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Determination of the Relationship between Voice and Swallowing Characteristics in Individuals Aged 65 and Over with Sarcopenia Risk

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ABSTRACT

Objective: Sarcopenia, which increases with age, causes a decrease in muscle mass and strength, potentially leading to changes in the voice's acoustic, perceptual, and aerodynamic parameters, as well as dysphagia. This study aimed to assess the voice and swallowing functions of individuals aged 65 years at risk of sarcopenia and to explore the relationship between these functions.

Method: Forty-nine participants who scored ≥4 on the Sarcopenia Risk Assessment Scale were included. Acoustic analysis was performed using the Multi-Dimensional Voice Programme (MDVP), and aerodynamic analysis included the maximum phonation time (MPT) and the s/z ratio. Swallowing was evaluated using the Swallowing Function Screening Test (EAT-10).

Results: Participants were categorised into dysphagic (n=29) and non-dysphagic (n=20) groups based on their EAT-10 scores. Significant differences were found in several acoustic parameters, including fundamental frequency (F0), Shimmer, vAm, and FTRI (p=0.011, p=0.043, p=0.037, p=0.001). A significant difference in the SPI parameter was observed only in female participants (p=0.028). MPT showed significant differences between the dysphagic and non-dysphagic groups in both men and women (p=0.001, p=0.003, p=0.037). Positive correlations were found between EAT-10 and the acoustic parameters SPI and FTRI (p=0.031, p=0.048), while a negative correlation was found between MPT and EAT-10 (p=0.001).

Conclusion: MPT was decreased in dysphagic individuals aged ≥65 years at risk of sarcopenia, and parameters related to decreased respiratory support and control, vocal cord closure, and airflow control during vocal cord adduction were negatively affected. These findings suggest that these parameters may be related to dysphagia risk factors in elderly individuals at risk of sarcopenia.

Keywords: Voice, swallowing, dysphagia, sarcopenia, voice analysis

INTRODUCTION

Recent studies on the human lifespan have shown that the number of elderly people is increasing worldwide and birth rates are decreasing (1). From a medical point of view, old age is a period in the life course in which losses and declines are frequently observed. The population group defined as "the older adults" constitutes a special segment that carries more health risks and has specific problems compared with other age groups (2). With ageing, the incidence of chronic diseases and cancers increases, cognitive abilities decrease, and skipping meals or malnutrition is common (35-40%) due to psychological and care problems. These conditions may lead to malnutrition and many health problems (3).

One of the important changes that occur in the ageing process is sarcopenia. "Sarcopenia is defined as a decrease in muscle mass and strength during the ageing process, and this is commonly observed in elderly individuals" (4). Sarcopenia induces functional and structural declines in muscles, leading to decreased mobility, falls, and increased fragility (1). The incidence of sarcopenia increases with age (1). Research shows that the prevalence of sarcopenia ranges from 5 to 25% in individuals aged 60-70 years and from 11 to 50% in those. Sarcopenia is linked to physical limitations, dependence on others, increased risk of falls, respiratory and immune system issues, reduced quality of life, and mortality (3).

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Sarcopenia is categorised as either primary or secondary based on its causes (5). Primary sarcopenia is mainly caused by ageing, while secondary sarcopenia is associated with factors like physical inactivity, malnutrition, and conditions such as stroke and Alzheimer's disease (6). Moreover, sarcopenia is linked to various adverse health outcomes, including disability, increased mortality, a higher risk of falls, longer hospital stays, and a greater need for post-discharge (7). Recent studies have also suggested a link between sarcopenia and dysphagia given that the overall decline in muscle mass and strength in the elderly might affect the muscles involved in swallowing (6).

Hoarseness and dysphagia can occur simultaneously, but the relationship between these symptoms in individuals with sarcopenic dysphagia is not well understood. Consequently, sarcopenia can cause both voice and swallowing difficulties. The primary cause of hoarseness is the irregular vibration of the vocal cords. This irregularity can be attributed to the insufficient functioning of the thyroarytenoid, arytaenoid, and lateral cricoarytenoid muscles, which are involved in vocal cord vibration. These muscles help close the vocal cords, contribute to voice production, and prevent aspiration. Therefore, impaired muscle function may result in both hoarseness and difficulty in swallowing voice (8).

The anatomical and physiological changes that occur with ageing affect the acoustic, perceptual, and aerodynamic parameters of the voice. The reduction in respiratory support results from age-related alterations in the respiratory system and oral motor structure, decreased secretion, loss of muscle mass, and muscle atrophy. In addition, changes in social and employment status, losses experienced, perceived physical changes, and psychological conditions during old age may also have positive or negative effects on voice (9). In individuals aged 60 years, atrophic changes in the laryngeal muscles responsible for voice production can result in long-term weakening of the voice and alterations in vocal quality. This condition can be manifested by symptoms such as roughness and breathiness, pitch changes, decreased vocal intensity, tremors, decreased speech rate, and vocal fatigue. The inability to project the voice in noisy environments can reduce communication effectiveness and lead to social anxiety. This can negatively affect the quality of life and cause psychological problems. Therefore, appropriate interventions should be provided to patients with presbyphonia (10).

Presbyphonia is a vocal condition caused by the ageing process and impacts 12-35% of the elderly (11, 12). After 65 years of age, ageing leads to structural, functional, and physiological changes in the larynx (11, 12). The key symptoms of presbyphonia include hoarseness, a weak and low voice, trouble producing high-pitched sounds, difficulty singing, breathlessness, and voice strain (11-14). Videolaryngoscopic examination revealed prominent changes such as marked concavity of the vocal folds, prominence of the vocal apophyses, pseudo-sulcus vocalis, bowing vocal folds, and glottic insufficiency. These symptoms and observations reflect the effects of ageing on the vocal system (11, 15, 16).

Structural and functional changes in the aging presbylarynx include hyaline cartilage calcification, decreased glandular secretion, reduced neuromotor transmission, atrophy of the thyroarytenoid muscle (vocal muscle), thinning of the vocal fold epithelium, increase in the extracellular fibrous matrix (with more collagen fibers and fewer elastic fibers), and reduction in hyaluronic acid levels. Additionally, ageing may lead to reduced lung capacity and less precise articulation because of tooth loss, slower speech rate, and decreased saliva production. These changes can indirectly affect the vocal output and speech quality (17).

To identify voice problems and apply appropriate treatment protocols, a detailed evaluation of the individual's voice is necessary. In this comprehensive evaluation process, both instrumental and perceptual evaluations were performed. Instrumental evaluation provides anatomical examination of the vocal cord structures and observation of the movements of these structures. Aerodynamic measurements were also performed to analyse the acoustic parameters. Instrumental evaluations included videolaryngostroboscopy (VLS), fibreoptic laryngostroboscopy, flexible laryngoscopy, airflow and volume measurements, maximum phonation time and s/z ratio. In the analysis of voice parameters, computer-assisted acoustic voice analysis programmes, such as the Multi-Dimensional Voice Programme (MDVP) and Customised Praat, are widely used in clinical applications (9, 18).

Another condition associated with sarcopenia is dysphagia. Dysphagia is a condition characterised by disruptions in the movement of food caused by damage to the structures or functions of the masticatory organs (jaw, lips, tongue, soft palate, and throat). This damage can result in serious complications, such as aspiration pneumonia, malnutrition, and, in severe cases, asphyxiation (19). Presbyphagia refers to the common changes in the swallowing process observed in healthy older adults. These alterations can partially diminish the body's natural functional reserve (its capacity to manage physiological stress), increasing the susceptibility of the elderly to dysphagia. Older individuals are more prone to presbyphagia, especially when faced with added stressors such as acute illnesses and medications (20).

Studies have revealed that swallowing disorders are more common in the elderly and that swallowing difficulties significantly affect the quality of life in the geriatric population (21). The older people are at a high risk of dysphagia and other diseases related to ageing. Early detection and support of age-related impairments in swallowing function are important for improving the quality of life of elderly individuals (21, 22). Demir et al. found that the risk of dysphagia increased with age in individuals aged 65 years and older without the development of an additional disorder (21).

There is limited research on the connection between speech acoustic parameters and swallowing function in older adults. Song et al. developed a prediction model for aspiration risk based on speech acoustic parameters (23). Findings from a prospective exploratory study indicated a significant correlation between bedside voice screening results and the objective outcomes of videofluoroscopic swallow studies and fiberoptic endoscopic swallow assessments. Dysphagia and aspiration are associated with abnormal dysphonia (24). Studies have shown that some acoustic parameters may be linked to the swallowing function (25).

Respiratory speech acoustic parameters that can affect swallowing function include maximum phonation time (MPT), subglottic pressure, respiratory rate, apnoea period, and pharyngeal transit time (PDT). In Song et al.'s aspiration risk prediction model for stroke patients with dysphagia, the MPT value might reflect the coordination between speech and breathing, with lower MPT values being associated with a higher risk of aspiration. Subglottic pressure may affect the neural regulation of swallowing by stimulating subglottic mechanoreceptors during swallowing (23). Gross et al. found that the duration of pharyngeal activity was significantly extended when using the residual air volume compared with the total lung volume or functional residual capacity (26). Pharyngeal residence time (PDT) refers to the duration of material remaining in the pharynx before swallowing, either due to a pharyngeal delay or residue from a previous swallow. Morton et al. identified PDT as a key indicator of aspiration risk before and after swallowing in patients with dysphagia following brain injury. Abnormal breathing patterns can also increase the risk of aspiration during swallowing (27).

The aim of this study was to determine the relationship between voice and swallowing by identifying the status of voice and swallowing functions among elderly individuals aged 65 years at risk of sarcopenia. For this purpose, this study investigated whether there was a difference in acoustic and aerodynamic sound parameters between individuals with and without swallowing disorders according to the dysphagia risk score.

MATERIAL AND METHOD

Subjects

In this study, a descriptive research model, which is a quantitative research method, was used. Participation was voluntary, and participants were contacted face-to-face using the snowball technique. The study included 49 individuals (28 women, 21 men) aged 65 years at risk of sarcopenia. The mean age of the participants was 71.04±4.35 years. [range: 82-66]. Participants were administered the SARC-F scale for sarcopenia risk assessment, and those with a score of 4 or above were questioned for other conditions in the study. The other inclusion criteria were age 65 years or older, agreement to participate in the study, not having a diagnosis of swallowing disorder, having a score of 24 or higher on the Standardised Mini Mental Test (MMSE), not having a stroke, and not having a neurodegenerative disease. Participants who did not meet at least one of the following criteria were excluded from the study group. The study was approved by the Ethics Committee and Commissions of Üsküdar University and was conducted in accordance with the Declaration of Helsinki (Date: 28.03.2023, No: 18). All patients met the specified inclusion criteria.

Assessment procedure

Sarcopenia assesment

The Simple Questionnaire to Rapidly Diagnose Sarcopenia (SARC-F) scale was used to determine the risk of sarcopenia. The SARC-F is a self-administered questionnaire used to determine the level of difficulty in five components: strength, walking assistance, getting up from a chair, climbing stairs, and falling. The SARC-F scale scores ranged from 0 to 10 (0=best to 10=worst). A SARC-F score of ≥4 is considered a patient at risk of sarcopenia' (28).

Swallowing assessment

The clinical evaluation of dysphagia was performed using the Eating Assessment Tool 10 (EAT-10). EAT-10 is a self-administered, symptom-specific dysphagia outcome tool that has been used in clinics worldwide and validated in Turkey (29). EAT-10 measures the severity of swallowing disorders, quality of life, and treatment efficacy. The scale comprises 10 questions that are scored between 0 and 4 (0=no problem, 4=serious problem). A total score of 3 or above indicates a risk of swallowing disorders.

Acoustic and aerodynamic voice assessment

Aerodynamic and acoustic sound measurements were used to assess the sound parameters of the participants. Aerodynamic measurements provide an assessment of the airflow and volume for sound production. Among the aerodynamic parameters, the maximum phonation time (MPT) and the S/Z ratio were evaluated. Acoustic analysis was performed using a Lavalier MicroPhone (Model: JH-042) microphone connected to a Lenovo IdeaPad S145 laptop computer equipped with Audacity 3.1.3 software. The microphone was placed 15 cm away from the participant's mouth at a 45° angle with a frequency range of 50-15000 Hz and sensitivity of 30 dB. Because the noise level affects the quality of the audio recording, the audio was recorded in a quiet environment (<30 dB background noise) and in the was format with a sampling rate of 44,100 Hz and 16-bit quantisation. Participants were asked to continuously pronounce the vowels /a/ three times in one breath at a comfortable pitch and loudness level. The sustained /a/ vowel samples were analysed using the Multi-Dimensional Voice Programme (Model 5105; Kay Elemetrics, Co., Lincoln Park, NJ, USA). For the acoustic analysis, a 3-s mid-segment was selected from each sustained vowel (30).

For the aerodynamic analysis, the participants were asked to produce /a/, /s/, and /z/ three times. To measure the maximum phonation time (MPT), participants were asked to breathe deeply and sustain the /a/ sound at a comfortable pitch and loudness for as long as possible. The duration was measured using a stopwatch. To determine the MPT and S/Z ratio, measurements were recorded three times, and the longest phonation time measured in seconds was accepted.

Statistical analysis

Statistical Package for the Social Sciences (IBM SPSS Corp., Armonk, NY, USA) 25 software was used in the statistical analysis of the scale and voice analysis findings obtained from data analysis. The descriptive statistics of the variables are presented as the number of participants (n), number of responses (f), and percentage (%). The descriptive statistics of the continuous variables are presented as mean ±standard deviation. Whether the scores on all scales were normally distributed was determined by the Shapiro–Wilk test, and Spearman correlation analysis was used in the correlation analysis because all scale scores were not normally distributed. Correlation coefficients between 0.05 and 0.30 indicate low

Table 1: Comparison of the demographic and clinical characteristics between patients with and without dysphagia

	Overall (n=49) x̄ ±SD	Dysphagic (n=29) x̄ ±SD	Non-Dysphagic (n=20) x̄ ±SD	p
Age	71.04±4.35	71.51±3.39	70.35±3.19	0.07
Gender (F/M)	28 (57.1%)/21 (42.9%)	19 (67.8%)/10 (47.6%)	9 (32.2%)/11 (52.4%)	0.15
EAT-10	5.12±6.52	7.97±7.99	1.15±1.08	**0.001****
SARC-F	3.83±2.57	5.03±2.92	3.2±2.13	0.20

EAT-10: Eating Assessment Tool, SARC-F: A Simple Questionnaire to Rapidly Diagnose Sarcopenia x̄: Mean, SD: Standard Deviation. *p<0.05, **p<0.01 is considered statistically significant.

Table 2: Voice analysis results for the sustained vowel /a/ in the dysphagic and nondysphagic groups

MDVP	Dysphagic group (n=29)			Non-Dysphagic group (n=20)					
	Mean±SD			Mean±SD			p	p	p
	Male	Female	Overall	Male	Female	Overall	Male (n=21)	Female (n=28)	Overall (n=49)
Fundamental Frequency									
F0 (Hz)	157.9±27.7	235.6±48.2	208.8±36.2	155.2±35.2	224.0±53.5	186.2±25.6	0.918	1.000	**0.011***
Frequency perturbation parameters									
Jitt (%)	0.91±0.49	1.09±0.84	1.03±0.73	0.86±0.52	1.09±0.53	0.97±0.53	0.756	0.664	0.976
RAP (%)	0.54±0.30	0.64±0.47	0.60±0.42	0.51±0.33	0.65±0.34	0.57±0.33	0.705	0.699	0.976
PPQ (%)	0.53±0.29	0.65±0.52	0.60±0.45	0.52±0.35	0.63±0.30	0.57±0.32	0.888	0.699	0.927
Amplitude perturbation parameters									
Shim (%)	4.74±1.9	4.13±1.73	5.13±1.34	4.60±1.81	5.61±2.82	4.29±1.74	0.605	0.243	**0.043***
APQ (%)	4.40±1.76	3.61±1.50	4.44±2.23	3.88±1.57	4.50±2.81	3.70±0.28	0.251	0.772	0.077
vAm (%)	26.7±11.6	28.2±10.7	27.71±2.01	24.7±9.32	24.1±15.1	24.46±8.02	0.918	0.357	**0.037***
Noise parameters									
NHR	0.15±0.05	0.13±0.02	0.14±0.04	0.13±0.01	0.13±0.02	0.13±0.02	0.205	0.980	0.230
VTI	0.04±0.03	0.04±0.01	0.04±0.02	0.04±0.01	0.03±0.01	0.04±0.01	0.307	0.325	0.919
SPI	15.0±21.3	13.2±10.8	13.91±8.94	13.8±11.1	6.22±3.59	10.43±4.28	0.387	**0.028***	0.070
Tremor parameters									
ATRI (%)	9.90±5.02	8.98±5.14	9.34±4.90	9.12±4.89	8.68±8.50	8.93±6.38	0.833	0.662	0.650
FTRI (%)	0.61±0.36	0.84±0.47	0.75±0.11	0.60±0.48	0.48±0.33	0.54±0.08	0.888	**0.046***	**0.001****
Subharmonics parameters									
DSH (%)	0.40±0.86	1.92±2.83	0.97±2.09	0.19±0.65	0.77±1.39	0.64±1.23	0.525	0.168	0.666
Voice break-related parameters									
DVB (%)	0.01±0.02	0.84±2.61	0.55±2.13	0.00±0.01	0.78±2.36	0.36±1.58	0.391	1.000	0.748
NVB	0.09±0.30	0.77±2.33	0.40.1.56	0.00±0.01	0.10±0.31	0.06±1.56	0.391	0.927	0.684
Aerodynamic parameters									
MPT	5.70±2.75	4.10±2.07	4.65±2.40	0.82±0.27	9.77±5.69	9.90±3.67	**0.037***	**0.003****	**0.001****
S/Z	0.83±0.23	0.93±0.51	0.87±0.41	0.82±0.28	0.89±0.29	0.87±0.27	1.000	0.801	0.861

F0: Fundamental frequency, Jitt: Jitter, RAP: Relative average perturbation, PPQ: Pitch perturbation quotient, Shim: Shimmer, APQ: Amplitude perturbation quotient, vAm: Amplitude variation, NHR: Noise harmonic ratio, VTI: Voice turbulent index, SPI: Soft phonation index, ATRI: Amplitude tremor intensity index, FTRI: Frequency tremor intensity index, DSH: Degree of subharmonics, DVB: Degree of voice breaks, NVB: Number of voice breaks, MPT: Maximum phonation Time. *p<0.05, **p<0.01 is considered statistically significant.

Table 3: Relationship between the EAT-10 and SARC-F scores and voice parameters

Acoustic parameters		EAT-10	SARC-F
Jitter	r	-0.154	0.035
	p	0.435	0.860
Shimer	r	-0.297	-0.091
	p	0.125	0.644
NHR	r	-0.116	0.199
	p	0.556	0.309
vAM	r	0.302	-0.064
	p	0.118	0.747
SPI	r	**0.409**	-0.021
	p	**0.031***	0.914
ATRI	r	0.170	0.244
	p	0.561	0.401
FTRI	r	**0.416**	0.026
	p	**0.048***	0.905
DSH	r	-0.363	0.052
	p	0.057	0.792
DVB	r	-0.015	0.177
	p	0.941	0.369
Aerodynamic parameters			
MPT	r	**-0.650**	-0.117
	p	**0 .001****	0.552
S/Z	r	-0.112	-0.129
	p	0.572	0.513

*p<0.05, **p<0.01 is considered statistically significant. NHR: Noise harmonic ratio, vAm: Amplitude variation, SPI: Soft phonation index, ATRI: Amplitude tremor intensity index, FTRI: Frequency tremor intensity index, DSH: Degree of subharmonics, DVB: Degree of voice breaks, MPT: Maximum phonation time.

correlation, between 0.30 and 0.40 indicate low-moderate correlation, between 0.40 and 0.60 indicate moderate correlation, between 0.60 and 0.70 indicate good correlation, between 0.70 and 0.75 indicate strong correlation and between 0.75 and 1.00 indicate excellent correlation (31). Mann-Whitney U test was used for intergroup comparison. In all statistical analyses, significance was evaluated at p<0.05 level.

RESULTS

The study included 49 people aged 65 years at risk of sarcopenia. Participants were divided into two groups according to their EAT-10 scores with and without dysphagia. Of the participants, 29 (59.19%) were in the dysphagia group and 20 (40.81%) were in the nondysphagic group. The mean age of the patients in the dysphagic group was 71.51±3.39, while the mean age of the patients in the non-dysphagic group was 70.35±3.19 years. The mean EAT-10 score of the dysphagic group was 7.97±7.99, the mean SARC-F score was 5.03±2.92, the mean EAT-10 score of the non-dysphagic group was 1.15±1.08, and the mean SARC-F score was 3.2±2.13. There were no statistically significant differences in age, gender, and SARC-F scores between the two groups. This indicates that the participants were homogeneously distributed among the groups. The demographic and clinical characteristics of the participants are presented in Table 1.

Acoustic sound measurements were analysed between the dysphagic and non-dysphagic groups, and the results of the sound parameters obtained using MDVP are presented in Table 2.

According to the results of the acoustic analysis performed with MDVP, a statistically significant difference was found between the two groups in the mean fundamental frequency (F0) parameter when the group was compared with the non-dysphagic group (p=0.011). However, no significant difference was found between the two groups according to gender.

In all frequency perturbation parameters (Jitter, RAP and PPQ), there was no statistically significant difference between the dysphagic and non-dysphagic groups.

Regarding the amplitude perturbation parameters Shimmer and vAm, a statistical difference was found between the dysphagic and non-dysphagic groups (p=0.043, 0.037). However, no significant difference was found between the two groups in terms of gender. For the APQ parameter, another amplitude perturbation parameter, no significant difference was found between the groups.

Although there was no significant difference between the groups in the noise parameters NHR and VTI, in the SPI parameter, a statistically significant difference was found between the dysphagic and non-dysphagic group in women (p=0.028).

There were no significant differences in ATRI among the tremor parameters. However, when the dysphagic group was compared with the nondysphagic group regarding the FTRI parameter, a statistical difference was found between the two groups (p=0.001). In the comparisons according to gender, a significant difference was found in the dysphagic female group (p=0.046), whereas no significant difference was observed between male participants in the same parameter.

The degree of subharmonic (DSH), which is one of the subharmonic parameters, was higher in both the total values and in the male and female dysphagic groups compared with the nondysphagic group, but did not show a significant difference.

There were no significant differences between the groups in the degree of voice breaks (DVB) and Number of voice breaks (NVB).

The MPT value, one of the aerodynamic parameters, a statistical difference was found between the dysphagic group and the non-dysphagic group (p=0.001). In the comparisons according to gender, a significant difference was found between the two groups in both the female and male participants (p=0.003, p=0.037). Another aerodynamic measure, the s/z Ratio, showed no significant difference between the groups.

The relationship between the EAT-10 and SARC-F scores and the acoustic and aerodynamic sound parameters of the participants included in the study was analysed, and the results are presented in Table 3.

Accordingly, a statistically significant, positive, moderate correlation was found between EAT-10 and the acoustic parameters SPI and FTRI (r=0.409; p=0.031, r=0.416; p=0.048). Among the aerodynamic parameters, a statistically significant, negative, good correlation was found between MPT and EAT-10 (r=-0.650; p=0.001). Accordingly, the MPT scores decreased as the severity of the swallowing disorder increased.

No significant correlation was observed for the remaining parameters. There was also no statistically significant relationship between the voice parameters and SARC-F.

DISCUSSION

It has been shown that voice quality deteriorates markedly with ageing in older people, and this is associated with a decrease in muscle mass. Another affected function is swallowing. These findings indicate that voice and swallowing disorders are common in individuals at risk of sarcopenia (32). The current study investigated the relationship between voice and swallowing by determining the status of voice and swallowing functions among elderly individuals aged 65 years at risk of sarcopenia. Acoustic and aerodynamic sound parameters were examined between individuals with and without swallowing disorders according to dysphagia risk scores and whether there was a difference between the groups.

According to the results of our study, dysphagia was observed in approximately 60% of the participants at risk of sarcopenia and over the age of 65. Yoshikawa et al. stated that impairments in the swallowing function in elderly individuals are a natural consequence of ageing and that these impairments negatively affect the nutritional and general health status. It is noted that voice and swallowing disorders, which share a common anatomy with muscle mass loss in individuals at risk of sarcopenia, may be more prevalent and severe (33). In a study involving participants aged 65 years and older at risk of sarcopenia, dysphagia was found in more than half of the participants, supporting these findings. Research has demonstrated a strong association between sarcopenia and dysphagia. Sarcopenia is characterised by reductions in muscle mass and strength, which can result in the weakness of the muscles involved in swallowing function (34). In a 2021 study, Çolak et al. explored the connection between sarcopenia and dysphagia in greater detail and demonstrated that muscle mass loss in elderly individuals can significantly impair swallowing function, increasing the risk of aspiration (32).

According to our acoustic sound analysis, the Fundamental Frequency (F0) parameter was notably lower in the dysphagic group. Rajappa et al. found that reduced F0 values were linked to impaired swallowing function and weakened airway protection (35). Our findings, which revealed a significant decrease in the F0 parameter in the dysphagic group, support the association between low F0 values, poorer swallowing function, and a higher risk of aspiration.

Our study results indicated that the amplitude perturbation parameters, shimmer and vAm, were significantly higher in the dysphagic group. These parameters reflect the control of the loudness and its variability. The amplitude is directly related to the air pulsations from the glottis and the sound pressure. When the vocal cords do not close properly and there is inadequate breath support for voice production, there is an increase in the deterioration of these parameters (36-39).

In studies examining acoustic sound parameters to predict dysphagia, the shimmer parameter was identified as a key indicator of aspiration risk. Ryu et al. found that the shimmer values were higher in patients at high risk of aspiration than in those at low risk (40). In research focused on voice parameters for detecting dysphagia in patients with multiple sclerosis, shimmer was reported to be significantly elevated in dysphagic individuals (41). Song et al. also noted a significant correlation between Shimmer values and silent aspiration in 55 participants with suspected dysphagia (42). The vAm parameter related to breath control may indicate incomplete closure of the vocal cords. The incomplete closure of the vocal cords can compromise airway safety and may also contribute to aspiration and swallowing disorders. These findings indicate that vocal vibrations and changes in the amplitude of the voice are more pronounced in individuals with dysphagia and that these changes may be related to the swallowing function. Shimmer and vAm parameters have been reported to be associated with dysphagia in many stupidity (36-42).

Another result of our study was that the SPI values of female individuals with dysphagia were significantly higher. The SPI parameter is related to the tenseness of the vocal cords during phonation and whether they are fully closed. The SPI parameter increases when the vocal cords are loosely or incompletely closed during phonation (36). Higher SPI values, particularly in women, are correlated with increased posterior glottal chink opening in women (42). In this context, the finding of a higher SPI value in women in relation to gender differences is supported by other studies in the literature.

In our study, acoustic sound analysis revealed that the FTRI parameter was significantly higher in the dysphagic group, including in women. The FTRI parameter assesses voice quality and stability by measuring the transgluteal resistance of the vocal cords, which increases when tremors are present during vocal cord vibration (43). The FTRI reflects more pronounced tremor changes in individuals with dysphagia, suggesting its utility as an effective indicator of voice changes related to dysphagia. It has been noted that FTRI is a crucial parameter for detecting tremors associated with dysphagia and should be carefully considered in voice analysis studies (43).

In our study, MPT values were statistically significantly lower in both the overall participant group and the dysphagic subgroup, according to gender. Additionally, a statistically significant negative correlation was observed between MPT and EAT-10, indicating that MPT scores decreased as the severity of the swallowing disorder increased. MPT was used to measure the continuity of the vocal cord function during voice production (39). High MPT values indicate that the vocal cords are strong and healthy, whereas low MPT values indicate that there is insufficient closure in the vocal cords or phonation process (39). This indicates that swallowing disorders may have an indirect effect on phonation duration. MPT is also a parameter that provides an idea of the respiratory capacity. Respiration is temporarily stopped during swallowing, and this mechanism protects the airways (44). The coordination between breathing and swallowing is coordinated by nerve centres in the brain stem. This coordination is critical for healthy digestive and respiratory functions (45). MPT is considered a respiratory speech acoustic parameter that may affect the swallowing function (25). Song et al. reported that a low MPT was associated with a high risk of aspiration (46). In a study examining the relationship between swallowing function and MPT in patients with Parkinsonism, impaired swallowing function was found to cause a significant decrease in MPT by affecting the continuity of the voice (47). Similarly, in another study that examined the relationship between swallowing function and respiration and phonation, MPT was found to play an important role in the coordination of respiratory and swallowing functions (48). In this context, the significant decrease in MPT duration observed in the dysphagic participants in our study supports these findings.

There are some limitations in our study. First, the lack of a control group that included participants aged who were not at risk of sarcopenia was one of the important limitations of the study. Another limitation of our study is that acoustic measurements were performed only for extended phonation. In addition to frequency-based measurements, spectral and cepstral measurements that allow sound analysis in connected speech may provide a more comprehensive evaluation.

CONCLUSION

Overall, this study emphasises the importance of assessing voice and swallowing function in elderly individuals at risk of sarcopenia and provides information for the early detection of impairments in these areas. This study compared the acoustic and aerodynamic voice analysis parameters between the two groups with and without dysphagia. The results suggest that reduced respiratory support and control, vocal fold closure, and airflow control deficits during vocal fold adduction are risk factors for dysphagia in the elderly population. The findings highlight the importance of monitoring and managing the voice and swallowing functions in clinical practise.

Ethics Committee Approval: This study was approved by the Ethics Committee of the Üsküdar University (Date: 28.03.2023, No: 18).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

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Clinical Outcomes of Transcervical and Transoral Approaches in Parapharyngeal Abscesses

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ABSTRACT

Objective: The aim of this study was to identify the microorganisms cultured from abscesses in patients who underwent drainage with transoral and transcervical approaches and to compare the demographic data, anaesthesia duration, and length of hospital stay of patients using both techniques.

Material and Methods: We included 96 patients who underwent surgery for parapharyngeal abscesses at the Dicle University, Faculty of Medicine, Ear, Nose, and Throat and Head and Neck Surgery Clinic between 2015 and 2023. Drainage was performed using a transoral approach in 48 patients and using a transcervical approach in 48 patients. We compared both groups based on gender, age, comorbidities, bacteriology, length of hospital stay, and duration of anaesthesia.

Results: Upon evaluating the culture results for all patients in both groups, we found that no growth was detected in 50% of the cultures, whereas growth was detected in the other 50%. The average duration of anaesthesia in the transcervical group was 85 min, whereas in the transoral group, it was 52 min, with the duration of anaesthesia in the transoral group being significantly shorter than in the transcervical group. The average length of hospital stay in the transcervical group was 10 days, whereas in the transoral group, it was 8 days, indicating a significantly shorter hospital stay in the transoral group.

Conclusion: In our study, we found that patients undergoing transoral drainage had less morbidity, shorter anaesthesia duration and length of hospital stays.

Keywords: Parapharyngeal abscesses, transcervical, transoral, culture

INTRODUCTION

Parapharyngeal infections account for approximately 50% of deep neck infections. These infections are often caused by odontogenic infections in adults, whereas in children, they are frequently caused by pharyngeal infections (1). If these infections are not treated, they can spread along the deep fascial plane and form abscesses, leading to significant morbidity and mortality. They can result in life-threatening complications, such as septicaemia, internal jugular vein thrombosis, carotid artery rupture, mediastinitis, pericarditis, Horner syndrome, cavernous sinus thrombosis, and even death (2-4). Early and aggressive treatment is necessary to prevent these complications.

The recommended treatment for parapharyngeal abscesses is surgical drainage combined with intravenous antibiotic therapy (5). There are two surgical methods for drainage: transoral and transcervical. Transoral surgery is usually preferred for infections located in the medial part of the great vessels and in a single area, whereas transcervical surgery is preferred for infections located in the lateral part of the great vessels and in multiple areas (6, 7). However, the optimal method for the surgical treatment of Parapharyngeal abscesses is a matter of debate, and no global consensus has yet emerged (8). The transoral approach has become a frequently preferred method, especially in medial and single-area parapharyngeal abscesses, as it causes less morbidity (1). The aim of this study was to identify the microorganisms cultured from abscesses in patients who underwent drainage with transoral and transcervical

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approaches and to compare the demographic data, duration of anaesthesia, and length of hospital stay of patients using both techniques. Furthermore, we compared patients with and without comorbidities in terms of the length of hospital stay and duration of anaesthesia in our study.

MATERIALS AND METHODS

We included 96 patients who underwent surgery for parapharyngeal abscesses at the Dicle University, Faculty of Medicine, Ear, Nose, and Throat and Head and Neck Surgery Clinic between 2015 and 2023. This study was approved by the Dicle University Faculty of medicine, Ethics Committee (Date: 17.01.2024, No: 220). Patients who underwent surgical drainage through an oral incision were called the transoral group, and patients who underwent drainage through a neck incision approach were called the transcervical group.

Transoral Approach: A tonsillectomy mouth gag is placed in the patient's mouth and opened to obtain adequate exposure of the oropharynx. The lateral pharyngeal wall on the involved side was palpated intraorally to localise the abscess. Once localised, an 18-gauge needle is inserted, transorally, through the lateral pharyngeal wall and into the abscess cavity, and the pus is aspirated through the needle. Then, an incision is made in the overlying mucosa, and dilation with a large clamp is performed longitudinally. The mouth gag was removed and the wound was left open for continued drainage of the abscess into the oropharynx.

Transcervical Approach: The conventional method for approaching the parapharyngeal space is to approach the lateral cervical. This method involves an external skin incision made about 3 cm below the inferior border of the mandible. The sternocleidomastoid muscle and great vessels are retracted posteriorly. The parapharyngeal space is entered anterior to the posterior belly of the digastric and under the submandibular gland. Finger dissection was used to break up any loculations. After a drain is left in the cavity, the wound is closed.

The patients were evaluated using contrast-enhanced neck computed tomography (CT) at the time of their initial presentation to determine the location of the abscess, specifically, whether it was located lateral or medial to the great vessels, and whether it was located in a single area or multiple areas. We often performed drainage with transoral surgery in patients with localised abscesses in the medial part of the great vessels and in a single area. We also performed drainage with transcervical surgery in patients with abscesses in the lateral part of the great vessels and in multiple areas. Half of our patients were on antibiotic therapy at the time of admission to our hospital. All the patients were started on intravenous antibiotic therapy consisting of Clindamycin 500 mg twice daily and Ceftriaxone 1 g twice daily.

Patients who underwent drainage with a fine needle were excluded from the study. We compared the two groups based on gender, age, comorbidities, bacteriology, length of hospital stay, and duration of anaesthesia.

Statistical analysis

The behaviour of the quantitative variables was expressed using measures of central tendency and variance: Mean±SD. The exact test (used for small sample sizes) and chi-square test were employed to determine differences between proportions or relationships among categorical variables. To assess behavioural differences of group means, an analysis of variance (ANOVA) was utilised for comparisons involving more than two groups, and Student's t-test was used for comparisons between two groups provided that the normality and homogeneity of variance assumptions were met. When these assumptions were not met, the Kruskal–Wallis H Test was used for more than two groups, and the Mann–Whitney U Test was applied for two groups. The Bonferroni post hoc correction method was used for multiple comparisons between groups. Statistical significance was set at $p<0.05$ for all analyses. Statistical analyses were conducted using the IBM SPSS (Statistical Package for the Social Sciences for Windows, Version 21.0, Armonk, NY, IBM Corp., USA) software.

Descriptive statistics

The distribution statistics of the categorical variables are presented as n (%).

RESULTS

Drainage was performed using the transoral approach in 48 patients and the transcervical approach in 48 patients. The transcervical group comprised 34 (59%) male and 14 (41%) female patients, whereas the transoral group consisted of 24 (50%) male and 24 (50%) female patients. There was no significant difference in gender distribution between the two groups ($p>0.05$). In both the transcervical and transoral groups, 14 patients had comorbidities, while 34 did not. No significant difference in comorbidity was observed between the groups (Table 1).

Upon evaluating the culture results for all patients in both groups, we found that no growth was detected in 50% of the cultures, whereas growth was detected in the other 50%. We consider that because 50% of our patients were receiving antibiotic treatment at the time of admission, there was no growth in the cultures of these patients. The identified organisms included *S. anginosus* and *S. aureus* in eight patients each, *S. constellatus* in six patients, and *Gramme-positive cocci, Prevotella oris,* and *S. pyogenes* in three patients each.

Table 1: Demographic data of the transcervical and transoral groups

Approach		Transcervikal	Transoral	p
Comorbidities	+	14 (29.2 %)	14 (29.2%)	0.99*
	-	34 (70.8%)	34 (70.8%)	
Sex	M	34 (70.8%)	24 (50%)	0.06*
	F	14 (29.2%)	24 (50%)	

n (%), P, *: Pearson Chi-Squared Test

Table 2: Parapharyngeal abscess culture results

Parameter	Group	n (%)
Culture results	*No reproduce*	48 (50.0%)
	S Anginosus	8 (8.3%)
	S Aureus	8 (8.3%)
	S Consellatus	6 (6.3%)
	Gramme Cocci	3 (3.1%)
	Prevotella Oris	3 (3.1%)
	S Pyogenes	3 (3.1%)
	Bacteroides Tectus	2 (2.1%)
	Parvimonas Micra	2 (2.1%)
	S Constellatus	2 (2.1%)
	Acidovonax Delafix	1 (1.0%)
	Bacillus Licheriform	1 (1.0%)
	Enterobac Aeroginosa	1 (1.0%)
	Fusabact Necrophoru	1 (1.0%)
	Fusabact Nucleatum	1 (1.0%)
	Neisseria Mucosal	1 (1.0%)
	Parvimonas Acne	1 (1.0%)
	Peptostreptokok	1 (1.0%)
	Prevotella Denticola	1 (1.0%)
	S Oralis	1 (1.0%)
	S Pnomonia	1 (1.0%)

Additionally, *Bacteroides tectus, Parvimonas micra*, and *S. constellatus* were identified in two patients each, and other organisms were detected in one patient each (Table 2).

The mean ages of the patients in the transcervical and transoral groups were 31 and 28 years, respectively. The age of the patients in the transcervical group was significantly higher than that in the transoral group (Table 3). The average duration of anaesthesia in the transcervical group was 85 min, whereas in the transoral group, it was 52 min; thus, the duration of anaesthesia in the transoral group was significantly shorter than that in the transcervical group (Table 3). The average lengths of hospital stay in the transcervical and transoral groups were 10 and 8 days, respectively, indicating a significantly shorter length of hospital stay in the transoral group (Table 3).

In the transcervical group, the mean duration of anaesthesia was 84.5 min, and the length of hospital stay was 13 days for patients with comorbidities. For patients without comorbidities, the mean duration of anaesthesia was 85.5 min, and the length of hospital stay was 9 days (Table 4). In the transoral group, the mean duration of anaesthesia was 54.5 min, and the length of hospital stay was 11 days for patients with comorbidities. For patients without comorbidities, the mean duration of anaesthesia was 48 min, and the length of hospital stay was 9 days (Table 5). Although no significant difference was found in the durations of anaesthesia between patients with and without comorbidities in both groups, patients with comorbidities had a longer length of hospital stay.

DISCUSSION

The parapharyngeal space is a deep cervical compartment resembling an inverted pyramid with its base adjacent to the skull base superiorly and its apex near the hyoid bone inferiorly. The buccopharyngeal fascia and constrictor muscles of the pharynx are situated medially, while the ramus of the mandible and pterygoid muscles are located laterally. This space is bordered posteriorly by the carotid sheath and anteriorly by the pterygomandibular raphe. It is anatomically divided into two regions, the prestyloid and poststyloid areas, by the stylopharyngeal aponeurosis. The prestyloid area contains more adipose tissue, while the poststyloid area houses vital structures, such as the carotid artery, jugular vein, and cranial nerves IX, X, XI, and XII (9).

Amar et al. discussed various surgical approaches to the drainage of deep neck abscesses, classifying them into intraoral and external methods (1). In our clinic, we employ two surgical techniques—transcervical and transoral—based on the location of the parapharyngeal abscesses. The literature raported that the transoral approach should be utilised only for localised abscesses, whereas the transcervical approach is recommended for larger abscesses that extend inferiorly or recur after intraoral drainage (10, 11). Daya et al. reported that in parapharyngeal abscesses located medial to the great vessels or close to the skull base, drainage with intraoral surgery may be more suitable and less morbid (12). Hidaka et al. reported

Table 3: Comparison of age, anaesthesia duration and length of hospital stay between the two groups

Aproach	Transcervical (48)	Transoral (48)	p
Duration of Anaesthesia (Min)	86.58±15.01	54.13±11.34	<0.001 (m)
	85 (63-118)	52 (38-89)	
Age	37.65±21.28	27.63±18.56	0.016 (s)
	31 (1-86)	28 (1-69)	
Length of Hospital Stay (Day)	10.73±3.52	8.13±2.83	<0.001 (s)
	10 (5-21)	8 (3-16)	

Mean±SD/Median (Min-Max), (m) Mann-Whitney U Test - (s) Student's t-test

Table 4: Comparison of length of hospital stay and anaesthesia duration according to comorbidity in the transcervical group

Comorbidity	Yes (14)	No (34)	p
Anaesthesia Duration (Min)	83.79±12.4	87.74±15.99	0.413 (s)
	84.5 (63-98)	85.5 (63-118)	
Length of Hospital Stay (Day)	12.79±3.83	9.88±3.06	0.008 (s)
	13 (7-21)	9 (5-16)	

Mean±SD/Median (Min-Max), (s) Student's t-test

Table 5: Comparison of length of hospital stay and anaesthesia duration according to comorbidity in the transoral group

Comorbidity	Yes (14)	No (34)	p
Anaesthesia Duration (Min)	58.0±13.77	52.53±9.98	0.191 (s)
	54.5 (38-89)	48 (38-72)	
Length of Hospital Stay (Day)	10.93±2.56	6.97±2.04	<0.001 (s)
	11 (6-16)	7 (3-11)	

Mean±SD/Median (Min-Max), (s) Student's t-test

that in parapharyngeal abscesses located medial to the great vessels or close to the skull base, drainage with intraoral surgery may be more direct (13). The external approach requires a wider incision and increases the probability of damage to the carotid sheath. Moreover, it can be difficult to reach the parapharyngeal abscess via an external approach because the surrounding structure is shielded by the mandible (14). Thus, preoperative CT examination is essential to assess the relationship between the abscess and the surrounding critical structures, aiding in the selection of the appropriate surgical technique. We prefer the transoral approach for localised abscesses in the prestyloid area, while the transcervical method is favoured for abscesses located laterally in the poststyloid area or those extending into adjacent spaces, as it minimises the risk of injury to vital vessels and nerves.

Our study found that the surgical time and length of hospital stays were shorter for patients undergoing drainage via the transoral approach. We also noted that these patients were younger on average. Additionally, we observed that patients with comorbidities had longer length of hospital stays, although no significant difference was noted in the duration of anaesthesia. Our culture results indicated no growth in 50% of the patients, with growth detected in the remaining 50%. The identified microorganisms included *S. anginosus, S. aureus, S. constellatus, Gramme-positive cocci, Prevotella oris,* and *S. pyogenes*. Oh et al. reported similar findings, where cultures from 19 patients yielded growth of *S. pneumoniae, S. pyogenes*, and *anaerobic bacteria* in most cases, with only one culture showing no growth (5). Klug et al. highlighted that the common microorganisms found in parapharyngeal abscesses included a*naerobes, non-haemolytic streptococci*, and various other species (15). Pare et al. reported no growth in three of the 16 patients, with different bacterial species identified in the remaining cases (3). Our results corroborate these findings, showing growth in 50% of the 96 patients, primarily from the organisms mentioned.

Amar et al. performed drainage with intraoral surgery in 15 patients and with conventional lateral cervical surgery in 10 patients due to parapharyngeal abscess and compared intraoral and cervical approaches for drainage of parapharyngeal abscess and found no difference between the two groups in terms of age and gender, but noted shorter length of hospital stays and anaesthesia times in the intraoral group (1). Maroun et al. performed drainage with transoral surgery in 1063 patients and with cervical surgery in 111 patients. They noted that patients who underwent cervical surgery were younger than those who underwent intraoral surgery. They also reported that longer anaesthesia times and length of hospital stays were observed in the cervical group. Moreover, no significant difference in comorbidities was noted between the two groups (16). Oh et al. used transoral drainage for abscesses in the prestyloid area and transcervical drainage for abscesses in the poststyloid area. They found that patients who were drained transorally had shorter length of hospital stays than those treated transcervically (5). Several studies have stated that transoral surgery is associated with reduced morbidity and shorter length of hospital stays compared with transcervical surgery (10, 17). Our findings are similar to those of these studies, and we report that patients who underwent transoral surgery had shorter anaesthesia times, less morbidity, and shorter length of hospital stays compared with those who underwent transcervical surgery. Although transoral drainage may not be feasible for all patients, we assert that it is a less invasive option that requires less anaesthesia, particularly for localised parapharyngeal abscesses near the peritonsillar area.

CONCLUSION

Surgical drainage plays a crucial role in the management of parapharyngeal abscesses. In this study, we believe that the transoral technique causes less morbidity and is a more beneficial technique compared with the transcervical technique, especially in medially located abscesses.

Ethics Committee Approval: This study was approved by the Dicle University Faculty of medicine, Ethics Committee (Date: 17.01.2024, No: 220).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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Author Contributions: Conception/Design of Study- Ş.C.; Data Acquisition- Ş.C., M.A., M.A.; Data Analysis/Interpretation- Ş.C., G.K.; Drafting Manuscript- Ş.C., M.A., M.A.; Critical Revision of Manuscript- Ş.C., G.K.; Final Approval and Accountability- Ş.C., M.A., M.A., G.K.; Supervision- Ş.C.

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Etiopathogenesis and Diagnosis of Vocal Fold Palsy in a Tertiary Centre: A Retrospective Study

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ABSTRACT

Objective: To profile the etiology of vocal fold paralysis (VFP) and the various diagnostic methods used to determine the aetiology in a tertiary care centre.
Material and Methods: A retrospective review of the records of patients diagnosed with VFP in the last 5 years was done. Details about whether the vocal fold palsy was unilateral or bilateral, the diagnostic workup, and the final diagnosis were obtained from the records.
Results: A total of 182 patients; comprising 118 males and 64 females, had VFP. Unilateral VFP was documented in 155 cases and bilateral VFP was documented in 27 patients. The cause for VFP was found to be neoplastic in 32.9% of cases, with lung cancer being the most common. Idiopathic VFP was observed in 31.9% of the cases. Trauma and inflammatory cause were diagnosed in 17% and 9.9% of cases, respectively. Neurological causes contributed to 8.2% of the cases. Contrast-enhanced computerised tomography (CT) was the most commonly used method to identify the cause.
Conclusion: Identifying the aetiology of VFP is challenging. Thorough clinical examination followed by appropriate investigations is paramount to initiate an early intervention. We propose an algorithm for the same.
Keywords: Vocal fold palsy, vocal cord paresis, etiology, idiopathic

INTRODUCTION

Vocal fold paralysis (VFP) is the loss of normal adduction/abduction. It occurs as a result of injury to the recurrent laryngeal nerve (RLN). Vocal fold paresis is the hypofunction or hypomobility secondary to neurologic injury, while vocal fold paralysis is the complete immobility of the vocal cord. The vocal folds rely on RLN signals for mobility, which is crucial for functions such as swallowing, breathing, and voice production. Due to its longer course, the left RLN is more frequently affected than the right, making left-sided vocal fold paralysis 1.4–2.5 times more common (1-4).

This study aimed to evaluate the etiology and proportion of vocal fold paralysis and the diagnostic techniques used in, a tertiary care hospital in Southern India.

MATERIALS AND METHODS

A retrospective review of the records of patients admitted and evaluated for vocal fold paralysis from December 2017 to January 2023 was conducted. Approval of the Institutional Ethics Committee was obtained (Date: 29.04.203 No: YEC-1/2023/063). Records showing vocal cord fixity secondary to laryngeal or hypopharyngeal malignancies and incomplete records were excluded.

The details of the patient's clinical history, such as change in voice, aspiration, dysphagia, smoking, pre-existing neurological disorders, and previous surgeries were noted. The clinical findings of neurological, cardiovascular, and ear, nose, and throat examinations were also recorded. The details of investigations performed as part of the diagnostic workup include blood investigations, endoscopy, imaging studies, and histopathology.

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The data was entered into an MS Excel worksheet and was analysed for laterality of VFP and, causative factors, and the investigations employed as a part of the diagnostic workup for the identification of the etiology were noted.

RESULTS

Of the 182 patients, unilateral vocal fold paralysis (VFP) was seen in 85.2% (n=155), with left-sided paralysis more common (53.8%; n=98). Of these 64.8% (n=118) were male while 35.1% (n=64) patients were female (Table 1). Neoplastic causes accounted for 32.9% (n=60) of cases, with lung cancer being the most frequent etiology in 17% (n=31). Thyroid cancer accounted for 6.6% (n=12) of cases, while oesophageal cancer, vestibular schwannoma and lymphoma accounted for 3.8% (n=7), 3.3% (n=6), and 2.2% (n=4) respectively (Table 1). Idiopathic VFP was noted in 31.9% (n=58), and trauma-related causes were seen in 17% (n=31) of which surgical trauma accounted for 13.2% (n=24) (Table 1). Thyroidectomy was performed in 9.3% (n=17). Oesophageal surgery was performed in 1.1% (n=2) and schwannoma excision in 2.7% (n=5).

Nonsurgical trauma caused VFP in 3.8% (n=7) cases. Intubation injury was responsible for 1.1% (n=2) and laryngotracheal trauma accounted for VFP in 2.7% (n=5) cases. Neurological causes were responsible for VFP in 8.2% (n=15). These included cerebrovascular accidents (6.6%; n=12), Guillain Barre syndrome (0.55%; n=1), amyotrophic lateral sclerosis (0.55%; n=1), and lateral medullary syndrome (0.55%; n=1) (Table 1). In 9.9% (n=18) of the patients, inflammatory process was the cause of VFP, of which 5.5% (n=10) were attributed to tuberculosis, while 3.8% (n=7) had skull base osteomyelitis and 1 case had paraglottic abscess (Table 1).

A total of 14.8% (n=27) of the patients were diagnosed with bilateral VFP. The most common cause of bilateral VFP was neoplasms, accounting for 4.4% (n=8) of the 27 cases, with lung cancer being the most frequent etiology. Cerebrovascular accidents were the second most prevalent cause seen in 3.8% (n=7).

Computerised tomography (CT) was the most commonly used investigation to diagnose the etiology, followed by bronchoscopy and ultrasonography of the neck. Direct biopsy or Fine Needle Aspiration Cytology (FNAC) confirmed the diagnosis of neoplastic etiology (Table 2).

Hoarseness was the most common complaint reported by 57.1% (n=104) of patients, cough while swallowing was reported by 50% (n=91). In patients with bilateral vocal cord palsy, difficulty in breathing was the most common complaint seen in 9.3% (n=17), followed by change in voice in 5.5% (n=10).

DISCUSSION

Our findings align with those of prior studies showing a higher prevalence of left-sided VFP due to the longer course of the left RLN. Male predominance was observed in both unilateral

Table 1: Percentage-wise distribution of causes of vocal fold palsy

Etiology		Unilateral left VFP	Unilateral right VFP	Bilateral VFP	Total
Neoplastic	Lung malignancies	10.4% (n=19)	3.3% (n=6)	3.3% (n=6)	17% (n=31)
	Oesophageal malignancies	2.7% (n=5)	0.55% (n=1)	0.55% (n=1)	3.8% (n=7)
	Lymphoma	1.65% (n=3)	1.1% (n=2)	0.55% (n=1)	3.3% (n=6)
	Thyroid malignancies	2.7% (n=5)	3.8% (n=7)	0%	6.6% (n=12)
	Schwanomma	1.1% (n=2)	1.1% (n=2)	0%	2.2% (n=4)
Idiopathic		18.1% (n=33)	11% (n=20)	2.7% (n=5)	31.9% (n=58),
Infectious	Tuberculosis	3.8% (n=7)	1.1% (n=2)	0.55% (n=1)	5.5% (n=10)
	Skull base osteomyelitis	2.2% (n=4)	1.1% (n=2)	0.55% (n=1)	3.8% (n=7)
	Paraglottic abscess	0.55% (n=1)	0%	0%	0.55% (n=1)
Trauma	Laryngotracheal trauma	1.1% (n=2)	1.1% (n=2)	0.55% (n=1)	2.7% (n=5)
	Post thyroidectomy	2.7% (n=5)	4.4% (n=8)	2.2% (n=4)	9.3% (n=17)
	Post gastrectomy	1.1% (n=2)	0%	0%	1.1% (n=2)
	Post schwannoma excision	1.65% (n=3)	1.1% (n=2)	0%	2.7% (n=5).
	Post intubation	1.1% (n=2)	0%	0%	1.1% (n=2)
Neurological	Cerebrovascular accident	2.2% (n=4)	0.55% (n=1)	3.8% (n=7)	6.6% (n=12)
	Guillain Barre Syndrome	0.55% (n=1)	0%	0%	0.55% (n=1)
	Lateral medullary syndrome	0%	0.55% (n=1)	0%	0.55% (n=1)
	Amyotropic lateral sclerosis	0%	0.55% (n=1)	0%	0.55% (n=1)
Total		53.8% (n=98)	31.3% (n=57)	14.8% (n=27)	100% (n=182)

VFP: Vocal fold palsy

Table 2: Investigations performed for VFP and their diagnostic yield.

Diagnostic tests	Tests performed	Diagnostic yield (%)
CT scan	143	50.3% (n=72)
Endoscopy	46	82% (n=38)
MRI scan	21	76% (n=16)

CT: Computerised Tomography, MRI: Magnetic Resonance Imaging, Endoscopy- bronchoscopy or upper gastrointestinal endoscopy

and bilateral cases, consistent with gender differences in healthcare-seeking behaviour and smoking prevalence (5-7).

The left VFP is nearly twice as common as the right VFP with a ratio of 1.72:1. This finding was consistent with earlier research conducted in Japan and Denmark (8, 9). This variation is attributed to the longer course of the left RLN (1).

According to studies conducted in Egypt, Taiwan, and Italy, the three most common causes of unilateral VFP are tumours, surgery, and idiopathic paralysis (2, 10, 11).

In our study, neoplastic etiology was the leading cause of VFP. Lung cancer was the most common cause followed by thyroid malignancies. A study conducted in Taiwan comprising 291 patients to identify the etiopathology of VFP reported surgical causes in 40.2% and, neoplastic in 29.9% of cases. Lung cancer was responsible for 11.6% of cases and was the most common neoplastic etiology (12).

In our study, most patients presented with a change in voice followed by cough while swallowing. The severity of this depended on the position of the vocal folds. The other symptoms were breathing difficulty and stridor, which was reported most often in bilateral VFP. A 12-year retrospective study in Pune encompassing 711 patients found change in voice as the most common presenting complaint in both unilateral and bilateral palsy. Idiopathic VFP accounted for 23% of the

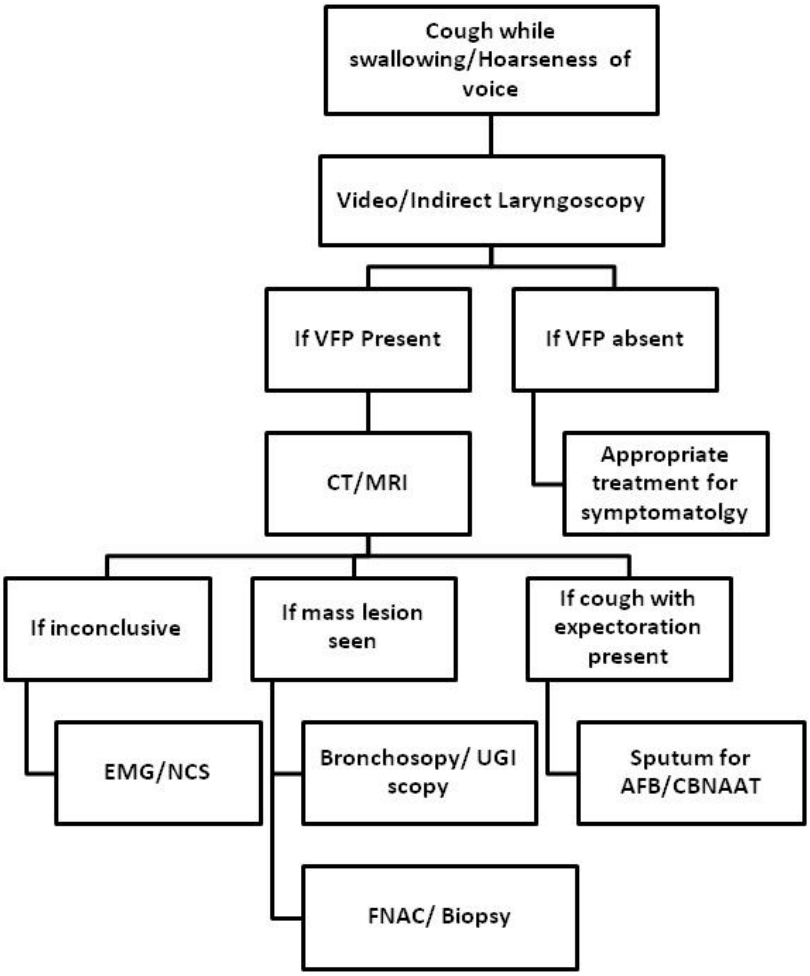

Figure 1: Flow chart representing the diagnostic algorithm for Vocal Fold Paralysis

VFP: Vocal Fold Paralysis, CT: Computerized Tomography, MRI: Magnetic Resonance Imaging, EMG: Electromyography, NCS: Nerve Conduction Study, UGI scopy: Upper Gastro-Intestinal endoscopy, FNAC: Fine Needle Aspiration Cytology, AFB: Acid Fast Bacilli Stain, CBNAAT: Cartridge Based Nucleic Acid Amplification Test unilateral cases, while malignancy was reported in 13.6% of the bilateral cases (13). Our study reflects the same with 34% of the unilateral VFP diagnosed as idiopathic and 29.6% of the bilateral VFP diagnosed as having neoplastic etiology. All patients with idiopathic etiology underwent adequate testing to eliminate other possibilities.

Only 13% of the cases in this study were secondary to surgical trauma. A retrospective cohort study conducted in Michigan reported, a maximum number of cases caused secondary to surgical trauma, most commonly thyroid surgeries. The study compared changing trends in the etiology of VFP over 20 years and reported an increase in the incidence of surgical causes (14). Similar trends were reported in a study conducted in Pune (13).

Neurological causes accounted for 8.2% of all cases marked by 12 cases of CVA of which 7 were bilateral VFP. In another study conducted in Taipei, from 2010 to 2019, 194 patients were evaluated for VFP. Only 4% of patients had neurological etiology (2).

Infectious causes accounted for 9.9% of the cases in our study. Similar percentages were reported by other studies conducted in Maharashtra and Himachal Pradesh (5, 6).

The most extensively used diagnostic tool was seen to be computerised tomography; either contrast-enhanced or high-resolution scans were used. It is preferred over MRI scans due to the lower cost and it being technically easier as well as faster. In some cases where lesions were seen in the oesophagus and the tracheobronchial tree, bronchoscopy and gastrointestinal endoscopy were performed to attain tissue diagnosis.

Causation of VFP can be due to injury anywhere from the cerebral cortex to mechanical injury of the larynx and can be secondary to trauma, malignancies, mass lesions, or infections (1). The diagnosis of the etiology of VFP is challenging but of utmost importance so that appropriate and early intervention can be initiated. Diagnostic techniques can vary in sensitivity and specificity. Previously, diagnosis was mainly via indirect laryngoscopy, but it has been replaced by flexible or rigid endoscopy in most centres. Early detection can help prevent complications like aspiration and stridor (15). This study systematically evaluated diagnostic techniques and presented their yields to enable clinicians to optimise diagnostic strategies for VFP.

The findings of our study align with the findings of previous studies and add regional data to existing literature, highlighting certain differences in demographics, etiology, and diagnostic trends specific to this population considering the socioeconomic factors and resources available.

Limitations

A long-term prospective study with a larger sample size would help fine-tune the working protocol for early diagnosis.

CONCLUSION

Vocal fold paralysis is a clinical finding requiring thorough evaluation to identify its etiology and enable timely intervention. This study highlights the need for comprehensive diagnostic protocols to improve outcomes. The current study provides insight into areas to focus efforts to prevent neuropathy and limit the morbidity associated with VFP.

While algorithms exist, we propose a customised protocol for the south Indian population, considering the paucity of available resources and diagnostic tools (Figure 1).

Ethics Committee Approval: This study was approved by the Institutional Ethics Committee was obtained (Date: 29.04.203 No: YEC-1/2023/063).

Informed Consent: Due to the retrospective design of the study, informed consent was not taken.

Peer Review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- A.S., S.M.S., V.S.; Data Acquisition- A.S.; Data Analysis/Interpretation- A.S., S.M.S., V.S.; Drafting Manuscript- A.S., S.M.S.; Critical Revision of Manuscript- S.M.S., V.S.; Final Approval and Accountability- A.S., S.M.S., V.S.; Supervision- S.M.S., V.S.

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Relationship between Anatomical and Physiological Problems with Speech Problems in Turkish-Speaking Children with Cleft Lip and Palate*

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ABSTRACT

Objective: The aim of this study was to describe the speech and resonance characteristics of Turkish-speaking children with cleft lip and palate (CLP) and to investigate the relationship between oral anatomical-physiological problems and speech-resonance problems.
Materials and Methods: 40 Turkish-speaking children with CLP between the ages of 3 and 15 underwent oral-motor evaluation, nasometric evaluation (The Nasometric Assessment Tool-Turkish), articulation evaluation (sentence repetition test), and perceptual resonance evaluation.
Results: The most common speech errors seen in the participants were backing, differentiation of glides, voicing errors, labialisation, nasalisation, palatalisation, dentalisation and lateralisation. 35% of the participants had normal resonance, while the remaining 65% had resonance-airflow problems. A significant relationship was found between hypernasality and nasalisation, weak articulation, and double articulation. A significant relationship was found between class III malocclusion and dentalisation, lateralisation, bilabialisation; crossbite and lateralisation; missing teeth and dentalisation, palatalisation, fronting.
Conclusion: There is a relationship between dental and occlusal anomalies and speech errors and between hypernasality and speech errors. In addition to articulation errors, phonological processes may also be present in Turkish-speaking children with CLP. The results of this study can be taken into consideration by speech and language therapists while conducting assessments and providing interventions for Turkish-speaking children with CLP.
Keywords: Cleft palate, speech disorders, speech sound disorder

INTRODUCTION

In humans, cleft lip and palate (CLP) is the most prevalent orofacial abnormality (1). CLP was the second most common major congenital anomaly after central nervous system anomalies in a study conducted in Türkiye (2). The prevalence of CLP in Türkiye has been reported as 8.11 per 10 000 live births (3).

Individuals with CLP may have structural and physiological problems in the oral-facial structures such as the jaw, teeth, nose, lips and palate (4). These problems can lead to various challenges, including speech deficits, feeding issues, hearing issues, and dental malformations (5). CLP can cause speech sound disorders and resonance problems (6). There are studies investigating the articulation and phonological characteristics of children with CLP who speak languages such as English, Swedish, Hebrew, Portuguese, and Arabic (7-11). Information about CLP speech characteristics in less assessed languages can teach researchers and clinicians more about universal CLP speech disorders. In addition, because each language has a different phonological system, the identification of language-specific CLP speech errors may enable the development or adaptation of interventions for that language.

There are very few studies describing the speech characteristics of Turkish-speaking children with CLP (12–14). Tezel evaluated

* This study was completed within the scope of the first author's Master's Thesis at the İstanbul Medipol University.

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the speech characteristics of five Turkish-speaking monolingual children aged 3.5-6.5 years with cleft palate (12). The most common speech errors in Tezel's study were nasalisation, backing, differentiation of glides, fricativisation, and voicing errors. Because phonological delays were observed in all participants in Tezel's study, Tezel stated that phonological problems were considered caused by phonetic errors. Dinsever-Eliküçük et al. evaluated the speech of 87 Turkish-speaking CLP children between the ages of 6-18 and found pharyngeal fricatives, posterior nasal fricatives/stop production, glottal stop production, middorsal palatal stop production, nasal frictional production, posterior nasal frictional production/phoneme specific nasal emission, use of nasal consonants for oral consonants, and replacement of trills consonant production errors (14). Dinsever-Eliküçük et al. focused on compensatory articulation errors in their study. Ünal-Logacev et al. assessed the speech problems of 35 children aged 0-18 years who grew up in a Turkish-speaking environment and found nasalisation, weak articulation, double articulation, differentiation of glides, labialisation, fronting, active nasal fricatives, lateralisation, voicing errors, dentalisation and palatalisation speech errors, with backing being the most common (13). In general, studies of CLP speech features in the Turkish literature are controversial and limited.

The anatomical features, physiological processes, and speech problems of children with CLP should be identified by speech and language therapists (SLTs). In addition, SLTs must demonstrate how speech problems relate to these structures and functions. As a result, the SLT's understanding of which anatomical and physiological issues are related to speech problems is important for making a differential diagnosis about the speech problem, guiding the child correctly and implementing effective intervention methods (4).

The aim of this study was to describe the oral anatomy-physiology and speech characteristics of Turkish-speaking children with cleft lip and palate and to examine the relationship between the anatomical-physiological problems and speech-resonance problems of these children. While this study primarily focuses on the relationship between articulation-phonological errors and anatomical-physiological problems in CLP participants, nasalance scores compared based on nasality judgments are included because they are significant from a clinical standpoint. The research questions of this study are as follows:

- What are the oral anatomical-physiological problems and speech-resonance characteristics of Turkish-speaking children with CLP?
- What is the relationship between the oral anatomical-physiological problems and the speech-resonance characteristics of Turkish-speaking children with CLP?
- Is there a statistically significant difference between the nasalance scores and the perceived resonance and nasal airflow of Turkish-speaking children with CLP?

MATERIALS AND METHODS

Participants

This cross-sectional study described the oral anatomical and physiological problems of Turkish children with cleft lip and palate between the ages of 3 and 15 years, using the Cleft Lip and Palate Assessment Form and the Nasality Microphone, and examined the relationship between these anatomical-physiological problems and speech-resonance problems.

This study was conducted on participants with cleft lip and palate who applied for speech and language assessment at the Medipol Language, Speech and Swallowing Therapy and Innovative Technologies Research and Application Centre (MEDKOM). Data were collected before the COVID-19 pandemic.

The criteria for inclusion in the study are as follows:

- Presence of cleft lip and palate, isolated cleft palate, submucous cleft, occult submucous cleft, or velopharyngeal insufficiency not attributable to any cause
- 3;0 - 18;0 years of age,
- Turkish mother tongue,
- Ability to cooperate in the assessment process (allowing oral-motor assessment, repetition of speech stimuli),
- Normal hearing, determined based on the caregiver/family report during the evaluation process,
- No behavioural disorder to an extent that would interfere with the assessment.

A total of 67 participants were assessed. 12 participants were excluded from the study because they did not meet the age criteria and 15 participants were excluded because they did not wish to participate in speech-related tasks, such as repeating speech stimuli. As a result, the study was completed with 40 participants who met the inclusion criteria.

The mean age of the participants was 5.4±1.45 years. Of the participants, 50% were girls and 50% were boys. The age distribution revealed that 62.5% of the participants were in the 3;0-6;11 age range, 35% were in the 7;0-12;11 age range, and 2.5% were in the 13;0-17;11 age range. Regarding syndromic conditions, 82.5% of the participants had no syndrome, while 17.5% had a syndrome. Distribution by cleft type showed that 32.5% had unilateral primary secondary complete cleft, 22.5% had bilateral primary secondary complete cleft, 10% had secondary complete cleft, 12.5% had secondary incomplete cleft, 20% had submucous cleft, and 2.5% had velopharyngeal insufficiency. In terms of palate surgery history, 12.5% had no prior surgeries, 55% had undergone one surgery, 22.5% had undergone two surgeries, and 10% had undergone three surgeries. Regarding speech and language therapy history, 80% of the participants had no prior therapy experience, while 20% had received therapy previously.

Data collection tools

The Cleft Lip and Palate Assessment Form and the Nasometric Assessment Tool (NADA) were administered to the participants (13, 15). The Cleft Lip and Palate Evaluation Form is a Turkish assessment tool designed to evaluate individuals with CLP or craniofacial anomalies according to a specific protocol. The subtests of the Cleft Lip and Palate Assessment Form are the CLP Family Interview Form, the CLP Oral Peripheral Assessment Form, and the CLP Speech and Resonance Assessment Form. The CLP Family Interview Form subtest was used to explore possible genetic and environmental factors underlying cleft lip and palate or craniofacial anomalies and to obtain information about the child's prenatal, perinatal and postnatal history, general health and development. The CLP Oral Peripheral Assessment Form subtest includes items to help associate anatomical and physiological problems with speech disorders and peripheral assessment items. This subtest includes items that provide structural and functional assessment of malocclusion of the teeth, tooth structure, and presence and location of fistula, tongue, uvula, velum, and nasopharynx. The CLP Speech and Resonance Assessment Form subtest contains speech stimuli that can be used to assess speech and resonance in people with CLP. The speech assessment section of this subtest consists of a Sentence Repetition Test. In the Sentence Repetition section, there is a target sentence for each consonant in Turkish to determine the individual's speech errors.

The Nasality Microphone is a handheld, portable device used to measure nasality during speech production. It consists of a plate placed between the upper lip and the nose, with microphones above and below the plate to capture acoustic energy from the nasal and oral cavities. The device calculates a nasal balance score by dividing the nasal acoustic energy by the total nasal and oral acoustic energy, providing a numerical representation of nasality. After proper placement, the device is operated using software to record the speech sample. The Simplified Nasometric Assessment Procedures Revised (SNAP-R) test, which is used to assess resonance and velopharyngeal function, has been phonetically adapted to Turkish under the name Nasometric Assessment Tool (NADA), and normative studies have been conducted for individuals aged 4 to 18 years (15, 16). According to normative data, high nasality scores are compatible with hypernasality and low scores are compatible with hyponasality. The NADA consists of three subtests: the Syllable Repetition/Prolonged Sound Subtest, the Picture-Cued Subtest, and the Reading Subtest. The Syllable Repetition/Prolonged Sound Subtest consists of syllables and extended sounds. The Picture Cued Subtest consists of five different sentence sets. The Reading Subtest consists of two easy-to-read paragraphs, one with five nasal sounds and a weighted of plosive sounds, and the other with no nasal sounds and a weighted of fricative sounds. As the NADA standards are set for the Nazometer II: Model 6450, it was used in this study only for data collection and not for diagnosis.

Procedure

Families who applied to MEDKOM for speech and language evaluations related to cleft lip and palate were informed about the study and invited to participate. Families meeting the eligibility criteria and agreeing to participate signed an informed consent form before the evaluation, which was conducted in the assessment and phoniatry rooms at MEDKOM.

The Cleft Lip and Palate Assessment Form was administered to the family and child. During the medical history assessment of children under seven years of age, a speech and language therapy graduate student engaged the child with games to prevent boredom during the family interview. Before the speech and resonance assessment, the participants underwent an oral motor assessment, including structural and functional evaluations of the occlusion pattern, teeth, tongue, velum, uvula, nasopharynx, and fistula (location and size) using a light source.

Participants repeated sentences targeting consonant phonemes from the Cleft Lip and Palate Speech and Resonance Assessment Form subtest after the evaluator. Children under seven were encouraged to imitate a parrot to facilitate sentence repetition, and a speech sample was taken. For children who forgot the sentence, the evaluator prompted them by saying one word at a time (e.g., the evaluator says "Baba," and the child repeats "Baba"). Phonemes requiring clarification were elicited with the /ʌ/ sound (e.g., pʌpʌpʌ for /p/, sʌsʌsʌ for /s/). When necessary, the participants produced the target phoneme along with minimal pairs for further analysis. For those with extreme hypernasality, some sentences were spoken with the nose closed to better identify phonemes. All assessments were conducted under the supervision of a CLP-specialised speech therapist with 10 years of experience and two graduate students.

Participants underwent the Straw Test and the Resonance Assessment Test, which are subtests of the Cleft Lip and Palate Speech and Resonance Assessment Form, to evaluate resonance. In the Resonance Assessment Test, participants opened and closed their nose while saying a long /i/ and non-nasal words if hypernasality was suspected, or a long /m/ and nasal words if hyponasality was suspected. The resonance type was marked based on changes observed with nose opening and closing. In the Straw Test, a flexible straw was used to detect the airflow and resonance type by placing one end in the participant's nostril and the other in the assessor's ear during high-pressure sound repetitions.

For instrumental assessment, participants completed the NADA using the nasal microphone. Initially, the Picture Cued Subtest was administered, with the Syllable Repetition Subtest used for those requiring simpler stimuli. Nasalance scores were calculated for utterances with high-pressure phonemes. Because children under 4 years of age could not undergo nasometric evaluation, nasalance scores were obtained from 22 participants. Each assessment took approximately 10 minutes.

Phonetic transcription, oral-peripheral assessment and resonance-nasal airflow assessment of the speech stimuli were carried out in consensus with a CLP specialised speech and language therapist who has ten years of experience in working with children with CLP and two graduate speech and language therapy students. Speech and resonance assessments were videotaped using a Canon Legria HF R806 camera. In cases where there was no consensus between the assessors on the phonetic transcription and perceived resonance- nasal airflow type, video recordings were used.

Ethics

Ethical approval was obtained from the İstanbul Medipol University Non-Interventional Clinical Research Ethics Committee (Date: 30.11.2018 No: 703). Institutional approval was obtained from the İstanbul Medipol University Institute of Health Sciences to conduct the study at MEDKOM. Families who agreed to participate in the study were given detailed information about the study and signed an "Informed Consent Form." The names of the participants were kept completely confidential and coded with specific letters and numbers.

Table 1: Oral anatomical and physiological characteristics of the participants

	n	%
Occlusion type		
Normal occlusionun	18	45
Class II malocclusion	6	15
Class III malocclusion	16	40
Anterior open bite		
Yes	2	5
No	38	95
Posterior open bite		
Yes	1	2.5
No	39	97.5
Supernumerary teeth		
Yes	2	5
No	38	95
Missing teeth		
Yes	21	52.5
No	19	47.5
Crossbite		
Yes	9	22.5
No	31	77.5
Fistula		
Yes	12	30
No	28	70
Fistula position		
Anterior fistula	8	66.7
Posterior fistula	4	33.3
Fistula size		
≤ 2 mm	3	25
3–5 mm	4	33.3
6–8 mm	4	33.3
9 mm ≥	1	8.3

Data analysis

Statistical data analysis was performed using IBM SPSS Statistics 29.0. Descriptive statistics were used for the demographic data, speech and resonance characteristics, and oral anatomical-physiological characteristics of the participants. Means and standard deviations were calculated for continuous variables and proportions and percentages for categorical data. The Shapiro-Wilk normality test, skewness-kurtosis values and graphs were used to determine whether the data conformed to the normal distribution. As the data followed the normal distribution, the one-way ANOVA test, one of the parametric methods, was used to analyse the data. The chi-square test was used for the relational analysis of the categorical data, and the Phi correlation coefficients were calculated. In this study, the interpretation of the Phi correlation coefficient was based on the study of (17). Statistically, a value of $p<0.05$ was considered statistically significant.

RESULTS

Anatomical problems that may affect articulation and resonance, such as occlusion types, dental characteristics, presence, location, and size of the fistula, are listed in Table 1.

Among the children who participated in the study, 45% had normal occlusion and 40% had class III malocclusion. Anterior open bite was present in 5% of the participants, posterior open bite in 2.5%, and overbite in 2.5%. In total, 52.5% of the participants had missing teeth, 22.5% had crossbite, and 30% had fistula. Of the participants with fistula, 66.7% had fistula in the anterior region. The fistula size of 66.6% of the participants with fistula was between 3 and 8 mm (Table 1).

The articulation and phonological errors determined by transcribing the participants' speech data are shown in Figure 1.

Backing was found in 55% (n=23) of the children, differentiation of glides in 57% (n=23), voicing errors in 45% (n=18), labialisation in 42.5% (n=17), nasalisation in 27.5% (n=11), palatalisation in 25% (n=10), dentalisation in 25% (n=10), lateralisation in 22.5% (n=10), weak articulation in 17.5% (n=7), double articulation in 10% (n=4), fronting in 10% (n=4), active nasal fricatives in 5% (n=2). 37.5% (n=15) had other errors such as stopping, fricativisation, retracted articulation.

The resonance and nasal airflow characteristics of the participants as judged by perceptual evaluation are shown in Figure 2.

Hypernasality (n=10, 25%), nasal turbulence (n=11, 27.5%), and normal resonance (n=14, 35%) were found in most participants (Figure 2).

Table 2: Comparison of participants' nasalance scores according to perceived resonance type

	Variable			n		Mean	SD
Resonance and Nasal airflow error type	(1) Hypernasality and nasal emission			7		52.11	7.38
	(2) Nasal turbulence			8		35.30	12.01
	(3) Normal resonance			7		24.68	9.11
	Total			22		37.27	14.66
Source of the variance	KT	SD	KO	F	p		Difference (Scheffe)
Between groups	2681.242	2	1340.621	13.868	**0.000***		**1-2**** **1-3*****
Within groups	1836.750	19	96.671				
Total	4517.992	21					

KT: Sum of squares, SD: Degrees of Freedom, KO: Mean Square, F: F-Test Value, *p<0.05, **: Significant difference between hypernasality and nasal emission and Nasal turbulence, ***: Significant difference between hypernasality and nasal emission and normal resonance

Table 3: Relationship between resonance-nasal airflow and speech errors

	Backing	Nasalisation	Weak articulation	Double articulation
Hypernasality	0.107 (p=0.499)	**0.624* (p=0.000)**	**0.453* (p=0.004)**	**0.355* (p=0.025)**
Nasal turbulence	0.107 (p=0.499)	-0.254 (p=0.108)	-0.136 (p=0.389)	-0.205 (p=0.194)
Normal resonance	-0.234 (p=0.140)	**-0.361* (p=0.022)**	-0.221 (p=0.162)	-0.086 (p=0.586)

*: P<0.05

Table 2 shows the nasalance values of the participants and the resonance types and nasal airflow errors judged by the perceptual evaluation of the participants with nasalance scores.

When the distribution showing the one-way analysis of variance comparison of perceived resonance type and nasalance scores was analysed, a significant difference was found between perceived resonance type and nasalance scores (F= 13.868, p<0.05). Scheffe's multiple comparison test was used to determine between which resonance-airflow types the significant difference was found. According to the Scheffe test results, the nasalance scores of the participants with hypernasality and nasal emission were significantly higher than the nasal scores of the participants with nasal turbulence or normal resonance (p<0.05) (Table 2, Figure 3).

Table 3 shows the relationship between the perceived resonance-nasal airflow and the speech errors.

To examine the relationship between the participants' perceived resonance-nasal airflow and speech errors, the chi-square test was applied and the phi (Φ) correlation coefficient was calculated. A very strong positive correlation was found between the presence of hypernasality and nasalisation (r=0.624, p=0.000); hypernasality and weak articulation (r=0.453, p=0.004); and hypernasality and double articulation (r=0.355, p=0.025). A very strong negative correlation was found between the presence of normal resonance and nasalisation (r=-0.361, p=0.022).

Table 4 shows the relationship between oral anatomical-physiological problems and speech errors.

Table 4: Relationship between oral anatomical-physiological problems and speech errors

	Backing	Dentalisation	Lateralisation	Palatalisation	Bilabialisation	Fronting
Fistula	0.263 (p=0.096)	0.252 (p=0.111)	0.039 (p=0.804)	0.000 (p=1.000)	-0.011 (p=0.944)	-0.218 (p=0.168)
Class III malocclusion	0.203 (p=0.204)	**0,622* (p=0.000)**	**0.318* (p=0.047)**	0.260 (p=0.104)	**0.793* (p=0.000)**	0.080 (p=0.617)
Crossbite	-0.235 (p=0.138)	-0.35 (p=0.827)	**0.427* (p=0.007)**	-0.173 (p=0.274)	0.142 (p=0.368)	0.220 (p=0.165)
Missing teeth	0.045 (p=0.775)	**0.434* (p=0.006)**	0.033 (p=0.835)	**0.318* (p=0.044)**	0.210 (p=0.184)	**0.317* (p=0.045)**

*: P<0.05

To examine the relationship between the participants' oral anatomical-physiological problems and speech errors, the chi-square test was applied and the phi (Φ) correlation coefficient was calculated. A very strong positive correlation was found between the presence of class III malocclusion and dentalisation (r=0,622, p=0,000); class III malocclusion and lateralisation (r=0.318, p=0.047); class III malocclusion and labialisation (r=0.793, p=0.000); crossbite and lateralisation (r=0.427, p=0.007); missing teeth and dentalisation (r=0.434, p=0.006); missing teeth and palatalisation (r=0.318, p=0.044); missing teeth and fronting (r=0.317, p=0.045).

DISCUSSION

This study described the oral anatomical-physiological and speech-resonance characteristics of children with CLP. It examined the relationship between the perceived resonance-airflow and speech errors. Additionally, the relationship between oral anatomical-physiological problems and speech errors was analysed. Finally, the perceived resonance-airflow types were compared with the nasalance scores.

Among the participants in our study, class III malocclusion, missing teeth, fistula (particularly anterior fistula), and crossbite were the most prevalent oral anatomical and physiological problems. In line with our findings, Ünal-Logacev et al. found that in children with CLP, there were 59% missing teeth, 29% class III malocclusion, and 23% crossbite (13). Similar to our study, it has been documented in the literature that people with craniofacial anomalies and cleft palates have an increased frequency of dental and occlusal defects compared with the non-cleft population (18). According to the incidence of oronasal fistula varies between 3.4% and 78% in the literature, meta-analyses have reported the incidence of oronasal fistula between 6.4% and 8.6% (19-22). Ünal-Logacev et al. also reported fistula in 26% of children with CLP in Türkiye with similar percentages to our study (13).

The most common speech errors observed in the participants were backing, differentiation of glides, voicing errors, labialisation, nasalisation, palatalisation, dentalisation, lateralisation and weak articulation. In the literature, backing is among the most common speech errors in Turkish-speaking children with CLP (12, 13). In our study, phonological processes such as the differentiation of glides were also detected in children with CLP in addition to articulatory errors. Similarly, phonological processes have been reported in Turkish-speaking children with CLP in the literature (12, 13). The reason why the differentiation of glides was observed in 57% of the participants in our study may be because the differentiation of glides is the phonological process that is eliminated at the latest in children with typical development in Turkish (23). In our study, in contrast to Tezel's study, dentalisation, palatalisation, lateralisation and labialisation speech errors were also reported in Turkish-speaking children with CLP (12).

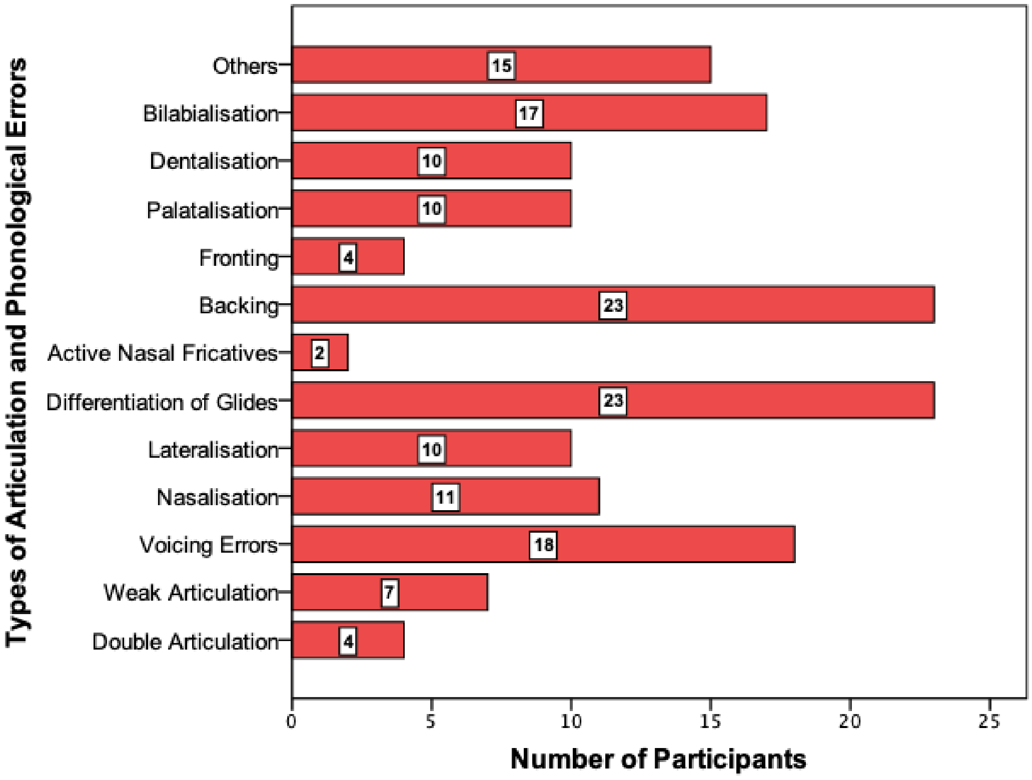

Figure 1: Distribution of participants' articulation and phonological errors

In this study, a strong positive correlation was found between hypernasality and nasalisation, weak articulation, and double articulation. In the literature, hypernasality, weak articulation, nasalisation, backing and double articulation are reported among the speech and resonance features in children with CLP (4). The results of our study support the literature and show a direct relationship between hypernasality and these speech errors.

In our study, a strong positive significant relationship was found between class III malocclusion and dentalisation, lateralisation and bilabialisation; between crossbite and lateralisation; between missing teeth and dentalisation, palatalisation and fronting. These findings highlight specific speech errors associated with dental and occlusal anomalies, providing further clarity to the existing literature. Class III malocclusion was strongly linked to labialisation, which may result from the misalignment of the upper and lower jaws affecting the ability to achieve proper lip closure. In Class III malocclusion, the mandible is positioned anteriorly relative to the maxilla, which can make it challenging for the lower lip to come into contact with the maxillary incisors—a critical movement for producing labiodental sounds such as /f/ and /v/. Instead, to compensate for this misalignment, these sounds may be articulated bilabially, where both lips come together to create the sound. This compensatory strategy alters the typical production mechanism, leading to labialisation. The relationship between class III malocclusion and dentalisation and lateralisation observed in our study can be explained by the altered positioning of the mandible and tongue. In class III malocclusion, the mandible and consequently the tongue are positioned anteriorly relative to the alveolar ridge. This misalignment creates challenges in producing sibilant and lingual-alveolar sounds, which require the tongue tip to be correctly positioned beneath the alveolar ridge. If the tongue maintains its natural position within the mandible during the production of these sounds, the result is often perceived as dentalisation. Alternatively, if the tongue retracts to compensate for the forward positioning of the mandible, the dorsum of the tongue may make contact with the palate, leading to lateral distortion by disrupting the airflow. Similarly, missing teeth were found to significantly contribute to dentalisation and palatalisation, likely due to the altered tongue placement and airflow required for accurate articulation. The relationship between missing teeth and fronting may result from protruding the tongue to compensate for the missing teeth in the anterior region when producing sibilant and linguo-alveolar sounds. The strong relationship observed between crossbite and lateralisation in our study can be explained by compensatory tongue movements. If the tongue moves back to compensate for the crossbite, the dorsum of the tongue may articulate against the palate instead of achieving the typical alveolar or dental placement. This compensatory movement can disrupt the central airflow path required for accurate articulation, causing lateral distortion by redirecting the airflow to one or both sides. These results are consistent with the findings of speech errors in dental and occlusal anomalies in the literature (4,18). Speech production can be affected by anomalies such as cleft lip and palate that affect the connection between the maxilla and mandible (18). The results of our study show that there is a direct relationship between dental and occlusal anomalies and speech errors.

In this study, it was found that the nasalance scores of participants with hypernasality-nasal emission were significantly higher than those with nasal turbulence and normal resonance. In this study, the concordance of nasalance scores with perceptual resonance-airflow results may be due to the fact that a speech and language therapist with 10 years of experience specialising in CLP was involved in the study. Similar to our study results, it is reported in the literature that the reliability of perceptual resonance-airflow judgments is high with clinical experience (24). In this study, no significant difference was found between the nasalance scores of participants with perceptual nasal turbulence and those with normal resonance. This may be due to the inconsistent occurrence of nasal turbulence (6).

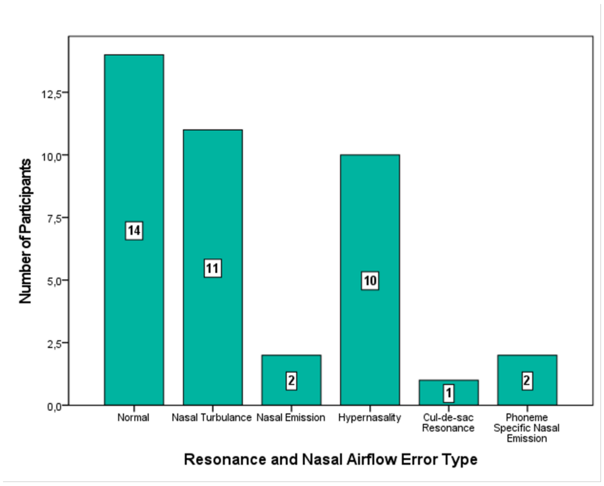

Figure 2: Participants' perceived resonance and nasal airflow types

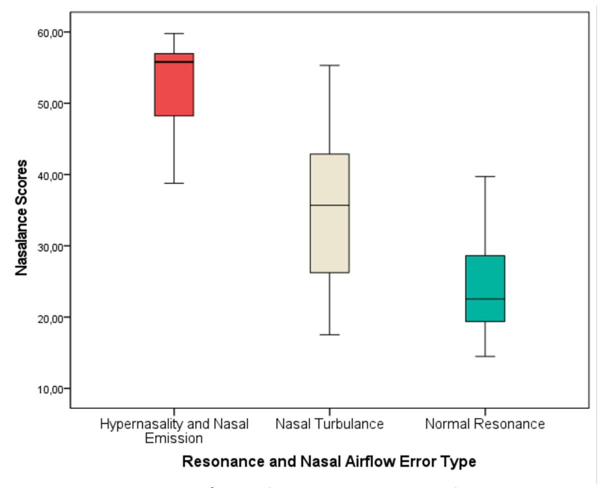

Figure 3: Participants' nasalance scores according to perceived resonance types and nasal airflow errors

Our findings have significant clinical implications for the assessment and intervention of Turkish-speaking children with cleft lip and palate (CLP). The observed relationships between specific dental-occlusal anomalies and articulation errors highlight the necessity for speech and language therapists (SLTs) to consider these structural factors during evaluation. For instance, the strong link between class III malocclusion and labialisation indicates that compensatory articulatory strategies may arise from mandibular misalignment, directly influencing speech production. Similarly, the association between missing teeth and dentalisation underscores the importance of evaluating the dental status when diagnosing speech errors. These insights can guide SLTs in tailoring intervention strategies. Furthermore, understanding the clinical significance of resonance issues, such as hypernasality associated with weak articulation, enables a more comprehensive approach to intervention, combining perceptual and instrumental assessments. Our study emphasises the need for multidisciplinary collaboration, involving dental specialists and SLTs, to address both structural and functional contributors to speech disorders in children with CLP.

There are some limitations of this study. First, the majority of the participants in our research were younger than six years old, which posed challenges during the sentence repetition test as pictorial cues were not provided to facilitate their understanding of the stimuli. Additionally, participants younger than four years of age could not undergo nasometric evaluation, resulting in the absence of nasalance scores for this age group. This limitation may have influenced the comprehensiveness of our findings regarding the resonance assessment. Second, the evaluation was completed in a single day, which might have reduced the participants' cooperation and attention towards the end of the assessment process. Third, the rare oral anatomical and physiological problems observed in a few participants were excluded from the statistical analyses due to their low frequency, potentially limiting the generalizability of our results. Addressing these limitations in future research, such as incorporating age-appropriate tools, extending evaluation durations, and including larger sample sizes, could enhance the robustness of the findings.

We have some suggestions for further research on this subject. The evaluation of speech errors can be supported by objective methods such as ultrasound and electropalatography. In this way, speech errors such as double articulation, which are difficult to evaluate perceptually, can be assessed. Using a sentence repetition test with picture cues for speech assessment and perceptual resonance assessment may increase children's interest in the test. Evaluating each participant individually will ensure that rare anatomical and physiological features that may affect speech are considered.

CONCLUSION

The most common speech errors in Turkish-speaking children with CLP were the backing and differentiation of glides. Phonological disorders may be observed in Turkish-speaking children with CLP. There is a very strong relationship between hypernasality and nasalisation, backing, weak articulation and double articulation. Dental and occlusal anomalies are very strongly associated with dentalisation, lateralisation and labialisation, palatalisation and fronting. These relationships should be considered in the assessment and intervention of children with CLP by speech and language therapists. Perceptual resonance-airflow assessment performed in highly clinically experienced hands supports instrumental nasometric assessments.

Ethics Committee Approval: This study was approved by the İstanbul Medipol University Non-Interventional Clinical Research Ethics Committee (Date: 30.11.2018 No: 703).

Informed Consent: Families meeting the eligibility criteria and agreeing to participate signed an informed consent form before the evaluation, which was conducted in the assessment and phoniatry rooms at MEDKOM.

Peer Review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- N.Y.B., Ö.Ü.L.; Data Acquisition- N.Y.B., Ö.Ü.L.; Data Analysis/ Interpretation- N.Y.B.; Drafting Manuscript- N.Y.B., Ö.Ü.L.; Critical Revision of Manuscript- Ö.Ü.L., N.Y.B.; Final Approval and Accountability- N.Y.B., Ö.Ü.L.; Technical or Material Support - N.Y.B.; Supervision- Ö.Ü.L.

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Relationship between Itching and the Presence of Demodex Species in the External Auditory Canal in Patients with Chronic Ear Itching

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ABSTRACT

Objective: The aim of this study was to investigate the relationship between ear itching and Demodex and to reveal the presence of Demodex in the aetiology of ear itching. Our study will contribute to this area, where there is a limited number of studies in the literature, and treatment planning can be provided by considering this aetiology in patients with chronic ear itching.
Material and Methods: Fifty-two patients with chronic ear itching and 51 patients without itching were included in the study. The patients' itching severity was assessed with the VAS (visual analog scale). A sample with the plug was taken from the external auditory canal. Demodex mites were investigated by examining the obtained samples using a light microscope.
Results: There was no statistically significant difference between the groups with and without ear itching in the presence of Demodex mites (p=0.09). However, Demodex positivity was found to be higher in the patient group with itching (53.8%). There was no statistically significant relationship between the presence of Demodex and VAS scores measuring itching severity (p=0.89).
Conclusion: In our study, the presence of Demodex mites was found to be numerically higher in patients with chronic ear itching. We believe that Demodex mites play a role in the aetiology of ear itching.
Keywords: Demodex, ear itchiness, external auditory canal

INTRODUCTION

The external auditory canal is covered with skin formed by keratinised stratified squamous epithelium (1). The skin on the bone forming the outer part of the canal contains hair follicles and cerumen-producing apocrine glands. The cerumen secretion produced by these glands serves to protect the external auditory canal against infections (2). However, in cases such as exposure to external trauma or use of local medication, the epithelial structure is disrupted and the skin flora may change. When the protective function is disrupted, there is an increased tendency of infection and complaints may develop (3). Ear itching has become a chronic problem that bothers many patients today. The aetiological causes of chronic ear itching are not fully understood, and a patient group called "itchy ear syndrome" has begun to emerge (4). Patients complain of persistent itching, burning, and pain despite the use of various medications. The intensity of itching and discomfort varies (4). These patients are usually evaluated considering the presence of contact dermatitis (5). Demodex is a type of mite found especially on the face of humans. These mites, which commonly settle in hair follicles and sebaceous glands, are found on the nose, nasolabial region, forehead and cheeks (6). Demodex mites can be found at a density of <5 mites/cm^2 on normal skin. Clinical symptoms occur when the density of Demodex increases (7). It causes diseases such as pityriasis folliculorum, rosacea, acne vulgaris, blepharitis and folliculitis (6).

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The aim of this study was to investigate the relationship between ear itching and Demodex and to reveal the role of Demodex in the aetiology of ear itching. Our research will contribute to this area, where there is a limited number of studies in the literature, and allow treatment planning to be provided by considering this aetiology in patients with chronic ear itching.

MATERIAL AND METHODS

This study was planned as a prospective, randomised controlled trial. Patients who applied to the ENT outpatient clinic of Malaty Training and Research Hospital between October 2022 and April 2024 were included in the study. A total of 103 people were included in the study, 52 of whom had complaints of ear itching for more than a month, and 51 of whom did not have ear itching. The control group was selected from patients who visited the ENT polyclinic with complaints other than ear itching and who had an earwax plug detected in the external auditory canal. Patients with skin diseases, eardrum perforation, and acute and chronic ear infections were not included in the study. Patients over the age of 18 years with normal eardrums were included in the study. Patients with ear itching were asked to score the severity of itching using the Visual Analog Scale (VAS) (8). Patients scored the severity of itching on a scale of 1-10, with 1 point for very mild itching and 10 points for very severe itching. Patients with 5 points were considered to have moderate itching, and patients with >5 points were considered to have severe itching. The duration of itching was asked and recorded. During the routine ear examination, a plug was taken from the external auditory canal with the help of a curette. While the plug was being cleaned, a sample was taken from the skin, including a scraping. The samples were delivered to the Malatya Training and Research Hospital Microbiology Laboratory within 2 h.

A slide-coverslip preparation was made from the samples, and microscopic examination was performed at x10 and x40 magnifications by dropping immersion oil (Figure 1). The presence of Demodex was detected and the results were recorded. Samples were also taken from the control group without ear itching using the same method and were examined.

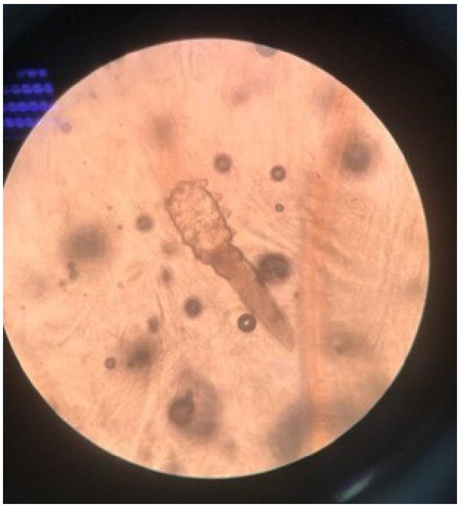

Figure 1: microscopic Demodex mite image

The study was reviewed and approved by the Clinical Research Ethics Committee of the Malatya Turgut Özal University (Date: 18.08.2022, No: 2022-39). All participants provided written informed consent. The study was conducted according to the principles expressed in the Declaration of Helsinki.

Statistical analysis

The data obtained in the study were evaluated in a computer environment using the SPSS "Statistical Package for Social Sciences v. 22.0 (IBS SPSS Corp., Armonk, NY, USA)" program. Ratios were calculated for the qualitative variables, and the mean, standard deviation, median, minimum and maximum values were calculated for the quantitative variables. Variables were evaluated using the Mann–Whitney U test from non-parametric tests when Kolmogorov-Smirnov test was $p<0.05$, and the Independent Samples Test from parametric tests when Kolmogorov-Smirnov test was $p>0.05$. The Pearson chi-square test was used for the comparison of qualitative variables. The results were taken at 95% confidence interval, and the statistical significance level was $p<0.05$.

RESULTS

Of the 103 patients included in the study, 52 were in the patient group with ear itching and 51 were in the control group without ear itching. In the patient group, 34.6% (n=18) were female, 65.4% (n=34) were male, and in the control group, 51% (n=26) were female and 49% (n=25) were male. No statistically significant difference was found between the patient and control groups in terms of sex (p=0.09) (Table 1).

The mean age of the patient group with ear itching was (52.51±17.67), while the mean age of the control group was (51.41±19.64). No statistically significant difference was found between the patient group and the control group in terms of mean age (p>0.05) (Table 2).

Demodex spp. positivity was found to be 53.8% (n=28) in the patient group with the complaint of ear itching. The positivity rate was higher than the control group. However, no statistically significant difference was found between the patient and control groups according to the Demodex status (p=0.09) (Table 3).

Table 1: Comparison of the patient and control groups based on sex

	Patient group n=52		Control group n=51		p
	n	%	n	%	
Female	18	34.6%	26	51%	0.09
Male	34	65.4%	25	49%	

Table 2: Comparison of the patient and control groups based on age

	Patient group n=52	Control group n=51	p
	Age	Age	
Mean±SD	52.51±17.67	51.41±19.64	
Median	56.50	52	0.88
Min-max.	17-86	18-80	

SD: Standard deviation

Table 3: Comparison of the patient and control groups based on the Demodex status

	Patient group n=52		Control group n=51		p
	n	%	n	%	
Demodex negative	24	46.2%	32	62.7%	0.09
Demodex positive	28	53.8%	19	37.3%	

In the patient group, no statistically significant difference was found in terms of the degree of itching VAS score, itch duration, and sex based on Demodex positivity and negativity (p>0.05) (Table 4). In patients with Demodex positivity, the itch duration was 8 months on average. The mean VAS score indicating the itch severity was determined to be 4.4, which was moderately severe.

The mean age of Demodex-negative patients was calculated as (48.95±16.28) while the mean age of Demodex-positive patients was calculated as (55.57±18.52). No statistically significant difference was found between Demodex-negative and Demodex-positive patient groups based on the mean age (p=0.18).

DISCUSSION

In our study, the rate of use of Demodex in patients with ear itching was found to be 53%, higher than that in the healthy control group. We believe that we have shown that Demodex mites may play a role in chronic ear itching.

Demodex mites are a type of parasite found on the skin of many healthy people. Although Demodex mites are currently considered as the cause of many skin diseases, their pathogenic effects remain controversial. The high rate of occurrence in healthy people without complaints causes this debate. It is thought that symptoms may appear as the density of the Demodex mites increases (9).

In a study conducted in China, the presence of Demodex in the external ear canal secretion was investigated. In this study conducted with 613 students, it was observed that the Demodex positivity rate was 11.58%. It was determined that 67% of the students with Demodex detected in the external ear canal had complaints of ear itching, and this rate was higher than the students who were Demodex negative (10). In our study, Demodex mites were found in 37.3% of healthy individuals. No significant difference was observed between the Demodex positivity in the patient group and healthy individuals, but the Demodex incidence rate was higher in the patient group at 53.8%.

Demodex mites are frequently observed in the facial area and settle particularly in hair follicles and glands. These mites play a role in the aetiology of rosacea, pityriasis folliculorum, perioral granulomatous dermatitis, and hyperpigmented lesions on the skin (11). Demodex mites are also commonly observed in eyelash follicles (12). Because the entrance of the external ear canal is adjacent to the skin, Demodex mites can settle in the external ear canal. Therefore, it can be considered that Demodex mites may play a role in the aetiology of external ear itching. In the study by Bilal et al., the relationship between the severity of itching in chronic ear itching and the presence of Demodex mites was investigated. In this study, a statistically significant relationship was found between the severity of ear itching and the presence of Demodex mites, which are thought to play a role in the aetiology of ear itching. Demodex positivity was found in 50% of the patients with ear itching. The average duration of itching in patients was found to be 36 days, and no significant relationship was found with Demodex (13). In our study, although no significant relationship was found between the severity of ear itching and Demodex positivity, Demodex was found to be positive in 53.8% of patients with ear itching. The average VAS score in the Demodex-positive patients was

Table 4: Comparison of itching severity and duration according to the Demodex status in the patient group

	Demodex negative n=24		Demodex positive n=28		p
	n	%	n	%	
Degree of itching					
0-5	15	62.5%	18	64.3%	0.89
6-10	9	37.5%	10	37.5%	
Itching duration					
1-6 months	13	54.2%	18	64.3%	0.45
6 months and over	11	45.8%	10	35.7%	
Sex					
Female	18	75.0%	16	42.9%	0.17
Male	6	25.0%	12	57.1%	

found to be 4.4. No significant relationship was found between the duration of itching and Demodex positivity, and the average duration of itching was determined to be 8 months.

Demodex positivity is generally seen more frequently in women than in men (14). In our study, we also found it to be more common in women (52.9%). Another study conducted in our region found Demodex positivity in women to be 49%, which supports our study (15).

During puberty, with the increase in sebaceous secretion, there is an increase in the number of Demodex mites (16). In a study conducted with individuals between the ages of 3 and 96, Demodex was seen in 34% of individuals between the ages of 19 and 25, while this rate increased with age, and it was detected in 95% of individuals between the ages of 71 and 96 (7). In the study conducted by Cheng et al., the mean age was found to be 52.1 years in the Demodex-positive group (17). Similarly, in this study, the mean age was found to be 55.5 years in the Demodex-positive patients, and no significant relationship was found between age and Demodex positivity.

The external ear canal secretion contains substances such as lactoferrin and lysozyme. This cerumen protects the external ear canal against external factors and microorganisms (3). Traumatic factors or factors that disrupt the secretion prevent the protective function. It is thought that local steroid use may disrupt the protective barrier and increase the rate of Demodex mites in the external ear canal. In a study conducted by Çevik et al., the frequency of Demodex mites in patients using local steroids due to ear itching was found to be statistically significantly higher compared to patients not using steroids. Demodex positivity was found to be 5.8% in the patients included in the study. The Demodex positivity rate was 7.6% in patients with ear itching. It was observed that 66% of the patients with Demodex mite positivity had local steroid use (18). In our study, these factors were excluded by obtaining samples from patients who had not used local steroids in the last 2 months and had no immune problems. However, our Demodex positivity rate (53%) was significantly higher in patients with ear itching. It may be thought that steroid treatment applied with the consideration of contact dermatitis may increase Demodex settlement and cause itching complaints again.

The small sample size is a limitation of our study. Further studies can be conducted with larger patient groups from different regions.

CONCLUSION

While studies on Demodex are mostly with regard to the skin, it has not yet been clarified whether the Demodex mite causes skin diseases. There are very few studies in the literature showing the prevalence of Demodex in the external ear canal. Based on the findings of our study, it can be said that Demodex colonisation in the skin of the external ear canal may be widespread. Although its relationship with ear itching could not be determined significantly, the Demodex positivity was found to be higher in people with chronic ear itching. In addition, incorrect diagnosis and treatment may increase Demodex colonisation and cause itching complaints again. Therefore, it is essential to clarify the aetiology of chronic ear itching. According to the results of our study, it can be concluded that the presence of Demodex mites in the external ear canal may be the cause of treatment-resistant ear itching. This result may contribute to the application of the correct treatment.

Ethics Committee Approval: This study was approved by the Malatya Turgut Özal University (Date: 18.08.2022, No: 2022-39).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

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A Questionnaire about Revision Rhinoplasty Among Surgeons

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ABSTRACT

Objective: Rhinoplasty is one of the most challenging facial aesthetics operations. Failure to meet patient expectations and the emergence of new deformities lead to the need for revision. This article presents the current revision surgery experiences of surgeons specialising in rhinoplasty.
Material and Methods: A questionnaire was used to obtain the experiences with revision rhinoplasty of 130 surgeons specialising in rhinoplasty. The demographic characteristics of the surgeons and data regarding revision rhinoplasty were recorded. Statistical analyses were performed, and the results obtained were compared with the literature data.
Results: Although 59% (n=77) of the surgeons stated that the revision rates after primary rhinoplasty were between 2% and 5%, the revision rate of 83% (n=108) of the surgeons was between 2% and 10%. The three most common reasons for revision were loss of nasal tip rotation (83%), inadequate hump resection (74%) and nasal axis deviation (71%). Rocker deformity (19.2%), step deformity (20%), skin problems (25%) and radix problems (27%) were less common. Concerning the timing of revision, most surgeons thought that at least one year should elapse after the first operation, and this did not vary according to the localisation of the deformity.
Conclusion: The participants of this study reported revision rates between 2% and 10%. The most common reasons for revision were loss of nasal tip rotation, residual dorsal hump, and nasal axis deviation. Both surgeons and patients should accept that the need for revision may arise due to the unpredictability of recovery.
Keywords: Revision, rhinoplasty, nasal, deformity, surgeon

INTRODUCTION

Rhinoplasty is one of the most challenging surgical operations in facial aesthetics, considering the three-dimensional structure of the bone, cartilage, and soft tissue of the nose; functional and aesthetic expectations; and the psychological state of the patient (1). This procedure can be seen as a combination of controlled nasal traumas and their repair. Complete patient satisfaction can only be achieved when functional problems and aesthetic expectations are addressed in detail. However, as in many aesthetic surgeries, dissatisfaction, complications and the need for revision may occur (2). Surgeons and patients should be prepared from the very beginning of the rhinoplasty journey for the possibility of revision surgery and accept that it is a part of this process.

Skin problems, contour irregularities, inadequate or excessive resection of tissues, nasal obstruction, and asymmetry may require revision surgery (2-5). Revision rhinoplasty rates reported in the literature vary between 5% and 15.5% (3, 6-8). The risk factors include inadequate intraoperative nasal tip treatment, history of nasal fracture, and any postoperative complication (3, 7).

The first and most important step in revision procedures is identifying patient concerns and accurately describing the deformity (1). Successful communication with patients in revision rhinoplasty is the key to more satisfactory results (1). Groups of patients with various psychological pathologies, such as body dysmorphic disorder, will seek revision for non-existent or insignificant features and will never be satisfied with the results. Surgical options should be avoided as much as possible in such patients with unrealistic expectations (6).

The maturation of the soft tissues and optimal healing takes approximately one year. Therefore, we recommend

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waiting one year for the re-evaluation of deformities and revision interventions (1, 6, 9). However, some exceptional postoperative problems require revision intervention within weeks or months (9, 10). Applications in revision surgery range from minimal filling applications for small depressions to larger reconstruction procedures with autologous costal grafts (1, 11). The septal cartilage is still the main graft material for revision rhinoplasty. In cases of insufficient septal cartilage, ear cartilage, autologous costal cartilage, irradiated costal cartilage, and alloplastic silicone implants can be used as graft material (10, 11).

Although the surgical techniques used in revision rhinoplasty are not very different from those used in primary rhinoplasty, revision surgery is often more complex and challenging due to the presence of scar tissue, inadequate osseocartilaginous

Table 1: Professional Experience of the Rhinoplasty Surgeons

	Participants No (%)
Surgeons' experience in rhinoplasty (in years)	
1-3 years	10 (7.7)
4-7 years	30 (23)
8-10 years	30 (23)
11 years and over	60 (46.3)
Surgeons' total amounts of rhinoplasty	
1-100	4 (3)
101-200	10 (7.7)
201-500	18 (14)
501-1000	27 (21)
1001 and over	71 (54.3)
Revision rates of surgeons after primary rhinoplasty	
≤1%	17 (13)
2-5%	77 (59)
6-10%	31 (24)
≤11%	5 (4)
Revision rhinoplasty rates among all rhinoplasty operations of surgeons	
≤1%	19 (14.6)
2-5%	37 (28.5)
6-10%	45 (34.6)
≤11%	29 (22.3)
Surgeons' total amounts of revision rhinoplasty	
1-50	52 (40)
51-100	28 (21.5)
101-200	26 (20)
201-500	7 (5.5)
501 and over	17 (13)
Technique preferred by surgeons in primary rhinoplasty	
Open technique	100 (77)
Closed technique	5 (4)
Both of them	25 (19)
Technique preferred by surgeons in revision rhinoplasty	
Open technique	96 (74)
Closed technique	2 (1.5)
Both of them	32 (24.5)

skeleton, and the disruption of nasal structures (1, 2). Patients have higher expectations for secondary surgery. Therefore, it requires better preoperative planning and greater surgical experience than primary surgery (6). Although surgical experience in rhinoplasty reduces the need for revision, secondary surgery remains a part of rhinoplasty because of the unpredictability of postoperative recovery. This article presents the current revision surgery experiences of surgeons specialising in rhinoplasty.

MATERIALS AND METHODS

Our study was conducted according to the guidelines stated in the Declaration of Helsinki and the ethical approval received from the Clinical Research Ethics Committee of Ankara Bilkent City Hospital (Date: 06.03.2024, No: TABED 2-24-36). In February and March 2024, performing surgery in Turkey, 130 surgeons specialising in rhinoplasty completed a detailed online questionnaire on revision rhinoplasty. All participants signed the informed consent. Rhinoplasty surgeons who did not perform revision rhinoplasty were excluded from the study.

All participants completed the questionnaire. Information about the surgeons' demographics and professional experience was obtained through this. Rhinoplasty and secondary surgery rates were determined, and the preferred surgical technique and indications for revision surgery were recorded. Finally, revision timings were shown according to the localisation of the deformity.

Data analysis was performed using SPSS software version 22 (IBM Corp., Armonk, NY, USA). Categorical variables are shown as number (n) and percentage (%), and continuous variables are shown as mean ± standard deviation.

RESULTS

Of the 130 participants comprising our study population, 88.5% (n=115) were male, 11.5% (n=15) were female, and the average age was 42.94 (±8.16, range 30-68) years.

More than half of the participants (58.3%, n=76) had more than 10 years of surgical experience, and 46.3% (n=60) had been performing rhinoplasty for more than 10 years. Most (54.3%, n=71) reported that they had performed more than a thousand Rhinoplasty. Although 59% (n=77) stated that their revision surgery rates after primary rhinoplasty were between 2% and 5%, the revision rate of 83% (n=108) of the surgeons was between 2% and 10%. An open technique was preferred in both primary rhinoplasty (77%, n=100) and secondary surgery (74%, n=96). The professional experience of the surgeons is shown in Table 1.

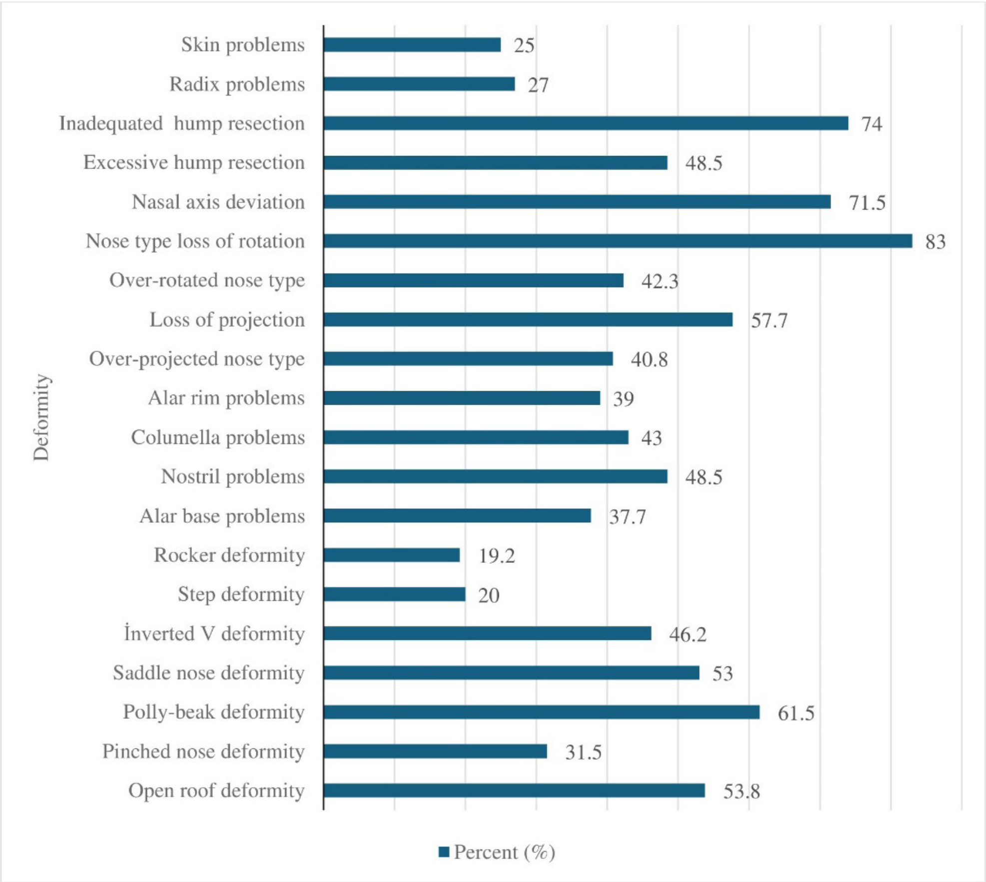

Figure 1: Revision of rhinoplasty reasons and rates

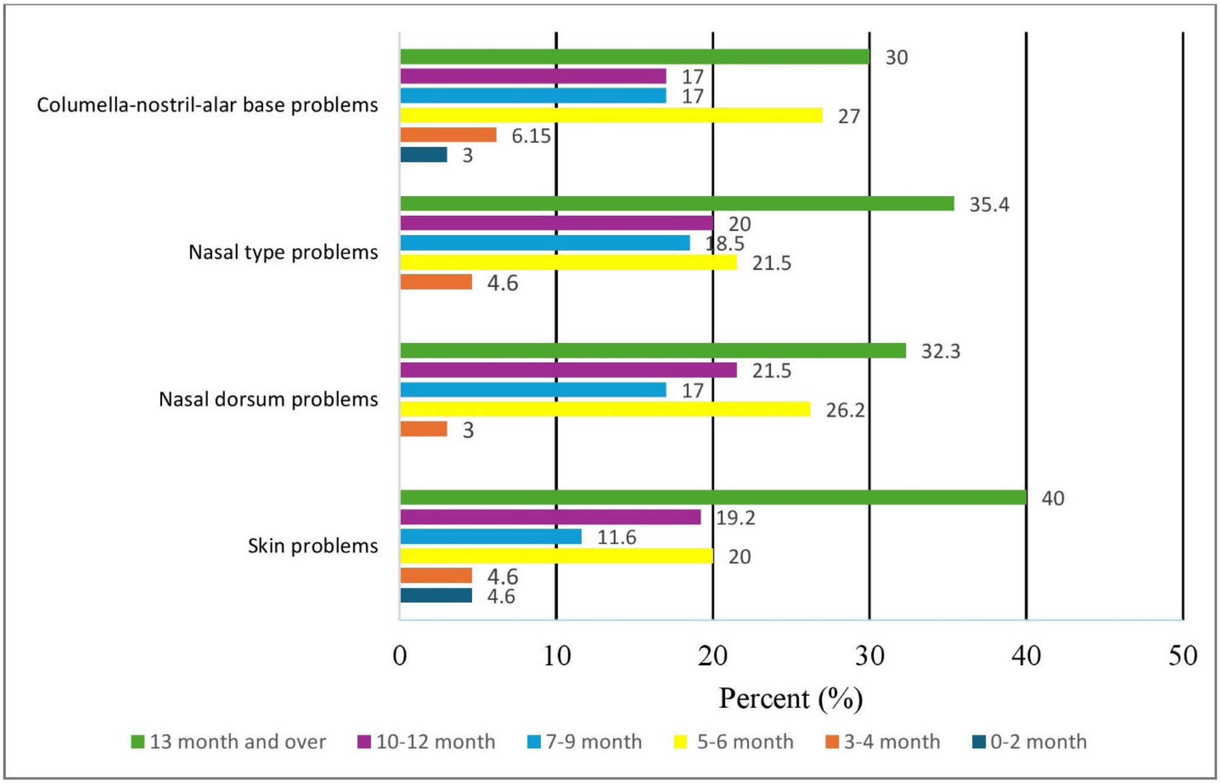

Figure 2: Timing of revision surgery according localisation deformities

While 14% (n=18) of the surgeons performed revision surgery on only their own rhinoplasty patients, the remaining 86% (n=112) performed revision surgery on both their own and colleagues' rhinoplasty patients.

Loss of nasal tip rotation (83%), inadequate hump resection (74%) and nasal axis deviation (71%) were the three most common reasons for revision surgery. Rocker deformity (19.2%), step deformity (20%), skin problem (25%) and radix problem (27%) were the least common reasons (Figure 1). Most surgeons evaluating the timing of revision thought that at least one year should elapse after the first operation, and this did not vary according to the localisation of the deformity. Additionally, no surgeon recommended surgical intervention for nasal dorsum or tip problems in the first 2 months. The timing of the revision rhinoplasty according to the location of the deformity is shown in Figure 2.

In cases where minor revision was required, 47.7% (n=62) of surgeons stated that they used fillers. The rate of surgeons experiencing medico-legal problems with revision rhinoplasty patients was 26%.

DISCUSSION

Rhinoplasty is a challenging journey to achieve results that will satisfy both the surgeon and the patient. If the original goal is not achieved or a new deformity appears and the patient is not satisfied with the result, the need for revision may arise (12). Undoubtedly, the interest in rhinoplasty among both surgeons and patients is increasing. This inevitably leads to an increase each year in the number of both primary and revision rhinoplasty surgeries. As the number of surgeons performing rhinoplasty increases, the average levels of experience among surgeons potentially decrease (6). Considering the inexperienced surgeons and patients who have been influenced by social media, the increase in revision rhinoplasty rates is not surprising.

We consider waiting at least 1 year before revision surgery prudent because of the impact of long-term healing on rhinoplasty outcomes (1, 6, 9, 13). This period allows soft-tissue oedema to resolve and problematic deformities to be re-evaluated (6, 13). Additionally, given enough time, patients may find that the deformity improves enough to become acceptable to them (14). Similar to the literature, most surgeons in our study recommended waiting one year before revision, regardless of the anatomical localisation of the deformities requiring revision. However, some authors in the literature think that this wait is unnecessary (9, 10); in our study, many surgeons advocated for that idea. However, no surgeon recommended surgical intervention for nasal dorsum or tip problems in the first 2 months. Major postoperative findings such as airway obstruction, loss of nasal tip support and saddle nose deformities will likely worsen within a year due to contracture, and loss of tissue planes will also make revision more difficult. In these exceptional cases, early surgical intervention may yield better results (6). Deformities that require very little soft-tissue dissection, such as inadequate osteotomy, alar base widening, and alar retraction, can be corrected early and alleviate patient concerns (9).

In our study, most surgeons stated low revision rates, contrary to the literature (3, 6-8). Patients prefer the same surgeon for minor revisions after the primary surgery. However, those who are not very satisfied and have revision surgeries requiring major changes often seek a new surgeon (8, 15). Therefore, assessing their revision rates completely accurately is difficult for surgeons. The revision rates of the surgeons in this study may have been higher than stated. Although revision rates after the first surgery vary between 5% and 15% in the literature, a higher rate of patients need revision after revision rhinoplasty (2, 16). Additionally, patients using extranasal cartilage grafts have a higher rate of need for revision surgery (2). Anatomical features such as thick skin, asymmetrical and wide nose tip, low nasolabial angle and wide bone roof make revision rhinoplasty more likely (3, 7).

The most common reasons for revision in our study were loss of nasal tip rotation (83%), inadequate hump resection (74%) and nasal axis deviation (71%). Yu et al. determined the most important reasons for revision rhinoplasty as type asymmetry, nasal obstruction and curvature of the middle third of the nose (8). In another study, the most common reasons were residual dorsal hump and extreme tip rotation and/or projection (3). In a study including 252 revision rhinoplasty patients, Sibar et al. found that the most common reasons for revision were inadequate nasal tip rotation, hanging columella, and supra-tip deformity. The same study also reported that being over 40 years of age and using the columellar strut instead of the tongue-in-groove technique increased the risk of revision rhinoplasty (7). These results show that the tip and the middle third of the nose are the points with the highest potential for problems after surgery. Therefore, as rhinoplasty surgeons, we must determine possible risks in advance and better manage the nasal tip and middle third of the nose to avoid revision. Moreover, not only aesthetic reasons cause revision. From a functional perspective, difficulty in breathing and nasal congestion are among the most common reasons for revision (8). The high rate of nasal congestion after rhinoplasty reminds us that the importance of the airway should not be compromised while focusing on the aesthetic appearance of the nose (16, 17).

Another reason for revision was inadequate hump resection. Surgeons now think that removing less is safer than removing more, considering the complications and deformities that may occur in rhinoplasty and the need for revision that may thus arise. This leads to patient dissatisfaction and revision reasons such as residual hump. Generally, some of the reasons for revision rhinoplasty are inadequate surgical techniques applied to not overdo the procedure. Although not included in our study, there are many other reasons for revision that can necessitate revision rhinoplasty, such as excessive columellar show.

In searching for ways to reduce the need for revision rhinoplasty, only surgical techniques and surgeon-focused solutions have been discussed. In this regard, patients should be included in the solutions. We believe that patients should help ensure effective patient–surgeon communication, make them feel confident in their surgeons, and carefully follow all preoperative and postoperative recommendations.

One of the most important treatment alternatives to surgery in revision rhinoplasty is filler application. The use of fillers was common in our study population, with 47.7% (n=62) stating that they used these in cases requiring minor revision. Many patients are hesitant about filling treatment after rhinoplasty because of the thought that they are temporary, whereas surgery is permanent, and complication rates may be high with nasal fillers (18, 19). Supporting patient hesitation, higher complication rates have been reported in patients who have previously undergone rhinoplasty surgery, possibly due to changes in vascular anatomy (18). Filler treatment is recommended for patients without an indication for surgery but who still have concerns after rhinoplasty, in cases such as contour irregularities (19). We think that as surgeon experience and patient awareness increase, the use of fillers in revision rhinoplasty will become more common.

Revision rhinoplasty poses many challenges in itself. One of the most important is the medico-legal problems that may be experienced with patients. Among the surgeons participating in the study, 26% stated that they had medico-legal problems with revision rhinoplasty patients. Patients may file a lawsuit on the grounds of dissatisfaction with the aesthetic results after rhinoplasty, the resulting complications or violation of the standard of care (20). However, most malpractice lawsuits filed after rhinoplasty end in favour of the surgeon (20, 21). Carefully keeping patient records, obtaining detailed and duly informed consent, effective communication with patients, and not exaggerating treatment results are important factors in preventing legal problems.

Many articles exist in the literature about revision rhinoplasty. These generally contain the results of an author's or a clinic's experiences. Our study's unique strength is that it includes data provided by over a hundred surgeons who specialise in rhinoplasty and have extensive rhinoplasty experience. Our study attracts readers' attention to the difficulties of revision rhinoplasty, current reasons for revision, and different points of revision surgery.

CONCLUSION

The participants of this study reported revision rates between 2% and 10%. The most common reasons for revision were loss of nasal tip rotation, residual dorsal hump, and nasal axis deviation. Minimising revision rates requires good preoperative consultation, correct surgical planning, not exaggerating treatment results, effective surgical techniques and long-term follow-up. Despite all this, both surgeons and patients should accept that the need for revision may arise due to the unpredictability of recovery.

Ethics Committee Approval: This study was approved by the Clinical Research Ethics Committee of Ankara Bilkent City Hospital (Number: 2-24-36).

Informed Consent: The study group patients gave their informed consent for participation in the study.

Peer Review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- A.Y., M.Ç.; Data Acquisition- O.O.; Data Analysis/Interpretation- A.Y.; Drafting Manuscript- A.Y.; Critical Revision of Manuscript- O.O., M.Ç.; Final Approval and Accountability- A.Y., O.O., M.Ç.; Supervision- M.Ç.

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A Comparison of Soft Tissue Face Analysis Measurements with Face Analysis Measurements in 3-D Modelling

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ABSTRACT

Objective: The face is the most important factor determining the physical appearance of individuals. Measurements of facial beauty have continuously been made and evaluated on two-dimensional, photographs. As an alternative method, the evaluation of facial morphology could be better determined using 3D technology. The aim of this study was to assist in facial analysis by measuring the soft tissue facial ratios in our society in order to compare these values with the proportions and measurements of the 3D facial model of the patient.

Materials and Methods: A total of 24 (10 male, 14 female) subjects' faces and their 3D masks were measured to compare the results of each measurement.

Results: There was a significant difference between the soft tissue measurements and 3D measurements of only the dorsal width measurements of male patients (p=0.019) and columellar length and upper lip width measurements of women (p=0.021, p=0.035), while other facial analysis measurements showed no significant differences. Additionally, no significant difference other than the upper width, nasolabial angle, and lateral intercantal distance measurements were noted in the 3D mask (p=0.026, p=0.022, p=0.042).

Conclusion: This study examined the compatibility of the 3D-printed models and soft tissue measurements. We found no significant difference except for the dorsal width measurements of male patients and the columellar length and upper lip width measurements of female patients. These results suggest that modelling with 3D printing is technologically safe and advantageous and has great potential in facial aesthetics and surgical interventions.

Keywords: Facial analysis, three-dimensional printing, facial aesthetics

INTRODUCTION

The face is the most important factor determining the physical appearance of individuals (1). The aesthetic appearance of our face comprises complex interaction of the viscera-cranium skeletal morphology and the soft tissue structures above it (2). Various methods have been continuously tested for the analysis of facial morphology and the examination of the proportions and measurements of the face (3, 4).

To date, traditional 2D photographs have been used for the analysis of facial morphology. In addition to being limited to one side of the face, an examination with 2D photographs has some disadvantages, such as various sensitivities pertaining to the adjustment of the picture, problems with patient compliance, and difficult metric measurements. Therefore, the evaluation of facial morphology in 3D may be a better alternative method. After the face has been scanned, the 3D technology allows any necessary adjustments of the facial structures and enables the use of natural and linear measurements with angular and linear measurements.

The efficiency of planning treatments may increase with 3D technology; however, it should be noted that it does not guarantee an ideal or perfect result, and that, despite its many advantages, it cannot replace the surgeon's decision or technical skill (5).

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The aim of this study was to assist in facial analysis and to facilitate the evaluation of facial differences and abnormalities and to measure the soft tissue facial ratios in our society in order to compare these values with the proportions and measurements of the 3D facial model of the patient.

MATERIAL AND METHODS

A total of 24 subjects were included in the study with 10 males and 14 females. The age range was between 19 and 41. Subjects were selected on a voluntary basis in that the first 24 subjects to apply without any exclusion criteria were accepted into the study. The exclusion criteria were previous rhinoplasty, previous facial surgery, previous maxillofacial trauma with plate/screw reconstruction and subjects under the age of 18 or over the age of 65.

Every subject then underwent a scan using the Meshmixer programme (Autodesk, Inc.) and a 3D version of their face was created. The 3D face was then uploaded to the Zortrax M200 3D printer (Zortrax S.A) and a model was created (Figure 1, 2). Both the 3D model and the subjects' faces were then subject to the same measurements made with the same calliper. The measurements were as follows (Figure 3);

Forehead: Trichion to the glabella (FH)

Dorsal Length: Nasion to the tip (DL)

Dorsal Width: Width of the radix (DW)

Intercanthal distance: Medial canthus (right) to medial canthus (left) (ICDm)

Lateral canthus (right) to medial canthus (left) (ICDl)

Columellar length: Tip to the subnasal (CL)

Alar width: Alar base (AW)

Upper lip: Subnasale to the labrale superior (UL)

Chin: Menton to the labrale inferius (C)

The nasofrontal angle, nasolabial angle and nasomenlal angle were also included in the measurements (Figure 4).

Measurements of the subjects' faces and their 3D masks were then compared to analyse the correlation between the two measurements.

Table 1: Patient characteristics

		Mean.±SD	Min-Max
Age		±	
		n	%
Gender	Male	10	41.7
	Female	14	58.3

Statistical analysis

The SPSS 15.0 program (IBM SPSS Corp., Armonk, NY, USA) was used for statistical analysis. Descriptive statistics for the numerical variables were given as the mean, standard deviation, minimum, maximum, median and 95% CI. As the numerical variables did not meet the normal distribution conditions, both independent groups were compared using the Mann–Whitney U test. The statistical significance level was set as $p<0.05$.

Ethical committee approval

This study was approved by Acıbadem University Ethics Committee (ATADEK) on 12/09/2019 with the approval number 2019-14/71.

This study was conducted according to the Helsinki Declaration.

RESULTS

Of the patients that were entered for the study, 41.7% of the patients were male (10) and 58.3% were female (14). The mean age of our patients was ± (Table 1).

When the facial and 3D measurements of the male patients were compared, there was a significant difference in the dorsal width measurements ($p=0.019$). However, there was no statistically significant difference in the other facial analysis measurements (Table 2).

When the facial and 3D measurements of the female patients were compared, a significant difference was found in the columellar length and upper width measurements ($p=0.021$, $p=0.035$). However, there were no statistically significant differences in other facial analysis measurements (Table 3).

When the normal and 3D measurements of male and female patients were compared, a significant difference was found in the measurements of the upper width, the nasolabial angle and the lateral intercantal distance in the 3D mask ($p=0.026$, $p=0.022$, $p=0.042$). However, there were no statistically significant differences in other facial analysis measurements (Table 4)

DISCUSSION

Taking photographs of patients is an important element in terms of patient follow-up, communication with the patient, medical-legal necessity and surgical planning. However, patients are often unable to understand the nature of their medical condition on screen or in two-dimensional photographs, which may lead to disappointment and poor results after treatment. 3D modelling, on the other hand, is an effective tool for demonstrating the relationship between facial structures. The 3D modelling process consists of 5 main components: analysis, planning, virtual surgery, 3D printing and comparison with the actual planned results (5-7).

Table 2 : Statistical analysis of normal values and 3D values of male patients in facial analysis measurements

	Male						
	Normal			3D			
	Mean±SD	Min-Max	Median	Mean±SD	Min-Max	Median	p
Forehead	6.07±0.8	4.5-7.3	6.2	6.19±0.7	4.6-7.3	6.4	0.522
Dorsal length	5.48±0.6	4.2-6.5	5.6	5.22±0.9	3.7-6.8	5.3	0.481
Dorsal width	1.25±0.2	0.8-1.8	1.2	1.94±0.7	0.9-3.2	1.9	0.019
Intercanthal-M	3.33±0.7	2.6-5.1	3	3.34±1.2	1.9-5.9	3.2	0.912
Intercanthal-L	10.78±1.3	8.8-13	10.7	11.5±1.5	9.6-14	11.4	0.28
Columellar length	1.93±0.3	1.3-2.7	2	2.22±0.8	1.1-3.9	2	0.631
Alar width	3.75±0.5	2.6-4.7	3.9	3.82±1	2.3-5.7	3.7	0.912
Upper width	1.87±0.4	1.1-2.8	1.9	2.37±0.8	0.8-3.4	2.5	0.89
Chin	2.85±0.9	2-5	2.6	3.45±1.5	1.8-6.3	3.2	0.481
Nasofrontal angle	142.1±6.9	130-151	141.5	140.3±12.9	123-167	138.5	0.436
Nasolabial angle	122.9±14.6	102-144	126.5	135.2±12.6	119-156	133.5	0.143
Nasiomental angle	137.6±10.8	125-160	133.5	138.6±13.5	120-165	141	0.796

Table 3: Statistical analysis of normal values and 3D values of female patients in facial analysis measurements

	Female						
	Normal			3D			
	Mean±SD	Min-Max	Median	Mean±SD	Min-Max	Median	p
Forehead	5.93±1.2	4.5-8.5	5.7	5.98±1.2	4,5-8.4	5.6	0.839
Dorsal length	4.82±0.9	3-6.1	4.8	5.26±0.9	3.5-7.1	5.3	0.210
Dorsal width	1.47±0.7	0.8-4	1.2	1.89±1	0.9-5	1.7	0.210
Intercanthal-M	3.08±0.5	2.5-4.5	3	3.15±0.9	1.9-4.7	3	1.000
Intercanthal-L	10.44±1.3	7.9-13	10.3	9.9±1.7	7.8-13	9.3	0.210
Columellar length	1.71±0.3	1.2-2.4	1.6	2.94±2.1	1.1-9.8	2.3	0.021
Alar width	3.24±0.6	2.3-4	2.1	3.27±0.9	1.9-4.6	3.3	0.804
Upper width	1.41±0.3	1-2	1.3	2.12±0.8	0.9-4	2.3	0.035
Chin	2.32±0.6	1.7-4	2.1	2.46±0.8	1.3-3.9	2.5	0.769
Nasofrontal angle	146.3±8.6	130-160	147	145.5±19.3	120-178	142.5	0.804
Nasolabial angle	134.8±14.7	105-156	138.5	132.5±17	100-152	136	0.511
Nasiomental angle	138.2±11.6	123-160	135.5	131.7±15.5	100-152	136	0.571

In recent years, there has been an increase in preoperative planning with the 3D printing method. 3D printed models allow surgeons to better understand individual anatomical variations and detect defects that may be difficult to compile from 2D images. In addition, it can be used to facilitate postoperative procedures and to obtain realistic examples of postoperative results (8). It is also thought that patients can manage their expectations more realistically when they can use their sense of touch in a printed model and examine their existing pathologies or conditions (6-9).

Facial appearance plays an important role in the quality of life of individuals. Over time, individuals become sensitive to changes in their facial appearance. Correction of these facial changes require careful and accurate planning, as even subtle changes in facial proportions can strongly effect the original appearance. Therefore, a reliable analysis of facial changes is very important in maximising surgical outcomes that meet patient expectations. Hence, the morphological and genetically objective evaluation of facial features has become increasingly important and, as the face is one of the most complex and variable regions of our face, the use of 3D printing in facial plastics has increased (9-11).

In the past, standard relationships between various parts of the face have been formulated by scientists and painters. Neoclassical laws are well known to surgeons, but the average ratios differ from the commonly used aesthetic standards. Ideal

Table 4: Statistical analysis of male and female ratios in the facial analysis measurements

	Male			Female			
	Mean±SD	Min-Max	Median	Mean±SD	Min-Max	Median	p
Forehead	6.07±0.8	4.5-7.3	6.2	5.93±1.2	4.5-8.5	5.7	0.666
Forehead 3D	6.19±0.7	4.6-7.3	6.4	5.98±1.2	4,5-8.4	5.6	0.437
Dorsal length	5.48±0.6	4.2-6.5	5.6	4.82±0.9	3-6.1	4.8	0.108
Dorsal length 3D	5.22±0.9	3.7-6.8	5.3	5.26±0.9	3.5-7.1	5.3	0.931
Dorsal width	1.25±0.2	0.8-1.8	1.2	1.47±0.7	0.8-4	1.2	0.709
Dorsal width 3D	1.94±0.7	0.9-3.2	1.9	1.89±1	0.9-5	1.7	0.585
Intercanthal-M	3.33±0.7	2.6-5.1	3	3.08±0.5	2.5-4.5	3	0.546
Intercanthal-M 3D	3.34±1.2	1.9-5.9	3.2	3.15±0.9	1.9-4.7	3	0.841
Intercanthal-L	10.78±1.3	8.8-13	10.7	10.44±1.3	7.9-13	10.3	0.625
Intercanthal-L 3D	11.5±1.5	9.6-14	11.4	9.9±1.7	7.8-13	9.3	0.026
Columellar length	1.93±0.3	1.3-2.7	2	1.71±0.3	1.2-2.4	1.6	0.154
Columellar length 3D	2.22±0.8	1.1-3.9	2	2.94±2.1	1.1-9.8	2.3	0.472
Alar width	3.75±0.5	2.6-4.7	3.9	3.24±0.6	2.3-4	2.1	0.064
Alar width 3D	3.82±1	2.3-5.7	3.7	3.27±0.9	1.9-4.6	3.3	0.285
Upper width	1.87±0.4	1.1-2.8	1.9	1.41±0.3	1-2	1.3	0.022
Upper width 3D	2.37±0.8	0.8-3.4	2.5	2.12±0.8	0.9-4	2.3	0.437
Chin	2.85±0.9	2-5	2.6	2.32±0.6	1.7-4	2.1	0.096
Chin 3D	3.45±1.5	1.8-6.3	3.2	2.46±0.8	1.3-3.9	2.5	0.096
Nasofrontal angle	142.1±6.9	130-151	141.5	146.3±8.6	130-160	147	0.212
Nasofrontal angle 3D	140.3±12.9	123-167	138.5	145.5±19.3	120-178	142.5	0.709
Nasolabial angle	122.9±14.6	102-144	126.5	134.8±14.7	105-156	138.5	0.042
Nasolabial angle 3D	135.2±12.6	119-156	133.5	132.5±17	100-152	136	0.886
Nasiomental angle	137.6±10.8	125-160	133.5	138.2±11.6	123-160	135.5	0.886
Nasiomental angle 3D	138.6±13.5	120-165	141	131.7±15.5	100-152	136	0.472

aesthetic proportions, angles and geometric relationships may not be fully seen on beautiful faces and may not be achieved surgically in the general population (12, 13).

Facial analysis dictates that the length of the face is divided horizontally into three parts. The upper part extends from the hairline to the glabella, the middle part extends from the glabella to the subnasal, and the third part at the bottom extends from the subnasal to the menton area (Figure 5). In terms of achieving desired aesthetic harmony, these three parts should be equal; however, they rarely are. As indicated in classical studies, the facial height ratios are compatible at approximately 50%. In accordance with the criteria of facial ratios, the width of the face was divided vertically into five parts; both eye widths formed one section each, and the intercantal distance and nose width is one fifth of the total width (Figure 3). The width of the lips should be approximately 40% of the width of the lower face and should generally be equal to the distance between the medial limbuses (1, 13).

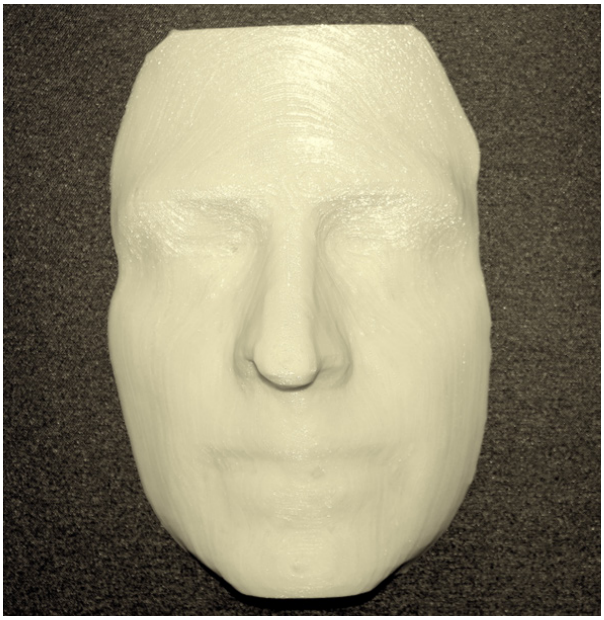

Figure 1: Figure of a 3D-printed mask

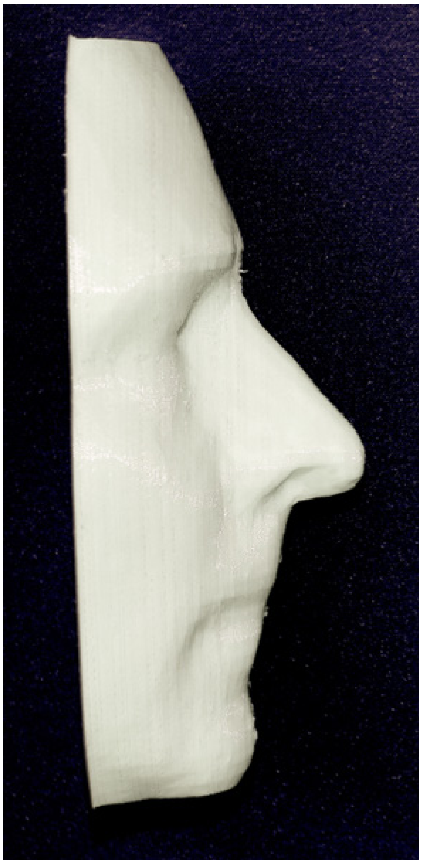

Figure 2: Figure of a 3D-printed mask.

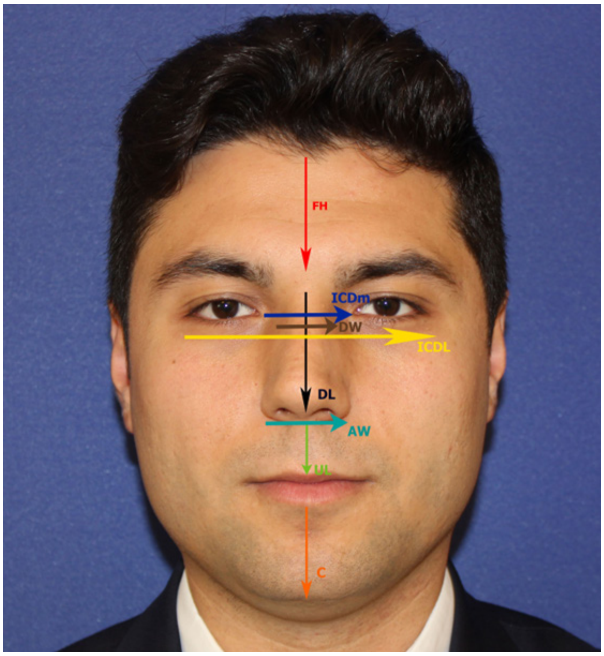

Figure 3: Length measurements made on the face and the 3D mask are depicted. FH: Forehead, ICDm: Intercanthal distance-medial, ICDL: Intercanthal distance-lateral, DW: Dorsal width, DL: Dorsal length, CL: Columellar length, AW: Alar width, UL: Upper lip, C: Chin.

Figure 4: Angle measurements made on the face and the 3D mask. NF: nasofrontal angle, NLA: nasolabial angle, NM: nasomental angle

In order to evaluate the patients' faces, we examined the compatibility of the 3D-printed models and the soft tissue measurements of our patients.

In our results, a significant difference was found between soft tissue measurements and 3D measurements in dorsal width measurements only of male patients (p=0.019) and only in columellar length and upper width measurements of female patients (p=0.021, p=0.035) while no other significant differences were noted (Table 2, Table 3).

In addition, no significant difference was found between male and female measurements except for upper width measurements, nasolabial angles and the lateral intercantal distance measurements in the 3D mask (p=0.026, p=0.022, p=0.042).

These results suggest that modelling with 3D printing is technologically safe and advantageous and shows great potential in facial aesthetics and surgical interventions. As it becomes easier and more widespread in its production, the use of 3D printing will increase in surgical interventions, patient's preoperative evaluations, training simulations and the reconstruction of complex defects. Therefore, further research and development is needed to increase access to this technology.

This research is a basic study on the Turkish population. The results may not represent the Turkish population due to the relatively small sample size.

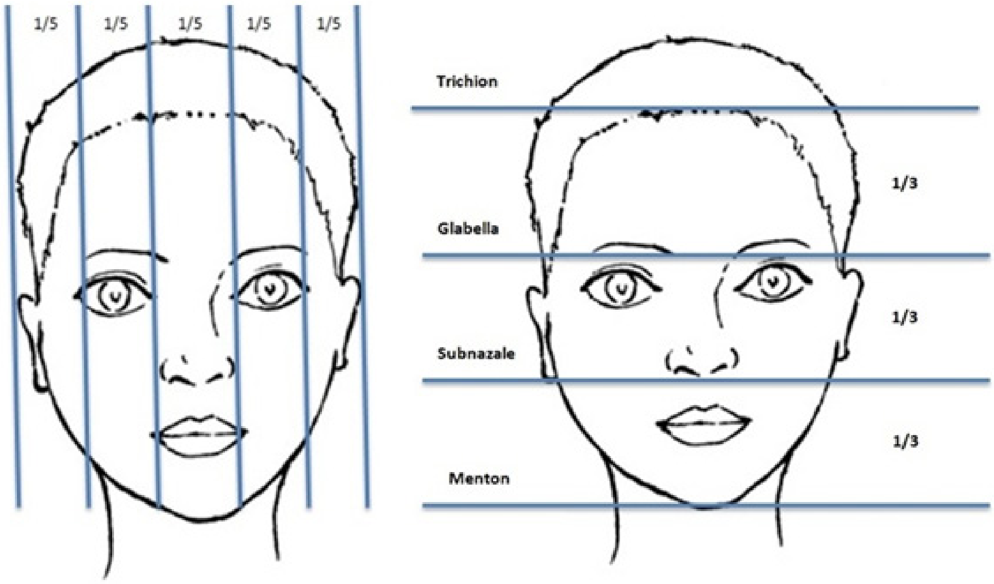

Figure 5: Facial divisions

Ethics Committee Approval: This study was approved by the Acıbadem University Ethics Committee (ATADEK) (Date: 12.09.2019, No: 2019-14/71).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

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Author Contributions: Conception/Design of Study- İ.E.E., K.S.K., M.V.K.; Data Acquisition- İ.E.E., K.S.K., M.V.K.; Data Analysis/Interpretation- İ.E.E., K.S.K., M.V.K.; Drafting Manuscript- İ.E.E.; Critical Revision of Manuscript- İ.E.E., K.S.K., M.V.K.; Final Approval and Accountability- İ.E.E., K.S.K., M.V.K.; Technical or Material Support – İ.E.E., K.S.K., M.V.K.; Supervision- İ.E.E., K.S.K., M.V.K.

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CASE REPORT
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Transoral Robotics Supracricoid Hemilaryngopharyngectomy

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ABSTRACT

Traditional open surgical approaches for hypopharyngeal carcinomas carry a great risk of developing treatment-related morbidity. Transoral robotic surgery (TORS) is an established treatment modality for head and neck cancer and can minimise this morbidity. Owing to the access and improved flexibility of the robotic system, hypopharyngeal tumours can now be reached and successfully treated with organ preservation, resulting in adequate function, especially in swallowing and phonation. In this study, we describe the surgical technique and clinical and oncological results for supracricoid hemilaryngopharyngectomy performed by transoral robotic surgery (TORS SCHLP) in a patient with hypopharyngeal carcinoma extending to the arytenoid mucosa. An interarytenoid sagittal cut extending to the cricoid cartilage was made. The epiglottis was split via a laterally placed vertical incision at the tumour-bearing side, extending to the anterior commissure. The inner perichondrium of the thyroid cartilage was peeled off. A horizontal cut in the postcricoid region was made, paying close attention to the safe surgical margins. A final cut, parallel to the cricoid cartilage, was made using curved scissors and the tumour was removed en bloc. In conclusion, TORS SCHLP should be considered for resectable tumours to avoid the undesirable consequences of open surgical resection.

Keywords: Robotic surgery, hypopharyngeal cancer, TORS

INTRODUCTION

Hypopharyngeal cancers have the lowest overall survival rates among all head and neck cancers. They often present in advanced stages and require comprehensive surgical resections, primary chemoradiotherapy, or a combination of both. Over the past decades, a definitive surgical approach (mostly total laryngopharyngectomy) has been the mainstay of treatment. However, the open surgical approach is highly invasive and often complicated by postoperative wound infection, phonation, and swallowing problems (1). Therefore, the treatment paradigm for many pharyngeal cancers has gradually shifted from open surgery to nonsurgical radiotherapy or chemoradiotherapy. However, late complications of radiation therapy, such as neck stiffness, dysphagia, and xerostomia, greatly reduce patients' quality of life (2).

With advances in technology, today, an increasing number of pharyngeal cancers are being detected at earlier stages (3). For selected patients with early-stage hypopharyngeal cancer, laryngeal preservation surgery can be performed with adequate functional results (4). Supracricoid hemilaryngopharyngectomy (SCHLP) is a well-defined conservative technique for patients with early carcinoma of the pyriform sinus (4). In this technique, resection of the medial wall of the pyriform sinus and hemilarynx is accomplished with good local control (4). To decrease treatment-related morbidities and increase postoperative quality of life, minimally invasive techniques such as transoral laser microsurgery (TLM) have been used for the treatment of hypopharyngeal cancers (5). The technique of TLM often necessitates the surgeon not only to split the tumour but also to cut the tumour into pieces. Surgeons often have the feeling of operating with inadequate dexterity in a dark hole. The inadequate operative field of view and tough learning curve lead to the disadvantages of TLM for laryngopharyngeal cancer treatment.

Transoral robotic surgery (TORS) is one of the options and has proven to be an effective, minimally invasive surgical technique for hypopharyngeal cancers (6). It has the advantage of good visualisation and manipulation of the tissue to facilitate surgical resection. The 360° motion of the robotic arms provides

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excellent access for cutting tissues that cannot be achieved with endoscopic or transoral laser surgery. Optimal transoral exposure is essential for the surgery. Patients eligible for TORS must be good candidates for endoscopic laryngeal conservation surgery. Relative or strict contraindications for TORS are vocal fold fixation, invasion of the pyriform sinus apex, and invasion of the thyroid cartilage inner perichondrium.

To the best of our knowledge, this is the first report of supracricoid hemilaryngopharyngectomy performed by transoral robotic surgery (TORS SCHLP).

CASE PRESENTATION

The patient was a 76-year-old man with a history of smoking (50 pack-years) who presented with globus sensation and throat discomfort. Upon evaluation, a cT1N0M0 lesion was identified, arising from the medial wall of the right pyriform sinus, extending anteriorly, and involving the aryepiglottic fold and the lateral mucosa of the right arytenoid. (Figure 1A). Vocal fold mobility was normal. Preoperative imaging showed no lymph node invasion. The diagnosis of squamous cell carcinoma was confirmed after hypopharyngeal biopsy.

Transoral robotic supracricoid hemilaryngopharyngectomy (TORS SCHLP) with ipsilateral functional neck dissection was performed at Umraniye Research and Training Hospital, Department of Otolaryngology Clinic. Informed consent was obtained from the patient. The patient's demographic and clinical characteristics are presented in Table 1.

SURGICAL TECHNIQUE

The airway was secured with a standard orotracheal tube. The patient was positioned for TORS. The larynx and hypopharynx were exposed using an FK-WO retractor (Gyrus ACMI, Southborough, MA). The daVinci Xi Surgical System (Intuitive Surgical, Sunnyvale, CA) was positioned on the patient's right side. A 30-degree robotic camera was placed in the midline with 8 mm Hot Shears™ monopolar curved scissor and ProGrasp™ forceps on the lateral arms. An interarytenoid sagittal cut extending to the cricoid cartilage was made. The epiglottis was split via a laterally placed vertical incision at the tumour-bearing side, extending to the anterior commissure. The superior laryngeal vessel was coagulated with a harmonic scalpel and cut. Upon reaching the thyroid cartilage, the dissection continued posteriorly along its inner surface. After incising the perichondrium, the inner perichondrium of the thyroid cartilage was peeled off to ensure a safe margin in the anterolateral portion. A horizontal cut in the postcricoid region, starting from the interarytenoid space and extending to the vertical epiglottic incision, was made, paying close attention to safe surgical margins at this time. The tumour specimen was grasped with ProGrasp forceps. A final cut, parallel to the cricoid cartilage, was made using curved scissors and the tumour was excised en bloc. The surgical margins were sent to the pathologist for frozen sections. Once it was confirmed that the margins were clear, the procedure was completed.

RESULTS

TORS exposure was adequate in our case. The operative time for the robotic setup was 20 min and the operative time to perform the procedure was 40 min. Negative surgical margins were achieved. The patient was extubated immediately after the surgery without tracheotomy. Venous bleeding at the operative site that did not require surgical intervention was the only postoperative complication. The nasogastric tube was removed on the 6th postoperative day, and normal food intake was possible. Figure 1B shows the postoperative endoscopic examination of the patient.

The patient underwent ipsilateral functional neck dissection. There was no lymph node metastasis in the pathological evaluation of the neck. Table 1 shows the data on the clinical and pathological staging of the patient. There was no sign of disease recurrence in the 45-month follow-up of the patient.

DISCUSSION

Supracricoid hemilaryngopharyngectomy was first described in the 20th century, and the first large series was published in 1987 (7, 8). Laccourreye et al. published long-term follow-up of

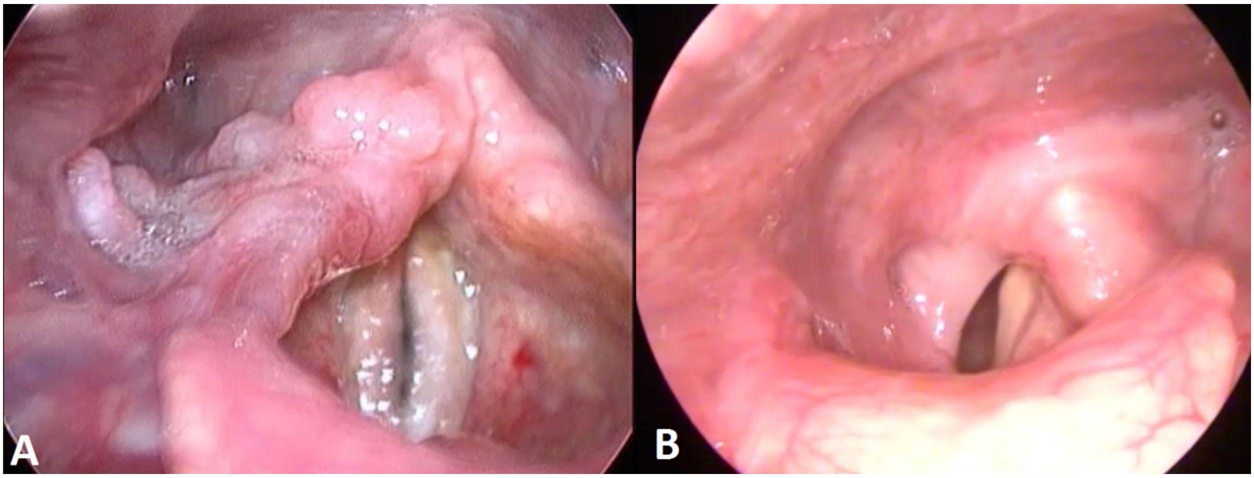

Figure 1: Preoperative (A) and postoperative (B) endoscopic examination of the patient

Table 1: Demographic and clinical characteristics of the patient

Patient	Sex	Age	Tumour staging	Extubation	Nasogastric removal (day)	Operation time (minutes)	Robotic positioning (minutes)	RT	Outcome (months)
1	M	76	cT1N0M0 pT1N0M0	Immediate	6	40	20	-	45

RT: Postoperative radiotherapy, M: Male

patients and comprehensive functional and oncological results of the technique (4). The technique was developed to resect ipsilateral hemilarynx and the medial wall of the pyriform sinus for tumors arising from the pyriform sinus and/or the hemilarynx. Despite the good results reported with SCHLP, it has not gained worldwide popularity, probably because the procedure is technically challenging.

Similar to any conservative surgical procedure performed by an external approach, SCHLP disrupts the physiological function of the larynx much more than transoral surgeries. Open surgery for hypopharyngeal cancer is frequently associated with organ loss and the need for permanent tracheotomy. Park et al. compared TORS and radical open surgery for hypopharyngeal cancer and showed better postoperative functional recovery results in terms of decannulation, swallowing, and duration of hospitalisation in the TORS group (9). In the TORS group, all patients underwent temporary tracheotomy and were decannulate on an average of 7.2 days. Laccourreye et al. reported a mean decannulation time of nine days in their SCHLP series (4). In the same study, the mean length of time for the removal of the feeding tube was 22 days (4). Patients treated with TORS for hypopharyngeal cancer have been reported to have tolerated an oral feeding after an average of 8.1 days (6). In our patient, the feeding tube was removed on the sixth postoperative day. We normally open a tracheotomy in TORS for hypopharyngeal surgeries. However, we did not perform tracheotomy for the patient. The fact that the operation was relatively nonbleeding compared to normal and that it would not disturb the operation site in terms of postoperative bleeding was effective in making this decision. Unfortunately, there was venous bleeding at the operation site on the third postoperative day. Fortunately, the bleeding ceased without any surgical intervention. Venous bleeding deep in the larynx/hypopharynx may prevent reintubation with catastrophic consequences. Therefore, regardless of how bleeding-free the operation is, we believe that temporary tracheotomy is absolutely necessary in these cases to ensure the safety of the patient. Park et al. reported postoperative bleeding in one of 23 patients who underwent transoral robotic hypopharyngeal surgery (6).

Similar functional and oncological results have been reported with the transoral laser resection of hypopharyngeal tumours (5). However*, "line of sight*" resection through a small laryngoscope lumen leads surgeons to remove the tumour in a piecemeal fashion. This type of resection does not allow caudal to cranial resection or axial plane resection. In unexperienced hands, piecemeal resection may result in three-dimensional disorientation of the surgeon and leave the tumoral tissue behind. En bloc resection yields a postoperative specimen that can be assessed by a pathologist as an en bloc specimen, in contrast to piecemeal resection. We performed resection in an en bloc fashion and achieved negative surgical margins in the patient.

Therefore, we believe that TORS SCHLP is an oncologically safe and reliable method for proper hypopharyngeal tumours. The main advantages of TORS over the endoscopic laser approach include three-dimensional magnified views, the ability to see and maneuver around curves or angles, and the availability of two or three robotic arms. Furthermore, the combination of a 30-degree robotic telescope with an FK-WO retractor provides excellent exposure of the hypopharyngeal wall and larynx, allowing wide en bloc resection of the larynx and hypopharynx. We performed all resections defined in SCHLP with explained advantages using a robotic system except thyroid cartilage removal.

CONCLUSION

With the increasing interest in minimally invasive surgery, the da Vinci surgical robot has seen enhancements that improve visualisation, exposure, and tissue manipulation. Although TORS is well established for oropharyngeal lesions, its application in hypopharyngeal and laryngeal surgery remains uncommon. In selected cases, surgical resection margins can be attained with transoral robotic surgery as in open surgery. We believe that a temporary tracheotomy is essential for ensuring patient safety in TORS for hypopharyngeal carcinoma.

Informed Consent: Written informed consent was obtained from patient who participated in this study.

Peer Review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- Ç.O., O.A.; Data Acquisition- O.A.; Data Analysis/Interpretation- Ç.O., O.A.; Drafting Manuscript- Ç.O., O.A.; Critical Revision of Manuscript- Ç.O., O.A.; Final Approval and Accountability- Ç.O., O.A.; Material or Technical Support- Ç.O., O.A.; Supervision- Ç.O., O.A.

Conflict of Interest: The authors have no conflict of interest to declare.

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CASE REPORT
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Oral Chondrolipoma: A Rare Case Report

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ABSTRACT

Chondrolipoma is a rare histological variant of lipoma characterised by the formation of mature hyaline cartilage along with adipose tissue. Chondrolipomas are rare in the oral cavity, with very few cases reported to date. Intra-orally chondrolipoma have been reported most commonly in the tongue, followed by the lower lip, vestibule, and floor of the mouth. Because of the very few cases of chondrolipoma reported in the oral cavity, there is a paucity of information regarding their biological behaviour and clinical outcome. We report a rare case of oral chondrolipoma occurring on the right maxillary attached gingiva; the lesion was initially diagnosed as fibroma. Histopathological examination rendered the diagnosis of chondrolipoma.

Keywords: Lipoma, chondrolipoma, hyaline cartilage, gingiva

INTRODUCTION

Lipomas are benign, slow-growing, mesenchymal tumours of adipose tissue that are histologically characterised by sheets of mature white fat cells separated by fibrous septa (1). Lipomas can occur anywhere in the body; 20% of the lipomas have been reported in the head and neck region; they are exceedingly rare in the oral cavity, with only 1%–5% of reported cases (2). Clinically, lipomas are benign, well-circumscribed, asymptomatic, and slow-growing lesions. Histopathologically, they comprise of sheets of mature adipocytes with occasional secondary mesenchymal tissue. Numerous histopathological subtypes of lipomas have been reported in the literature based on the secondary mesenchymal tissue, i.e., fibrolipoma, osteolipoma, myxolipoma, spindle cell lipoma, sialolipoma, myolipoma, angiolipoma, chondroid lipomas, and chondrolipoma (1-3). Chondrolipomas are characterised by mature hyaline cartilage tissue underlying the sheets of mature adipocytes (4).

CASE REPORT

An otherwise healthy 44-year-old male patient reported to our institute for the evaluation of a painless, localised growth on his left upper back region of the jaw from the last year. The swelling was initially small and gradually reached this size. The family history, past medical history, and personal history of the patient were non-contributory to the presenting symptoms. Intra-oral examination of the patient revealed a yellowish-white dome-shaped growth extending from the attached gingiva of tooth number 24 and extending towards the alveolar mucosa, measuring about 3 × 2 cm (Figure 1). No signs of pus discharge or sinus formation were noted in the lesion. On palpation, it was found to be soft and movable. The cervical lymph nodes were non-palpable.

The panoramic radiograph revealed that the growth was superficial and no bone loss was noted (Figure 2). The lesion was completely removed under local anaesthesia, and the gross tissue was sent to the department of oral pathology and microbiology for the microscopic evaluation (Figure 3). The haematoxylin and eosin-stained section revealed a well-capsulated tissue mass made up of sheets of adipocytes divided by fibrous tissue septa (Figure 4a). A focus of mature hyaline cartilage was noted along with the adipocytes; the metaplastic cartilaginous tissue was surrounded by spindle-shaped cells. The connective tissue stroma was fibrocellular (Figure 4b). On the basis of the histopathological features, the final diagnosis of chondrolipoma was made. No recurrence was noted in the

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6-month follow-up period. An informed consent of the patient was obtained for the publication purpose.

DISCUSSION

Lipoma is considered as benign, slow-growing mesenchymal tumours of adipose tissue origin. They are the most common mesenchymal tumours of the head and neck, but are rare in the oral cavity (3-5). They can occasionally be associated with one or more secondary mesenchymal elements (6).

Chondrolipoma is a rare histopathological subtype of lipoma, characterised microscopically by the formation of mature hyaline cartilage with the sheets of mature adipocytes (5, 6). An exhaustive literature review revealed 18 cases of oral chondrolipoma reported in the English literature.

Figure 1: Clinical picture of the lesion

Intraorally, the most common site for oral chondrolipoma is the tongue, followed by the lower lip, floor of the mouth, and vestibule (4-6). McAndrew and Greenspan reported the first case of oral chondrolipoma in 1976 in a 72-year-old female in the lower lip (7). No case of chondrolipoma has ever been reported in the gingiva; hence, the present case is the first report of chondrolipoma in the gingiva to the best of our knowledge.

Clinically, chondrolipoma show features similar to their conventional counterparts; they are usually asymptomatic and slow-growing tumours (3, 4). An exhaustive literature review revealed that chondrolipomas have a wide peak of occurrence from 14 years to 72 years, with a mean age of 51 years (6). Oral lipomas are more common in males than in females; chondrolipoma, too, have shown a preference for males (2, 3, 8). Intra-orally, conventional lipomas have been reported most commonly in the buccal mucosa; however, chondrolipoma have a strong preference for the tongue, but contrary to their conventional counterparts, no case of oral chondrolipoma has been reported in the buccal mucosa (6). Chondrolipomas are diagnosed microscopically because of the presence of mature adipocytes with mature hyaline cartilage tissue; however, the histogenesis of this neoplasm is still enigmatic (6, 8). Numerous hypotheses have been proposed to explain the formation of cartilage in a tumour which is primarily adipocytic in origin (Figure 5).

Histopathologically, chondrolipoma closely resemble chondroid lipoma, an uncommon variant of lipoma characterised by immature lipoblast along with cartilage tissue formation. Chondroid lipoma is considered a pseudosarcomatous entity that imitates malignancies of the adipose and chondroid tissues (9). The treatment modality for chondrolipoma is surgical excision of the tumour; no recurrence has been reported in the literature to the best of our knowledge (10, 11).

Figure 2: Panoramic radiograph of the patient

CONCLUSION

Chondrolipomas are an unusual variant of lipoma characterised histologically by mature adipose tissue with hyaline cartilage formation. The histogenesis of these tumours is not clear; several theories have been proposed to explain the formation of cartilage in an adipose tissue tumour. This case is the first report of chondrolipoma in the gingiva.

Figure 3: Gross specimen

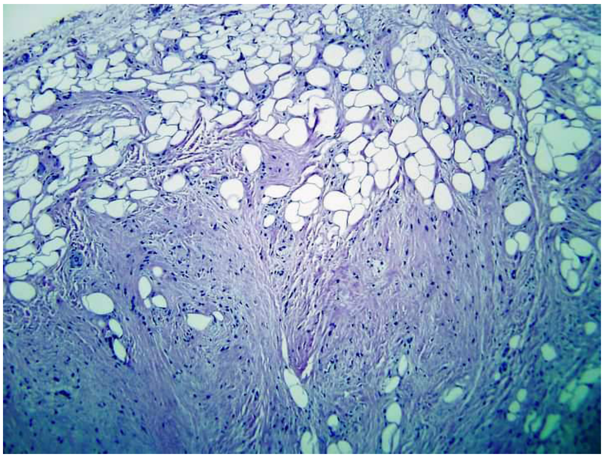

Figure 4a: Encapsulated tissue mass made up of sheets of mature adipocytes lined by fibrous septa. (Haematoxylin and Eosin staining (10x)

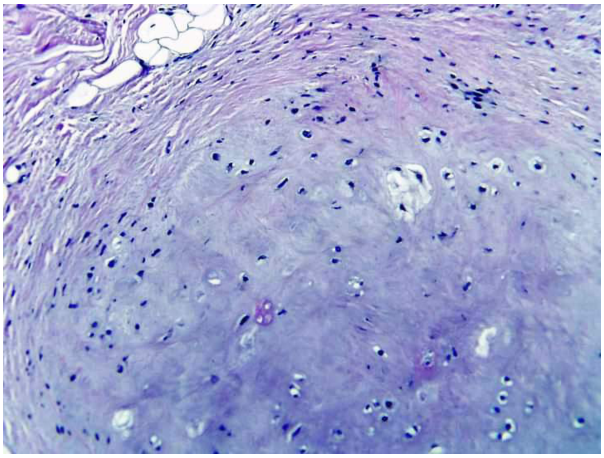

Figure 4b: Hyaline cartilaginous tissue surrounded by mature adipocytes(Haematoxylin and Eosin staining (40x))

Informed Consent: Written informed consent was obtained from patient who participated in this study.

Peer Review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- S.M., M.B., S.L.S.; Data Acquisition- S.M., M.B., S.L.S.; Data Analysis/ Interpretation- S.M., M.B., S.L.S.; Drafting Manuscript- S.M., M.B., S.L.S.; Critical Revision of Manuscript- S.M., S.L.S.; Final Approval and Accountability- S.M., M.B., S.L.S.; Technical or Material Support – M.B.; Supervision- S.M., S.L.S.

Conflict of Interest: The authors have no conflict of interest to declare.

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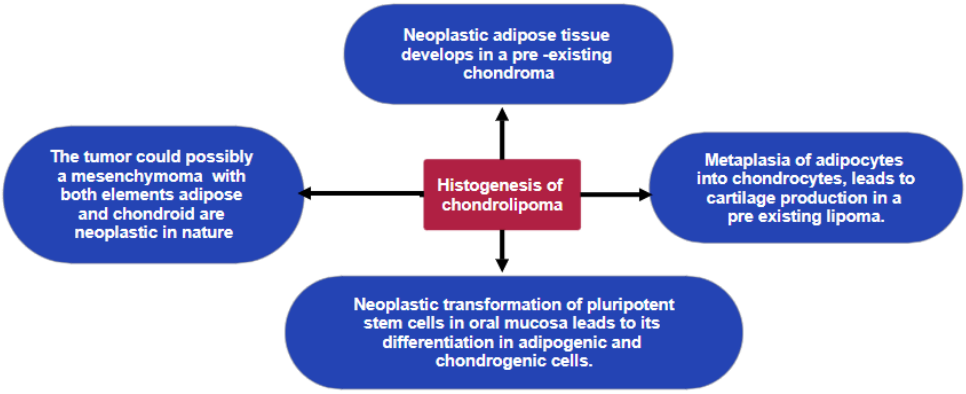

Figure 5: Possible hypotheses to explain the histogenesis of chondrolipoma

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