Laan BF, Plukker JT, Roodenburg JL. Int J Oral Maxillofac Surg 2004; 33: 253-257.
[29] Selcuk A, Selcuk B, Bahar S, Dere H. Tumori 2008; 94: 36-39.