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Original

Postoperative Auditory Effects After Neck Dissection

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Abstract

Objective: The objective of this prospective study was to investigate the prevalence of hearing loss after neck dissection combined or not with postoperative radiotherapy. Study design: Prospective Study. **Material and Methods**: Only patients with no previous history of ototoxic treatment, nasopharyngeal carcinoma or hearing loss were included. Fifty-one patients signed the informed consent and underwent a pure tone audiometry, immitance audiometry and otoacoustic emissions tests before and after the surgery, and after postoperative radiotherapy. They were divided into three groups as follows: Group 1 (N=21), included subjects who underwent neck dissection combined with further radiotherapy; Group 2 (N=14), included subjects who underwent only neck dissection; and Group 3 (N=16), a control group, included patients who underwent other head and neck surgery without neck dissection. Criterium to indicate hearing decrease after the treatment was defined as either a 20 dB decrease at any one test frequency or a 10 dB decrease at any two adjacent test frequencies. Statistical analyses were performed to determine the effect of neck dissection on post treatment hearing loss. **Results**: In group 1, eleven (52%) showed some degree of hearing loss after the neck dissection, while in group 2, five of the patients (36%) showed a decrease in hearing. In the control group, four patients (25%) presented a hearing loss after surgery. In group 1, radiotherapy added hearing loss to eleven patients. **Conclusion:** Our results showed that neck dissection, as well as radiotherapy, may induce hearing loss in patients treated for head and neck cancer.

Keywords: Hearing Loss, Neck Dissection, Head and Neck Cancer

Introduction

An unilateral or a bilateral neck dissection is frequently used in the treatment of most head and neck malignancies, implying remarkable changes in the lymphatic and venous drainage leading to facial edema.[1-2] It may be used in combination with radiotherapy which, if delivered to the temporal bone region may lead to acute and long-term middle and inner ear disorders.[3-4]

Any loss in human being life may be hard to overcome. Hearing loss may also bring human contact and communication breaks. Although there are different degrees of hearing loss, any impediment in the conduction of the auditory information to the central auditory nervous system implies in a loss of part or the whole message content. This may be worse in the children and in the elderly, who have central auditory nervous system still in maturation or in deterioration, respectively.

In clinical practice, some patients have been complaining about hearing loss after the treatment, which usually involves surgery, radiotherapy or the use of ototoxic agents. Generally the hearing loss has been conveyed to ototoxic agents, to radiotherapy or both.[5-7]Although there are many papers related to the effects of the radiotherapy on the temporal bone[8], the implications of surgery as a worsening or a trigger effect of auditory disorders remains unknown. The identification of the auditory effects after the induction of the changes in the lymphatic and venous drainage may be helpful to guide preventive actions.

The objective of this paper was to study the

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prevalence of hearing loss in patients submitted to neck dissection combined or not with postoperative radiotherapy.

Patients and Methods

This was a prospective study that included patients with no previous history of hearing loss or ototoxic treatment. All of them presented primary head and neck squamous cell carcinoma and the surgical treatment included unilateral or bilateral neck dissection. Treatments that included chemotherapy and nasopharyngeal carcinomas were excluded. The Internal Review Board approved the protocol and all participants signed an informed consent form.

Among the 65 patients who fulfilled the selection criteria 51 of them finished the audiologic follow-up. They were divided into three groups as follows: Group 1, 21 subjects who underwent surgery and postoperative radiotherapy; Group 2, 14 subjects who underwent surgery alone; and Group 3, 16 patients with benign head and neck tumors who underwent a surgery without neck dissection. This group was studied in order to avoid bias of intubation or anaesthetic procedures that might interfere in the hearing system.

All of the patients were submitted to pure tone audiometry (Madsen, Orbiter 922) in a sound booth, immitance audiometry (Madsen, Zodiac 901) and transient evoked otoacoustic emissions (TEOAEs) (Otodynamics, ILO 88) before and after one month of each procedure (surgery and radiotherapy).

Changes in hearing sensitivity were computed related to baseline measures after surgery including neck dissection and to the previous pure tone audiometry after radiotherapy. Criteria to indicate hearing decrease after each treatment followed American Speech and Hearing Association (ASHA) guidelines and were defined as either a 20 dB decrease at any one tested frequency or a 10 dB decrease at any two adjacent tested frequencies.[8] When neck dissection was performed bilaterally, changes in hearing were considered in either ear, otherwise the criteria were only applied to the ear on the side of the surgery. The immitance audiometry results were analysed according to the tympanometry and the acoustic reflexes. Tympanograms type B or C were considered abnormal, as well as the absence of the acoustic reflexes, in either ear. Abnormal tympanograms are related to dysfunction in the middle ear. For the TEOAEs, the absence of responses once present in the initial evaluation was interpreted as a change in the middle ear or in the cochlear function, in either ear.

Statistical analysis was performed using Chi-square test for categorical variables and analysis of variance test to compare continuous variables between the three groups. Statistically significance was considered for p-values<0.05.

Results

Most of the patients were males not equally distributed between the groups. Ages ranged from 28 to 85 years (mean, 58 in group 1 and mean, 54 in group 2) and from 21 to 70 years (mean, 45) in the control group (Table 1). In groups 1 and 2 tumor site included: oral cavity, pharynx, larynx, parotid and thyroid. Regarding the neck dissection, the group 1 were more likely to receive a radical neck dissection (38% vs. 21%, p=0.461) and bilateral neck dissection (57% vs. 29%, p=0.096) than patients in group 2.

Table 1 – Demographics and clinical characteristics of the groups

Variables	Categories	Group 1 n(%)	Group 2 n(%)	Group 3 n(%)	p-value
Gender					
	Female	3(15)	8(57)	13(81)	<0.001
	Male	18(85)	6(43)	3(19)	
Age					
	≤ 55 years	9(43)	7(50)	11(69)	0.285
	≥ 56 years	12(57)	7(50)	5(31)	
Neck dissection type					
	Selective	13(62)	11(79)	N/A	0.461
	Radical	8(38)	3(21)	N/A	
Neck dissection side					
	Unilateral	9(43)	10(71)	N/A	0.096
	Bilateral	12(57)	4(29)	N/A	

N/A - Not applied: Patients in in the control group were not submitted to neck dissection

In group 1, from the 21 subjects, 11 (52%) showed some degree of hearing loss and from the 14 subjects in group 2, five of them (36%) showed hearing loss, after neck dissection. In the control group, four of the sixteen patients (25%) presented hearing loss after surgery (Table 2). Patients included in group 1

were also submitted to postoperative radiotherapy, after radiotherapy and eleven patients (52%) presented a worsening of the hearing threshold according to the criterium. Among these 11 patients, seven of them had already had a hearing loss detected after the neck dissection, before the postoperative radiotherapy.

Five patients in group 1 showed a loss in all of the tested frequencies, in at least one ear after surgery, whereas in groups 2 and 3, all the hearing losses were limited to two or three adjacent frequencies. Mean difference changes in the hearing thresholds presented by each group after each treatment were around 5 to 10 dB, with a high standard deviation mainly in group 1 (Table 3). In group 1 the type of neck dissection did not play a role in the presence of hearing loss, but in group 2, all the patients who were submitted to radical dissection presented hearing loss (Figure 1).

Tympanometry and acoustic reflexes were analyzed to determine whether a hearing loss was due to middle ear disorders after surgery. Table 4 shows that five patients in group 1 (36%) and two patients (20%) in group 2, among those who presented hearing loss after the surgery, showed abnormal tympanograms and absence contralateral acoustic reflexes suggesting a middle ear disorder. On the other hand, in group 1, among 7 subjects who showed absent contralateral acoustic reflexes after neck dissection (which were present at initial evaluation), five may be due to an afferent reason (hearing loss), since they did not appear to have abnormal tympanometries in the efferent ear (Table 5).

Not all the patients in both studied groups could be submitted to TEOAEs. Among those who perfomed the test, in group 1 (19 patients), otoacoustic emission results did not change after any treatment, in all the studied groups. Those emissions that were absent before remained absent after the treatment, in all groups, except in one patient of the control group (Table 6).

of the times radiotherapy or chemotherapy is believed to be the cause[9-10]. Frank et al.[6] studying a series of 51 patients treated with neck dissection and concomitant radiochemotherapy for advanced head and neck cancer, found only one patient with mild hearing loss during the treatment, and did not receive his final cycle of cisplatin.

Table 2 – Hearing status after each treatment in the three studied groups, according to the ASHA criteria

	No hearing loss after surgery (normal hearing)	Hearing loss only after surgery (ref: pre surgery audiometry)		Hearing loss only after radiotherapy (ref: post surgery audiometry)	Hearing loss after each treatments (ref: pre surgery audiometry)
	n(%)	n(%)	p-value	n(%)	n(%)
Group 1	10(48)	11(52)	0.110	11(52)	10(48)
Group 2	9(64)	5(36)		N/A	N/A
Control Group	12(75)	4(25)		N/A	N/A

N/A - Not applied: Patients in group 2 and in the control group were not submitted to radiotherapy

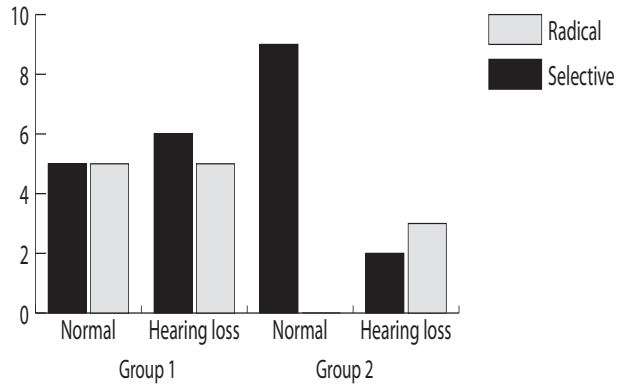
Discussion

Some patients in the clinical practice complain about hearing problems after oncologic treatment, most

Table 3 – Average hearing decrease (and standard deviation) in decibels hearing level (dBHL) after surgery in the three studied groups, in each tested frequency

	250 Hz	500Hz	1kHz	2kHz	4kHz	6kHz	8kHz
Right ear							
Group 1	12.7 (21.6)	13.6 (19.5)	15.9 (19.6)	13.1 (13.8)	16.8 (19.9)	14.5 (15.8)	15.0 (12.0)
Group 2	13.0 (2.7)	10.0 (3.5)	3.0 (2.7)	5.0 (3.5)	5.0 (7.0)	8.0 (12.5)	1.0 (14.7)
Control Group	1.2 (4.7)	2.5 (2.8)	1 (4.0)	1.2 (2.5)	3.7 (4.7)	3.7 (2.5)	6.2 (4.7)
Left ear							
Group 1	10.4 (15.8)	9.0 (10.9)	11.3 (14.3)	9.5 (7.8)	5.0 (18.1)	8.6 (13.4)	11.3 (13.4)
Group 2	8.0 (5.7)	4.0 (4.1)	5.0 (0)	3.0 (2.7)	2.0 (5.7)	3.0 (8.3)	5.0 (17.3)
Control Group	1.2 (2.5)	1.0 (5.7)	1.2 (4.7)	3.7 (4.7)	1.2 (4.7)	13.7 (4.7)	10.0 (0)

Figure 1 – Number of patients with and without hearing loss in the groups that were submitted to the neck dissection according to type of dissection



Normal. No hearing loss after surgery; Hearing loss. Hearing loss only after surgery (ref: pre surgery audiometry)

Table 4 – Tympanometric results among the groups in the initial and subsequent evaluations after each treatment

	Initial evaluation n (%)		After surgery n (%)		After radiotherapy n (%)	
	Type A	Type B/C	Type A	Type B/C	Type A	Type B/C
Group 1	18(86)	3(14)	12(57)	9(43)	10(48)	11(52)
Group 2	14(100)	0(0)	8(86)	2(14)	Not applied	
Control Group	12(75)	4(25)	15(94)	1(6)	Not applied	

Not applied: Patients in group 2 and in the control group were not submitted to radiotherapy.
Type A: normal tympanogram
Type B/C: abnormal tympanogram

Table 5 – Contralateral acoustic reflex results in all groups, in the initial and subsequent evaluations after each treatment.

	Initial evaluation n (%)		After surgery n (%)		After radiotherapy n (%)	
	Present	Absent	Present	Absent	Present	Absent
Group 1	15(71)	6(29)	8(38)	13(62)	4(19)	17(81)
Group 2	12(86)	2(14)	11(79)	3(21)	Not applied	
Control Group	12(75)	4(25)	15(94)	1(6)	Not applied	

Not applied: Patients in group 2 and in the control group were not submitted to radiotherapy

In our sample we found 52% (N=21) of patients in group 1 and 36% (N=5) in group 2 with hearing loss after neck dissection. In the control group (group 3) 25% (N=4) showed a hearing loss according to ASHA criteria[8]. In group 1, half of the hearing losses after surgery were found to be conductive, while in group 2 all of them were mainly sensorineural.

Table 6 – Absent contralateral acoustic reflex and tympanometric (efferent ear) results in all groups, in the initial and subsequent evaluations after each treatment.

	Initial evaluation		After surgery		After radiotherapy	
	Absent reflex		Absent reflex		Absent reflex	
	A	B/C	A	B/C	A	B/C
Group 1	3(50)	3(50)	9(69)	4(31)	8(47)	9(53)
Group 2	2(100)	0(0)	1(33)	2(77)	Not applied	
Control Group	0(0)	4(100)	1(100)	0(0)	Not applied	

Not applied: Patients in group 2 and in the control group were not submitted to radiotherapy
Type A: normal tympanogram
Type B/C: abnormal tympanogram

Table 7- Type of hearing loss after surgery in both studied groups in each ear

	Conductive		Sensorineural	
	Right ear	Left ear	Right ear	Left ear
Group 1	5 (71)	4 (50)	2 (29)	4 (50)
Group 2	1 (12)	1 (12)	7 (88)	7 (88)

Table 8 – TEOAEs among the groups in the initial and subsequent evaluations after each treatment.

	Initial evaluation		After surgery		After radiotherapy	
	Present	Absent	Present	Absent	Present	Absent
Group 1 (N=19)	5	14	5	14	4	15
Group 2 (N=11)	10	1	10	1	Not applied	
Control Group (N=16)	15	1	16	0	Not applied	

Not applied: Patients in group 2 and in the control group were not submitted to radiotherapy

In group 1 the number of patients who acquired a hearing loss after radiotherapy was the same as the number of patients who acquired hearing loss after surgery, nevertheless in seven cases there was an increase in the hearing loss acquired with the surgery after radiotherapy. In four other cases no loss was present after surgery but there was a shift in the baseline thresholds after radiotherapy.

Radiotherapy involving the temporal bone may induce conductive hearing loss due to swollen mucous, fluid collection, stiffness of the ossicular chain articulations or of the tympanic membrane layers may appear[4]. What we had not expected prior to beginning of this study was the fact that surgery alone may have taken part in the auditory dysfunction of such patients.

Some differences in age and gender were noticed among the groups in our study. The high number of female patients in the control group was due to the chosen type of benign tumour. Although the mean age was different, being lower in the control group than in group 2 and 1, the studied groups showed similar ages considering the proportion of patients over 55 years in each group.

Neck dissection was performed in both study groups and the hearing loss showed to be worse in group 1. This finding may drive some hypothesis. There may be an influence of the type and side of neck dissection once group 1 was more likely submitted to radical and bilateral neck dissection than group 2. This would lead to major manipulation during surgery involving soft tissue structures near the Eustachian tube opening, the lymphatic and vein drainage. In fact, middle ear disorders were revealed after surgery by the tympanometric results.

Although hearing loss was almost twice as frequent in group 1 than in group 2, the statistical analysis did not show a significant value in the number of patients who acquired hearing loss after surgery in the three studied groups. We observed that in group 2 all patients who were submitted to radical dissection presented hearing loss. Although this information about the risk of hearing loss due to the type of neck dissection would be of importance in the pre-operative counselling, it must be seen with caution due to the size of our sample.

Table 3 displays separate data from the right and left ears, showing that the increase in thresholds (in dBHL) was seen in both ears in almost all the tested frequencies in group 1, and in group 2 the threshold shifted mainly in the low frequencies region (250 and 500Hz). These results confirm that the hearing loss in group 1 was not only greater than in group 2 but probably more annoying due to the compromise of the speech frequencies (from 500 to 2kHz).

Type B/C tympanometric results were found in 43% of the cases in group 1 after surgery, showing a middle ear involvement.

Table 6 displays the contralateral acoustic reflexes absence according to the result of the tympanograms in the efferent ear, in order to ellucidate the reason for the absence. It can be seen that in group 1 only 4 of the 13 absent reflexes after surgery were due to alterations in the middle ear function. The other cases may have been due to afferent reasons such as an increase in the hearing thresholds.

A possible cause for the sensorineural hearing loss observed after neck dissection might be a decrease of vein flow or lymph drainage. Actually, Young and O'Keefe[11] reported a case of a bilateral sudden hearing loss immediately after simultaneous bilateral neck dissection, although the baseline audiometry was carried out six months before the surgery. The audiological results showed both sensorial and neural signs. According to the authors, those findings indicate that severe damage to the cochlea including spiral ganglion and nerve fibers, hemorrhage in the perilymphatic and endolymphatic spaces, may follow sudden venous obstruction of the labyrinth.

Goycoolea et al.[12] described that the primary source of blood to the inner ear is the labyrinthine artery. This vessel is usually described as being originated from the basilar artery, although it probably originates more frequently from the anterior inferior cerebellar artery. In addition, terminal branches that arise independently to enter the internal acoustic meatus may duplicate it. Descriptions of the venous drainage of the inner ear conflict. The described patterns include the following: a) a vein of the vestibular aqueduct, draining most of the semicircular canals and emptying into either the sigmoid or the inferior petrosal dural sinus; b) a vein of the cochlear aqueduct, draining the entire cochlea and vestibule. It runs in a long canal paralleling the cochlear aqueduct to enter the superior bulb of the internal jugular vein or the inferior petrosal dural sinus; c) a labyrinthine vein, which seems to be insconsistent. When present, it drains the apical and middle coils of the cochlea and traverses the internal acoustic meatus to become tributary to the inferior petrosal dural sinus.

Young and O'Keefe raised some explanations to the presence of hearing loss after neck dissection[11]. They believed that a poor collateral circulation explained as follows might cause it: a) communication between the external jugular vein and the posterior facial vein is either

absent or too small; b) the amount of blood in the facial vein is very large and that of the external jugular vein is very small. Therefore, there may be less drainage from the intracranial contents after ligation of the internal jugular vein; c) posterior facial vein is superficial to posterior belly of the digastric and the stylohyoid muscles, and it may be injured in neck dissection; d) external jugular vein is ligated when the skin flaps are prepared; e) there may be an injury to the short connection between the external jugular vein and the posterior facial vein; f) there may be an inadequate anastomosis between the internal vertebral venous plexus, vertebral and deep cervical veins.

According to Miller et al.[13] the function of the inner ear is to convert mechanical energy into spatial-temporal pattern of activity to trigger impulses to the auditory nerve fibers. Optimal performance of this complex function requires the maintenance of specific mechanical features and the bioelectric transduction capabilities of the inner ear tissues. In any organ, the efficient and timely delivery of O2 and nutrients, their metabolism, and the removal of waste products is of paramount importance. They suggest Laser Doppler Flowmetry may be used in patients who undergo neck dissection.

Conclusion

In this study we observed that neck dissection, as well as postoperative radiotherapy, may induce hearing loss in patients treated for head and neck cancer. Studies evaluating long term should be carried out to verify whether the hearing after neck dissection improves when new routes of venous drainage are naturally generated.

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