The case we presented is characterized by large dimensions, compared with the cases reported by other authors. Most of the cases reported were female patients. Female patients felt that their condition is a deformity, often shun contact with other people, and experience a decline in social relationships.

Hard palate schwannoma relapse after excision is very rare: only a case 3 years after surgery is described in the literature.[10]

With this article, we report a rare case of giant schwannoma. Conservative surgery is the preferred treatment for such tumors. Medical history, dimensions, and accurate postoperative follow-up play an important role.

REFERENCES

1. Colreavy MP, Lacy PD, Hughes J, et al. Head and neck schwannomas—a 10 year review. *J Laryngol Otol* 2000;114:119–124
2. Carinci F, Carls FP, Grasso D et al. Schwannoma of the parapharyngeal space. *J Craniofac Surg* 2000;11:367–370
3. Jones JA, McWilliam LJ. Intraoral neurilemmoma (schwannoma): an unusual palatal swelling. *Oral Surg Oral Med Oral Pathol* 1987;63:351–353
4. Amir R, Altman KW, Zaheer S. Neurilemmoma of the hard palate. *J Oral Maxillofac Surg* 2002;60:1069–1071
5. López-Carriches C, Baca-Pérez-Bryan R, Montalvo-Montero S. Schwannoma located in the palate: clinical case and literature review. *Med Oral Patol Oral Cir Bucal* 2009 1;14:e465–e468
6. Murthy VA, Ramaswamy S, Sunita M. Schwannoma of the hard palate *Indian J Otolaryngol Head Neck Surg* 2009;61(suppl 1):52–54
7. Lollar KW, Pollak N, Liess BD, et al. Schwannoma of the hard palate. *Am J Otolaryngol* 2010;31:139–140
8. Isildak H, Yilmaz M, Ibrahimov M, et al. Schwannoma of the hard palate. *J Craniofac Surg* 2010;21:276–278
9. Shetty SR, Mishra C, Shetty P, et al. Palatal schwannoma in an elderly woman.*Gerodontology* 2012;29:e1133–e1135
10. Krolls SO, McGinnis JP Jr, Quon D. Multinodular versus plexiform neurilemoma of the hard palate. Report of a case. *Oral Surg Oral Med Oral Pathol* 1994;77:154–157

Changes in Dental Pulp Blood Flow of Different Maxillary Tooth Types After Le Fort I Osteotomy

*Seyda Ersahan Eroglu, DDS, PhD,**
Fidan Alakus Sabuncuoglu, DDS, PhD†

Abstract: This study examined the effects of Le Fort I (LF-I) osteotomy on pulpal blood flow (PBF) in maxillary teeth during a 12-month postsurgical period. A laser Doppler flowmeter was used to measure PBF in maxillary incisors, canines, and first premolars of 14 patients undergoing LF-I osteotomy (study group), 7 patients undergoing mandibular osteotomy (surgical control group), and 7 nonsurgical controls. The PBF was measured at baseline (preoperatively) and at 1 week and 1, 3, 6, and 12 months postoperatively and at similar intervals in nonsurgical control subjects. Data were evaluated using Kruskal-Wallis and post hoc Mann-Whitney tests. Changes in PBF over time for each tooth type were evaluated using the Wilcoxon signed-rank test. The level of significance was set at $P < 0.05$. Study findings showed that baseline PBF values did not differ significantly between groups. Maxillary PBF in the control group did not vary over time; however, an initial decrease in PBF was observed in all tooth types immediately after surgery in the study group. A gradual increase to near-preoperative levels was then observed during a 12-month healing period. Although dramatic reductions in maxillary perfusion of the first premolar and canine pulps were observed at 1 week and 1 month after LF-I osteotomy when compared with baseline ($P < 0.001$), PBF significantly recovered over time. Moreover, hyperemia was observed in lateral incisors 3 months postoperatively, demonstrating a tooth type–specific effect of LF-I osteotomy on PBF.

Key Words: Le Fort I, pulpal blood flow, laser Doppler flowmetry

From the *Department of Endodontics, Oran Poliklini Dis Servisi, Beytepe Asker Hastanesi, Oran, Cankaya, Ankara, Turkey; and †Department of Orthodontics, Center for Dental Sciences, Maresal Cakmak Hospital, Erzurum, Turkey.

Received December 21, 2013.
Accepted for publication February 10, 2014.

Address correspondence and reprint requests to Seyda Ersahan, DDS, PhD, Beytepe Hospital, Department of Endodontics, Beytepe Asker Hastanesi, Oran Poliklinigi Dis Servisi, Oran/Cankaya, Ankara 06018, Turkey; E-mail: seydaersahan@hotmail.com

The authors report no conflicts of interest.

Copyright © 2014 by Mutaz B. Habal, MD

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000000920

Correction of dentofacial deformities often requires a combined orthodontic and surgical approach to obtain satisfactory functional and esthetic results with long-term stability. The Le Fort I (LF-I) maxillary osteotomy is the operation most commonly used to correct vertical and transverse maxillary deformities.[1] Although rare, this procedure may result in severe complications, including development of periodontal defects, degenerative pulp changes, poor bony union, or in extreme cases, partial or complete loss of the repositioned segment.[2,3] Pulpal response after LF-I osteotomy may be evaluated by histologic observation,[4] fluorescent microsphere injection,[5] and pulp-tissue respiration rate measurements;[4] however, all these methods can be applied only after tooth extraction. In contrast, laser Doppler flowmetry (LDF) is a noninvasive method of performing repeated measurements of pulpal blood flow (PBF) without causing damage to the pulp.[6] Therefore, LDF is the most widely used method for investigating vascular changes associated with LF-I osteotomy.

Several authors have reported LDF measurements indicative of changes in maxillary teeth PBF during healing after LF-I osteotomy.[7–10] Ramsay et al[7] studied dental pulp blood flow in the upper incisors of 14 patients after LF-I osteotomy, and Geylikman et al[10] observed changes in gingival and PBF for 24 hours after LF-I osteotomy. However, both these studies provided longitudinal data on post-osteotomy PBF for central incisors only.[7–10] Only 2 studies have presented tooth type–specific effects of LF-I separately;[11,12] however, these studies were carried out without an operative control group and with very short observation periods. In short, there is scarce data on tooth type–related PBF values in patients receiving LF-I osteotomies, especially when compared with the amount of data available for central incisors. Consequently, the current study aimed to evaluate the effects of LF-I osteotomy on maxillary PBF values of different tooth types during a 12-month postoperative period.

MATERIALS AND METHODS

Subjects and Surgical Procedures

This study was approved by the institutional review board and ethics committee of the Ministry of Health's Kecioren Training

 © 2014 Mutaz B. Habal, MD

Copyright © 2014 Mutaz B. Habal, MD. Unauthorized reproduction of this article is prohibited.

and Research Hospital (no. 158; November 14, 2012) and was conducted in compliance with the principles of the Helsinki Declaration. Informed consent was obtained from all participants. A total of 28 healthy patients (age range, 18–25 y; mean age, 19.7 y) with skeletal class III malocclusion were selected from among the patients applying to the hospital for treatment. Intraoral periapical radiographs were taken, and patients with missing teeth in the maxillary anterior area, a history of trauma, root canal treatment, caries, restoration, previous orthodontic treatment, or excessive gingival display were excluded from the study. Study participants were randomly divided into a study group of patients receiving a single-segment LF-I osteotomy (n = 14) and 2 control groups—a surgical control group consisting of patients receiving mandibular osteotomies but no maxillary surgical procedures (n = 7) and a nonsurgical control group (n = 7) of subjects who received no surgery, but orthodontic treatment. The mandibular osteotomy group was included to control for factors associated with surgery (eg, hospitalization, general anesthesia, pain medications, and tooth movement) that might influence maxillary blood flow.[13] The nonsurgical control group was included to account for temporal variability that may occur with repeated blood-flow measurements. Because there is some evidence that initial loading can affect PBF,[14] patients in both control groups had brackets attached to their maxillary teeth but had no archwires placed.

A single-segment LF-I osteotomy was performed on each patient in the study group. A horizontal incision was made in the buccal and labial sulcus from the right second premolar to the left second premolar, a minimum distance of 5 mm was maintained between osteotomy line and teeth apices, and the osteotomized maxilla was rigidly fixed with 4 titanium miniplates. Mean maxillary advancement as measured on lateral cephalograms was approximately 4 mm anteriorly. In the surgical control group, bilateral sagittal split-ramus osteotomies were performed, with the mandible and bony segments of the mandibular rami fixed bicortically with 3 titanium screws on each side. In no case was a surgical splint affixed to a patient's palate to achieve postsurgery retention of the maxilla, and in no case was maxillomandibular fixation performed postoperatively. All sutures were removed at 7 days postoperatively, and orthodontic treatment was reinstated. Two intermaxillary elastics were applied after surgery and used continuously for 2 months, except for meals and pulpal examination. Thereafter, the postoperative orthodontic therapy was continued up to approximately 1 year after the operation.

Laser Doppler Flowmeter

The PBF was measured using an LDF (Periflux PF 4001; Perimed, Järfälla, Sweden), which records amounts of backscattered light. The LDF output signal voltage is linearly correlated to red-blood-cell flow (number of cells × mean velocity), which is recorded in perfusion units (PUs) to provide a relative measure of blood flow. The LDF used in this study has a 1-mW helium-neon laser with a wavelength of 632.8 nm. A straight probe (PF 416; Perimed, Järfälla, Sweden) with a 2-mm diameter was used to conduct a laser light beam of 125 μm (fiber-to-fiber distance, 500 μm) to the measurement site within the dental pulp and to return the backscattered light to the flowmeter. Before each measurement, the probe was calibrated for zero voltage and a motility standard of 250 PU (Perimed) using a plastic block (Perimed, Järfälla, Sweden).

Recording Procedures

The LDF measurements were recorded bilaterally for the maxillary central incisors, lateral incisors, canines, and first premolars at T0 (within 1 w preoperatively), T1 (1 w postoperatively), T2 (1 mo postoperatively), T3 (3 mo postoperatively), T4 (6 mo postoperatively), and T5 (12 mo postoperatively). Measurements were taken at similar intervals in the nonsurgical control group. To ensure accuracy and reproducibility of measurements, each patient was provided with a custom-fabricated splint constructed from self-curing acrylic resin to secure the probe in the appropriate position between the gingival margin and the orthodontic bracket. Before LDF measurement, patients were allowed to rest in a supine position in the dental chair for approximately 10 minutes. Splints were then placed on the teeth, and the lips were retracted using cotton rolls. The LDF measurements were continuously recorded for each tooth until 2 minutes of stable PBF data values were registered on the flowmeter screen. All measurements were performed by the same operator under standard environmental conditions at a constant room temperature. Attempts were made to minimize bias due to movement of subjects and probe, and pulse rate and blood pressure were recorded throughout the measurement sessions. None of the participants reported any pain or discomfort during the procedure.

For each session, mean PUs for each tooth were calculated for the phase of stable values, with peaks attributable to movement artifacts excluded. The LDF data were transferred to a computer connected to the RS-232 port of the flowmeter using the system's own software (PeriSoft for Windows, Perimed) and stored for analysis at a later date.

Statistical Analysis

Statistical analysis was performed using the software MedCalc12.0 (SPSS Inc, Chicago, IL). Differences in PBF between the groups at each point in time were evaluated using the Kruskal-Wallis test, with the post hoc Mann-Whitney test used to identify significant differences among groups. The PBF changes in time were evaluated for each tooth type using the Wilcoxon matched-pairs test. Statistical significance was set at $P < 0.05$.

RESULTS

Mean (SD) PBF values for each group are given in Table 1. Baseline (T0) PBF values did not differ significantly between study [8.9 (1.1) PU], surgical control [8.8 (0.8) PU], and nonsurgical control groups [9 (1.3) PU] ($P = 0.741$). However, PBF values for the study group were higher than those for both control groups at all times during the postoperative observation period. A significant decrease in PBF was observed postoperatively in the study group. Mean PBF also decreased from T0 to T1 in the surgical control group; however, this decrease was not statistically significant, nor were any of the other differences in PBF measured at different time points in this group ($P > 0.05$). No significant differences were observed in the nonsurgical control group between any time points.

The PBF values by tooth type and time are given in Table 2. PBF values for the study group decreased postoperatively and remained significantly lower than preoperative values throughout the entire observation period. The PBF values for all tooth types in the study group were significantly higher at T0 [8.9 (1.1) PU] than at T1 [5.9 (0.9) PU] ($P < 0.001$) and T2 [6.1 (1.0) PU] ($P < 0.001$); no statistically significant differences were found between T1 and T2 ($P = 0.0510$); and statistically significant differences were also found between T3 and T4 ($P < 0.001$), T4 and T5 ($P < 0.001$), and T3 and T5 ($P < 0.001$). Canine and first premolar PBF values were significantly higher at T0 [8.2 (0.8) and 9.0 (1.0) PU, respectively] when compared with T1 and T2 [6.5 (1.7) and 7.1 (1.9) PU for T1 and 6.7 (1.7) and 7.4 (1.9) PU for T2; $P < 0.001$]. For lateral incisors, differences in PBF between T0 and T3 were not statistically significant ($P = 0.067$); however, PBF was significantly higher at T3 when compared with T2. The

Copyright © 2014 Mutaz B. Habal, MD. Unauthorized reproduction of this article is prohibited.

TABLE 1. Diagnostic Group-Related PBF Measurements

	Study Group, n = 112, mean (SD)	Surgical Control Group, n = 56, mean (SD)	Nonsurgical Control Group, n = 56, mean (SD)	*P*
T0	8.9 (1.1)	8.8 (0.8)	9.0 (1.3)	0.741*
T1	5.9 (0.9)	8.6 (0.8)	9.0 (1.3)	<0.001
T2	6.1 (1.0)	8.8 (0.8)	9.0 (1.3)	<0.001
T3	7.9 (1.2)	8.8 (0.8)	9.0 (1.3)	<0.001
T4	8.1 (1.0)	8.8 (0.8)	9.0 (1.3)	<0.001
T5	8.1 (1.0)	8.8 (0.8)	8.9 (1.2)	<0.001

lateral incisors did not show differences in PBF between T0 and T3, whereas all other tooth types did, thus indicating that tooth type affects LF-I osteotomy PBF outcomes.

DISCUSSION

The current study looked at differences in post-LF-I osteotomy PBF outcomes according to tooth type by evaluating and comparing LFD data for maxillary teeth of subjects undergoing single-segment LF-I osteotomy with data for the surgical and nonsurgical control groups during a 12-month period. Whereas preoperative PBF values did not differ significantly between groups, postoperative PBF values were significantly lower in the LF-I osteotomy group than in both the control groups at all times postoperatively. No statistically significant mean change in maxillary teeth PBF was observed during the postoperative period in either control group, indicating that the reduction in PBF registered in subjects undergoing osteotomy is unrelated to repeated measurement, flowmeter calibration, or test sensitivity. Moreover, the maxillary teeth PBF in the surgical control group did not vary significantly during the postoperative period, thus indicating that mandibular surgery has no major physiological effect on the maxilla.

Mean PBF in the study group decreased after surgery and remained low for approximately 1 month. The most pronounced reduction in PBF occurred during the first week postoperatively and thus may be attributed to either stretching of the descending palatine arteries caused by the advancement of the osteotomized maxilla or to the redirection of blood flow to localized facial swelling. This redirection was first reported by Tonder,[15] who documented reduced blood flow in the dental pulp of dogs after infusion of vasodilating drugs and who referred to this phenomenon as "stealing" of dental pulp perfusion pressure. In the current study, severe facial swelling and vascular dilation in the soft tissue surrounding the osteotomy region caused by acute inflammation was observable 1 week postoperatively, suggesting that "stealing" may have been responsible for the reduction in postoperative PBF in the study group. The stealing effect of mandibular osteotomy on maxillary perfusion would also explain the slight reduction in the mean PBF value of the surgical control group 1 week postoperatively.

Postoperative recovery can be affected by factors including surgical technique, duration of surgery, and patient age and sex. In the current study, the vascular disturbances in the study group gradually began to improve after 1 month but had not returned to preoperative values at the end of the 12-month observation period. The initiation of recovery in PBF after a distinct period may be related to the preservation and recovery of apical circulation said to result from the maintenance of anastomosis between the apical dental artery and the apical and intra-alveolar arteries originating in the mucoperiosteum.[16] Although the lower PBF values at the end of the observation period in comparison with baseline may reflect a general reduction in the perfusion of the entire maxillary complex after the trauma of osteotomy,[2] it could also be a reflection of a reduction in the size of the pulp chamber due to secondary dentine formation.[17–19] This latter phenomenon has been previously reported in a similar situation,[19] although 28 months after surgery, it was observable in only 2.3% of patients. Further research is required to determine whether blood flow returns to normal after longer periods.

The present study's finding of a significant effect of LF-I osteotomy on maxillary PBF values, with the greatest PBF reduction observed during the first week postoperatively, is in line with many earlier studies.[4,5,8–10,20–22] In contrast, some studies reported significant increases in PBF immediately after surgery, a phenomenon considered to be an "immediate hypervascular episode."[17,22–24] To date, there is insufficient research into the phenomenon of hypervascularization, with conflicting findings reported by different research. Ramsay et al[7] reported that PBF to at least 1 maxillary incisor increased relative to preoperative values in 11 of the 14 patients; however, for most patients, this increase occurred between 2 and 3 weeks postoperatively. Unfortunately, because that study lacked a separate control group, the findings are not sufficiently strong to characterize the reported increases as hypervascular episodes. Another recent study[17] in which LDF was used to evaluate changes in maxillary incisor blood flow after LF-I osteotomy reported considerable variability in PBF between subjects, with a significant mean increase over baseline at 1 to 2 weeks postoperatively. Contrary to Ramsay et al and Buckley et al, who reported a hypervascular period between the first and third weeks postoperatively,[7,17] the current study found a pulpal hypervascular period to occur between the first and third month after surgery, which is in line with some other studies as well.[13,25] Conflicting results can be seen between the long-term findings of

TABLE 2. PBF Measurements Taken From 4 Tooth Types at Each of the 6 Time Points (*P* < 0.001, Significant Difference)

	T0		T1		T2		T3		T4		T5		Sum	
Tooth Type	**M (SD)**	**Range**	**M (SD)**	**Range**	**M (SD)**	**Range**	**M (SD)**	**Range**	**M (SD)**	**Range**	**M (SD)**	**Range**	**M (SD)**	**Range**
Central incisor, n = 28	9.1 (1.1)	6.9–11.1	7.6 (1.5)	5.1–11.2	7.9 (1.4)	5.4–10.9	8.6 (1.2)	6.5–11	8.7 (1.5)	6.8–11.1	8.7 (1.1)	6.9–11.1	8.4 (1.2)	6.3–11.0
Lateral incisor, n = 28	9.2 (1.1)	7.0–11.1	7.8 (1.6)	5.3–11.0	8.0 (1.5)	5.7–10.9	9.1 (1.1)	6.9–11	8.9 (1.1)	6.5–11.1	8.9 (1.1)	6.6–11.0	8.6 (1.2)	6.3–10.9
Canine, n = 28	8.2 (0.8)	6.7–10.0	6.5 (1.7)	4.1–9.5	6.7 (1.7)	4.2–9.4	7.6 (1.1)	5.5–9.3	7.8 (0.9)	6.1–9.3	7.9 (0.9)	6.2–9.3	7.5 (1.1)	5.6–9.4
First premolar, n = 28	9.1 (1.0)	6.9–11.0	7.1 (1.9)	4.2–10.9	7.4 (1.9)	4.3–11.0	8.3 (1.2)	5.8–11.2	8.6 (1.1)	6.4–11.1	8.7 (1.0)	6.5–11.0	8.2 (1.2)	5.7–11

Comparison between T0 and T3 for lateral incisor was not significant, *P* = 0.067.
M, mean.

© 2014 Mutaz B. Habal, MD

Copyright © 2014 Mutaz B. Habal, MD. Unauthorized reproduction of this article is prohibited.

different studies. Whereas the current study, as well as most earlier studies,[7,8,17] found postsurgery PBF measurements to be significantly lower than presurgery baseline measurements, some studies have reported blood flow to increase above preoperative and/or control levels during the postoperative healing process.[20,24,26] However, those studies were either animal or histologic studies that did not investigate possible mechanisms responsible for the observed increases in PBF; thus, the clinical implications of their findings remain unknown.

Data from the current study indicate that post-LF-I-osteotomy PBF outcomes vary significantly by tooth type. Although significant reductions in PBF occurred in all tooth types at 1 week after surgery, supporting the concept of a direct link between maxillary osteotomy and short-term functional or structural changes to pulpal tissue,[7] at 3 months postoperatively, lateral incisors alone were found to have PBF values that were significantly higher than at 1 month and almost as high as at baseline. This finding may be related to anatomic and functional heterogeneity. Canines and first premolars accounted for the most teeth presenting significant changes in PBF immediately after surgery. Despite that the horizontal LF-I incision was positioned at least 5 mm from the apices of the maxillary canines to minimize vascular compromise, the considerable reduction in canine PBF values observed immediately after surgery could be explained by the close proximity between root apex and horizontal osteotomy.[7,12,27] The initial decrease in PBF values of the first premolars may be due to the location of these teeth adjacent to the vertical cuts of LF-I maxillary osteotomies. This finding is in line with those of other studies reporting teeth adjacent to vertical osteotomy cuts to have lower PBF values than nonadjacent teeth.[12,28–31]

Ramsay et al[7] described a statistically significant long-term reduction in central incisor PBF values in association with LF-I osteotomy in humans. However, their findings of a high variability of blood flow among individuals and periodic ischemia after surgery are contrary to our findings. In our study, postoperative PBF values were lower than preoperative values for all tooth types, and in no instance was an absence of PBF recorded. In addition, contrary to our findings are Emshoff et al's[12] finding that central incisor postoperative PBF values are higher than preoperative values. In another study by Emshoff et al,[11] the authors performed anterior, superior, and posterior osteotomies and then calculated their findings related to PBF and tooth type as the mean for all 3 subtypes. However, both these studies were conducted with only a short-term follow-up and no control group. Moreover, given that superior repositioning and transverse expansion has already been reported to entail a potential risk for vascular impairment,[2,3] the findings of the latter study may be discounted.

Although our data suggest that tooth morphology has a significant effect on PBF, further studies are needed to determine whether additional osteotomy-related factors such as heat generation, compression of adjacent tissue, removal of interdental bone, and soft-tissue flap design should be defined as "prognostic for specific outcomes."

Critique of LDF

Thermal and electric pulp tests are currently the tests most commonly used to obtain information about pulp condition.[32] However, in addition to the unpleasantness and occasional pain involved in patient response to sensory stimulation, the subjectivity of patient response represents a limitation to the diagnostic usefulness of these tests. Another major limitation is that conventional pulp tests rely on indirect monitoring of pulp vitality by measuring neural response, not vascular circulation,[32] which provides a more accurate account of pulp vitality.[3] Tests that rely on nerve response may falsely report lack of pulp vitality in teeth that have temporarily or permanently lost their sensory function, such as teeth undergoing orthodontic treatment, which may disrupt the pulp's sensory response system for up to 9 months.[33] For this reason, this study chose to evaluate pulp status using LDF.

It is possible that the smaller reduction in PBF values registered 1 week postoperatively by the current study (15.8%) in comparison with an early study[25] (43%) is due to the sensitivity limitations of the LDF. The LDF assessment of PBF is known to be highly susceptible to environmental and technical factors. Variables such as flowmeter characteristics,[34,35] gingival isolation device,[36,37] ambient temperature, position of the probe, and patient position and rest status[34,36,38,39] as well as other patient-related factors such as stress, medication, and age-related changes may significantly influence LDF results.[40,41] Although lasers with longer wavelengths give higher flux readings, probably due to their greater penetration through the tooth tissue, the inclusion of non-PBF within the signal may reduce the vital-nonvital signal ratio[35,42]; for this reason, this study used a 632.8-nm laser source rather than a 780- or 810-nm laser. The study also used a custom-made acrylic resin splint to stabilize the probe, maintain it in contact with the tooth, and create a reproducible position for follow-up measurements. To minimize the contribution of the neighboring pulp and gingiva to the flux signal, in conjunction with the splint, cotton rolls were applied between the lip and the teeth, because a rubber dam could not be applied to teeth with brackets.[36] A similar technique has been successfully used in earlier studies.[43–46] Furthermore, to improve the validity of measurements, special care was taken to maintain ambient temperatures and patient-related factors such as position, rest, and stress levels.

CONCLUSIONS

Results of longitudinal LDF readings from 28 patients taken during a 12-month period indicate that PBF decreased in all tooth types after LF-I surgery; however, the effect of LF-I osteotomy on PBF varied by tooth type. At no time was an absence of PBF recorded. Although dramatic reductions were observed in canine and first premolar PBF levels of some patients shortly after LF-I ostetomy and hyperemia was seen in lateral incisors between 1 and 3 months postoperatively, PBF gradually but significantly recovered over time, although not to preoperative levels.

REFERENCES

1. Bell WH, Darab D, You Z. Maxillary and midface deformity. In: Bell WH, ed. *Modern Practice in Orthognathic and Reconstructive Surgery*. Philadelphia: WB Saunders, 1992:2210–2333
2. Epker BN. Vascular considerations in orthognathic surgery. II: maxillary osteotomies. *Oral Surg Oral Med Oral Pathol* 1984;57:467–472
3. Lanigan DT, Hey JH, West RA. Aseptic necrosis following maxillary osteotomies: report of 36 cases. *J Oral Maxillofac Surg* 1990;48:296–300
4. Bell WH, Fonseca RJ, Kenneky JW, et al. Bone healing and revascularization after total maxillary osteotomy. *J Oral Surg* 1975;33:253–260
5. Nelson RL, Path MG, Ogle RG, et al. Quantitation of blood flow after a Le Fort I osteotomy. *J Oral Surg* 1977;35:10–16
6. Gazelius B, Olgart L, Edwall B, et al. Non-invasive recording of blood flow in human dental pulp. *Endod Dent Traumatol* 1986;2:219
7. Ramsay DS, Artun J, Bloomquist D. Orthognathic surgery and pulpal blood flow: a pilot study using laser Doppler flowmetry. *J Oral Maxillofac Surg* 1991;49:564–570
8. Okada Y, Miyazawa M, Nagura H. Pulpal blood flow after Le Fort I type maxillary osteotomy using laser Doppler flowmetry. *J Oral Maxillofac Surg* 1992;50:160

© 2014 Mutaz B. Habal, MD

Copyright © 2014 Mutaz B. Habal, MD. Unauthorized reproduction of this article is prohibited.

9. Dicerbo M. Blood flow determined by laser Doppler flowmetry in orthognathic surgery. *Am J Orthod Dentofacial Orthop* 1993;103:488–489
10. Geylikman YB, Artun J, Leroux BG, et al. Effects of Le Fort I osteotomy on human gingival and pulpal circulation. *Int J Oral Maxillofac Surg* 1995;24:255–260
11. Emshoff R, Kranewitter R, Norer B. Effect of Le Fort I osteotomy on maxillary tooth-type related pulpal blood flow characteristics. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2000;89:88–90
12. Emshoff R, Kranewitter R, Gerhard S, et al. Effect of segmental Le Fort I osteotomy on maxillary tooth-type related pulpal blood flow characteristics. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2000;89:749–752
13. Justus T, Chang BL, Bloomquist D, et al. Human gingival and pulpal blood flow during healing after Le Fort I osteotomy. *J Oral Maxillofac Surg* 2001;59:2–7
14. McDonald F, Pitt Ford TR. Blood flow changes in permanent maxillary canines during retraction. *Eur J Orthod* 1994;16:1–9
15. Tonder KJ. Effect of vasodilating drugs on external carotid and pulpal blood flow in dogs: "stealing" of dental perfusion pressure. *Acta Physiol Scand* 1976;97:75–87
16. Bell WH. Surgical-orthodontic treatment of interincisal diastemas. *Am J Orthod* 1970;57:158–163
17. Buckley JG, Jones ML, Hill M, et al. An evaluation of the changes in maxillary pulpal blood flow associated with orthognathic surgery. *Br J Orthod* 1999;26:39–45
18. Ellingsen RH, Artun J. Pulpal response to orthognathic surgery: a long-term radiographic study. *Am J Orthod Dentofacial Orthop* 1993;103:338
19. Vedtofte P. Pulp canal obliteration after Le Fort I osteotomy. *Endod Dent Traumatol* 1989;5:274
20. Meyer MW, Cavanaugh GD. Blood flow changes after orthognathic surgery: maxillary and mandibular subapical osteotomy. *J Oral Surg* 1976;34:495–501
21. Qeujada JG, Kawamura H, Finn RA, et al. Wound healing associated with segmental total maxillary osteotomy. *J Oral Maxillofac Surg* 1986;44:366–377
22. Sugg GR, Fonseca RJ, Leeb IJ, et al. Early pulp changes after anterior maxillary osteotomy. *J Oral Surg* 1981;39:14–20
23. Ramsay DS, Artun J, Martinen SS. Reliability of pulpal blood flow measurements utilizing laser Doppler flowmetry. *J Dent Res* 1991;70:1427–1430
24. Bell WH. Revascularization and bone healing after anterior maxillary osteotomy: a study using adult rhesus monkeys. *J Oral Surg* 1969;27:249–255
25. Harada K, Sato M, Omura K. Blood-flow and neurosensory changes in the maxillary dental pulp after differing Le Fort I osteotomies. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004;97:12–17
26. Zisser G, Gattinger B. Histologic investigation of pulpal changes following maxillary and mandibular alveolar osteotomies in the dog. *J Oral Maxillofac Surg* 1982;40:332–341
27. Robinson PP. Reinnervation of teeth after segmental osteotomy in the cat. *Int J Oral Maxillofac Surg* 1986;15:152–159
28. Theisen FC, Guerney LH. Postoperative sequelae after anterior segmental osteotomies. *Oral Surg Oral Med Oral Pathol* 1971;41:139–151
29. Pepersack WJ. Tooth vitality after alveolar segmental osteotomy. *J Oral Maxillofac Surg* 1973;1:85–91
30. Vedtofte P, Nattestadt A. Pulp sensibility and pulp necrosis after Le Fort I osteotomy. *J Craniomaxillofac Surg* 1989;17:167–171
31. Bell WH. Immediate surgical repositioning of one and two tooth dento-osseous segments. *Int J Oral Surg* 1973;2:265–272
32. Gopikrishna V, Tinagupta K, Kandaswamy K. Comparison of electrical, thermal and pulse oximetry methods for assessing pulp vitality in recently traumatized teeth. *J Endod* 2007;33:531–535
33. Sailus J, Trowbridge H, Greco M, et al. Sensitivity of teeth subjected to orthodontic forces. *J Dent Res* 1987;66:556
34. Ingolfsson AER, Tronstad L, Riva CE. Reliability of laser Doppler flowmetry in testing vitality of human teeth. *Endod Dent Traumatol* 1994;10:185–187
35. Odor TM, Pitt Ford TR, McDonald F. Effect of wavelength and bandwidth on the clinical reliability of laser Doppler recordings. *Endod Dent Traumatol* 1996a;12:9–15
36. Hartmann A, Azerad J, Boucher Y. Environmental effects on laser Doppler pulpal blood-flow measurements in man. *Arch Oral Biol* 1996;41:333–339
37. Soo-ampon S, Vongsavan N, Soo-ampon M, et al. The sources of laser Doppler blood-flow signals recorded from human teeth. *Arch Oral Biol* 2003;48:353–360
38. Akpinar KE, Er K, Polat S, et al. Effect of gingiva on laser Doppler pulpal blood flow measurements. *J Endod* 2004;30:138–140
39. Odor TM, Watson TF, Pitt Ford TR, et al. Pattern of transmission of laser light in teeth. *Int Endod J* 1996b;29:228–234
40. Okabe E, Todoki K, Ito H. Direct pharmacological action of vasoactive substances on pulpal blood flow: an analysis and critique. *J Endod* 1989;15:473–477
41. Ikawa M, Komatsu H, Ikawa K, et al. Age-related changes in the human pulpal blood flow measured by laser Doppler flowmetry. *Dent Traumatol* 2003;19:36–40
42. Vongsavan N, Matthews B. Experiments on extracted teeth into the validity of using laser Doppler techniques for recording pulpal blood flow. *Arch Oral Biol* 1993;38:431–439
43. Anderson KK, Vanarsdall RL, Kim S. Measurement of pulpal blood flow in humans using laser Doppler flowmetry: a technique allowing stability and repeatability of pulpal blood flow measurement during surgical manipulations. *Int J Adult Orthod Orthognat Surg* 1995;10:247–254
44. Ingle JI, Heithersay GS, Hartwell GR. Endodontic diagnostic procedures. In: Ingle JI, Bakland LK, eds. *Endodontics, 5th edition*. London, UK: BC Decker Inc, 2002:203–217
45. Olgart LM, Edwall B, Gazelius B. Neurogenic mediators in control of pulpal blood flow. *J Endod* 1989;15:409–412
46. Matthews B, Vongsavan N. Advantages and limitations of laser Doppler flow meters. *Int Endod J* 1993;26:9–10

Malignant Peripheral Nerve Sheath Tumor of the Parotid Gland

Octavian Chis, MD, Silviu Albu, MD†*

Abstract: Malignant peripheral nerve sheath tumor (MPNST) refers to spindle cell sarcomas arising from or separating in the direction of cells of the peripheral nerve sheath. The MPNST of the parotid gland is an extremely rare tumor, usually having a poor prognosis, and only a few cases been described in the literature. In this article, we report the diagnostic and therapeutic challenges related to a new case of MPNST of the parotid. Diagnosis was made

From the *Oncology Institute "N. Chiricuta;" and †II-nd Department of Otolaryngology, "Iuliu Hatieganu" University of Medicine and Pharmacy Cluj-Napoca, Cluj-Napoca, Romania.
Received December 9, 2013.
Accepted for publication February 17, 2014.
Address correspondence and reprint requests to Silviu Albu, MD, II-nd Department of Otolaryngology, University of Medicine and Pharmacy Cluj-Napoca, Str. Republicii nr. 18, 400015 Cluj-Napoca, Romania; E-mail: silviualbu63@gmail.com
The authors report no conflicts of interest.
Copyright © 2014 by Mutaz B. Habal, MD
ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000000938

© 2014 Mutaz B. Habal, MD

Copyright © 2014 Mutaz B. Habal, MD. Unauthorized reproduction of this article is prohibited.