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Assessment of Patient Perception, Healing Outcomes and Gained Vestibular Depth of Er: Yag Laser Versus Conventional Surgical Mandibular Vestibuloplasty

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Abstract **Background:** Insufficient sulcular depth dramatically affects denture retention and stability. Preprosthetic sulcular deepening could be carried out either with lasers, conventional surgeries or, electrocautery to afford the required sulcular length. **Purpose:** compare pain, discomfort, wound healing results and gained vestibular depth of Er: YAG laser and the conventional surgical vestibuloplasty techniques. **Materials and Methods:** 18 patients who suffered from severely atrophic mandibular ridge were randomly allocated to go through vestibuloplasty either by laser (L) or conventional surgery (S). Visual analysis scale (VAS) of pain and discomfort used to assess pain and discomfort along the 1st. 3rd. 7th. days and three pointer scale for healing to assess healing process at the 1st. 3rd. 7th. and 21st. day. The gained vestibular depth was measured immediately after surgery, one month, 3 and six months postoperatively. The obtained data were investigated for intergroup and intragroup comparison using an independent t-test and a student paired t-test and Friedman tests. **Results**: VAS scores of pain and discomfort within the laser group in the 1st, 3rd and the 7th days exhibited a significant difference ($p<0.05$). Laser group patients exhibit lower pain and discomfort scores in comparison with conventional surgical patients. The 1st, 3rd and the 7th days results of the 3-pointer scale exposed better wound healing scores in the laser group compared to the conventional surgical group. The gained ridge height of the mandible in laser group was more stable without rebound on the 1st. 3rd. and 6th. months compared to the conventional surgical group. **Conclusion:** Er: Yag laser vestibuloplasty has better patient's perception, healing outcomes and improvement of the vestibular depth than conventional surgical vestibuloplasty.

Keywords: *conventional surgical vestibuloplasty, laser, preprosthetic surgery*

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1. Introduction

The ideal denture-supporting ridge should fulfill certain criteria such as, adequate bone support covered by adequate soft tissue without any undercut or overhanging protuberances or sharp ridges. It should have satisfactory buccal and lingual sulci without muscle fibers or scars or freni that may interfere with the periphery of the prosthesis. No soft tissue folds or hypertrophies on the ridge or sulci. Acceptable ridge relationships between the maxilla and mandible should exist [1].

Residual ridge resorption is a difficult physiological multifactorial process that occurs in a very rapid rate during the first year after teeth extraction then it becomes slower but more progressive [2]. Well fitted dentures decrease ridge atrophy through functional loading while ill fitted dentures will increase the rate of ridge resorption [3].

Denture stability and retention may be dramatically affected by severe ridge atrophy [4,5]. Ulceration and pain may occur because the thin mucosa covering the denture-bearing areas is unable to bear functional stresses. The negative effects of ridge atrophy on oral health related quality of life, and the masticatory function have been explained in several studies which revealed impaired masticatory function in complete denture patients due to sever ridge atrophy [4,5,6].

To overcome the sequels of ridge resorption, several approaches had been described such as different

techniques of vestibuloplasty, ridge augmentation, and endosseous implants [7]. One method to improve denture stability is to increase the depth of the sulcus without any bone addition [8,9].

Conventional surgical techniques aim to increase vestibular length are surgical procedures to modify the relationships and level of gingival-mucous membrane, position of the muscle attachments and freni and hence deepening of the vestibule [10]. Multiple techniques have been described such as Clark's, Kazanjian, Edlanplasty techniques, etc [11,12,13,14].

Clark's surgical method is one of the most accepted and successful techniques in improving the sulcular depth. Other Surgical Vestibuloplasty procedures have the drawbacks of loss of about 50% of the added alveolar ridge length as a consequence of scar contraction. The patient criticizes pain and discomfort due to the open wound. In addition, patients have to return to the Prosthodontic clinics to take care of pressure sores because of scar contraction. If the patient didn't wear the relined denture, the result will be a situation like the pretreatment one [15].

By using laser technology more stable results, without the disadvantages of the traditional technique can be accomplished. CO_2 laser have been applied as a surgical modality for accurate cutting and coagulation of oral soft tissues [16-19]. To decrease undesired thermal damage to adjacent tissues and bone, the older pulsed or continuous wave CO2 lasers should be applied very quickly [16,18]. The Er: YAG laser uses an erbium source. It is a solid-state laser and its active means is an yttrium-aluminum-garnet crystal, doped with erbium, which has a 2.940 nm wavelength. This wavelength has a great affinity with water and hydroxyapatite: this means that is able to perform a strong photoablation on enamel, dentin and bone. Its high light radiation absorption peak, both on hard and soft tissues, defines an excellent ablation and minimal thermal effects. The erbium laser doesn't have the same diode's laser coagulation ability, but it is possible to get a good homeostasis on soft tissues by lowering the power (usually 1W), while drastically reducing (or setting to zero, in some cases) air and water percentages. The high peak level affinity with the hydroxyapatite allows a very precise micrometric cut on the bone tissue. The erbium YAG laser is a very performing choice if compared with the usual rotating instruments. The photobiology characteristics of Er: YAG laser enable it to do soft tissue surgeries with the advantages of decreased thermal damage and increased working time [20]. The healing process after Er: YAG laser surgical procedure is faster, without thermal damages and necrosis [21]. The general practitioners with the addition of the Er: YAG laser, can perform less traumatic and more valuable soft-tissue excisional procedures than formerly offered with CO2 lasers [22].

The aim of this study was to compare patient perceptions, healing outcomes and gained vestibular depth of Er: YAG laser and the conventional surgical vestibuloplasty.

2. Materials and Methods

18 completely edentulous (9 females, 9 males) patients, who required ridge deepening to improve the stability and retention of their mandibular removable dentures, were selected from the outpatient Prosthodontic department in the faculty of dentistry, Taif University. The age range of patients was 51-67 years with an average age of 59 years. The patients were randomly distributed to either the conventional surgical (S) group or laser (L) group. Clinical and radiographic examination had been done. Patients were informed about different steps of each surgical procedure, risks, and expected postoperative discomforts. Each operation was achieved after signed informed consent. Inclusion criteria for Patients selected in this study were that who received full lower denture from for at least six months and complained from poor denture retention and stability and suffering from severe ridge atrophy (Figure 1). Exclusion criteria were those patients with systemic diseases (e.g. autoimmune disorders, diabetes etc.) which affect wound healing; smokers, and patients with poor oral hygiene.

The study was planned and performed at the specialty clinics of Prosthodontic Department, Faculty of Dentistry, Taif University from October 2014 to March 2015 in accordance with Declaration of Helsinki and approved by the Research and Ethics Committees in Faculty of Dentistry, Taif University.

Figure 1. Patients with inadequate vestibular depth

2.1. Surgical Procedure

2.1.1. Clark's Vestibuloplasty

At first we recorded the sulcular length and measurements of attached gingiva. Bilateral mental nerve block was done by 2% Mepivacaine HCl and Levonordefrin 1: 20,000[1]. Then, with a scalpel blade no. 15, a horizontal incision started at the mucogingival junction and extended with sharp dissection cutting supraperiosteal muscle fibers (Figure 2) and the edges of the mucosal flap was sutured at the depth of the vestibule. Any soft tissue attachments or residual muscle fibers were removed from the periosteal surface. Then the operation field was irrigated by saline and bleeding was evaluated before discharging the patient. The old lower denture lined with a periodontal pack[2] was used and extended into the newly formed

[1] (Scandonest® 2% L), Septodont, Lancaster, PA, USA.
[2] (Coe-Pak®), GC Europe, Leuven, Belgium.

vestibule then the denture was relined in mouth by a soft acrylic resin material[3]. Patients were instructed strictly to wear their temporary relined denture for at least 6 weeks after surgery and not to remove it except for hygienic purposes. Augmentin 1gm 2 times per day was prescribed for one week along with Cataflam 50 mg as analgesic three times a day with chlorhexidine 0.2% mouthwash solution. Suture removal was done after 10 days.

Figure 2. Clark's Vestibuloplasty

2.1.2. Laser-Assisted Vestibuloplasty

The clinician and the patients took the necessary laser protective precautions including safety glasses. Bilateral mental nerve block was done by 2% Mepivacaine HCl and Levonordefrin 1: 20,000. The laser apparatus used was an Er: YAG laser[4] (Figure 3). By using 600 micron tip, contact mode, power of 2.5 W, Frequency of 50 Hz, 15% water and 80% air according to the manufacture manual, an incision was carried out at the mucco-gingival junction (Figure 4). Er: YAG laser incision was cautiously started from the margin of attached mucosa of the ridge and ended 2 mm from bottom of the vestibule to avoid any future pain or discomfort caused by severe contact between denture flanges and the bone of the vestibule. Occasionally, a very large area from the retromolar area to the other was incised. After supraperiostal incision, the prepared area was immobile without sutures (Figure 5). Low level laser therapy [LLLT] was applied over the surgical site after completion of laser vestibuloplasty. The old lower denture lined with a periodontal pack was used and extended into the newly formed vestibule then the denture was relined in mouth (Figure 6) by a soft acrylic resin material. Patients were instructed strictly to wear their temporary relined denture for at least 6 weeks after surgery and not to remove it except for hygienic purposes. The vestibular depth was measured at the end of each surgery, by digital calipers[5] with an accuracy of 0.01 mm. The wounds healed in second intention without sutures or grafts. Vestibuloplasty aimed to remove muscles' attachments to increase ridge height. Medication such as antibiotics, non-steroid anti-inflammatory, analgesics, and 0.2% chlorhexidine mouth wash were prescribed for one week.

Figure 3. Pluser ErYag Doctor Smile Dental Laser

Figure 4. Anterior laser-incision

Figure 5. Immediately after laser-mandibular-vestibular

Figure 6. Intraoral relining in to the new vestibular depth by a soft acrylic resin material

[3] (Silagum, automix comfort soft relining), DMG Chemisch-Pharmazeutische Fabrik GmbH, Hamburg, Germany.
[4] (Pluser Er: Yag Doctor Smile Dental Laser), Lambda, Spa, Italy.
[5] (Caliper digital IP 67 300 mm), Digital Micrometers Ltd, Sheffield ,UK.

Figure 7. A white fibrin layer appeared at 2-week-post laser-mandibular-vestibuloplasty

2.2. Evaluation

2.2.1. Wound Healing

Three examiners of different specialties utilized the three point scale described by Amorim et al for scoring the wound healing at the 1st, 3rd, 7th.and 21st day after surgery [23]. Score (+1): represented superior healing of laser-treated wounds over the conventional surgical wounds, Score (0): represented same degree of healing between laser and conventional surgical wounds and Score (-1): represented that healing of conventional surgical wounds was superior to the laser-treated wounds.

2.2.2. Pain and Discomfort

Pain and Discomfort after the completion of both techniques were evaluated using a Visual Analog Scale (VAS) which consisted of a 100 mm scale with (0) score on the left side representing "no pain" and (100) score on the right side indicating "A lot" of pain. Patients were educated to record Scores (1-30): when there were a slight pain, Scores (31-60): if moderate pain was present and Scores (61-100) when they suffered from severe pain [24].

Disabilities or problems related to ordinary functions such as chewing and talking were evaluated using VAS scores for discomfort similar to the VAS scale for pain representing (0) score on the left side indicating "no discomfort" and (100) score on the right side indicating "A lot" of Discomfort".

The Patients in the two groups were educated to score their response on both scales on the 1st, 3rd and the 7th days postoperatively.

2.2.3. Vestibular Depth

The sulcular depth was measured and recorded, by different investigator that was blinded to the treatment, at three different sites: one at the midline; and two each distal end of the operation and the average was set as the 'Baseline sulcular depth". The sulcular depth was again measured after 1, 3 and 6 months. 'Relapse' was defined as the difference between the baseline vestibule depth and the vestibule depth at these intervals.

The obtained data were analyzed using SPSS version (16.0)[6]. An independent t-test was used to compare results within each group whereas a paired t-test and Friedman tests were used to compare the results of the laser group and that of the conventional surgical group for pain, discomfort at the 1st, 3rd, and 7th day postoperatively and the results of the vestibular depth and relapse at 1, 3 and 6 months after operations. The results were judged significant at $p < 0.05$

[6] SPSS, IBM INC., Chicago Illinois, USA

3. Results

3.1. Wound Healing

The three examiners scored '+1' on the three point scale of wound healing at the 1st, 3rd and 7th days postoperatively however at the 21st day postoperatively, they scored '0' demonstrating that the laser vestibuloplasty had a superior healing results in the first seven days then both groups showed similar healing pattern on the 21st day.

During the postoperative period the patient experienced Pain, edema, and swelling. Complete healing of wounds with a normal tissue reached after 4 weeks in some cases. Throughout the recovery time, the wounds appeared as a white or grey fibrin layer (Figure 7). Patients were advised not to construct a new removable denture or a permanent relining before 10 weeks even though the operated area healed at second or fourth weeks. The operated areas represented an excellent healing quality without scar formation. Er: YAG Vestibuloplasty took about 8 to 12 minutes.

3.2. Patient Perceptions

Table 1 summarized the demographic data regarding patient's age and gender.

Table 1. Demographic data for both groups

Variable	S	L	p-value
M/F	5/4	4/5	NS
Age (Years)	60 ± 4.14	58.56 ± 4.88	NS
Age range(Years)	53-67	51-65	N/A

S: Surgical Group.
L; Laser Group
NS: Non Significant.
N/A: Non Applicable

Table 2 represented the VAS scores of pain and discomfort within the conventional surgical (S) group. The results of the 3rd day were not significant when compared with those on the 1st day. On the other hand, a highly significant difference was found ($p<0.05$) when the VAS scores of the 7th day were compared with those of the 3rd and the 1st day.

Table 3 represented the VAS scores of pain and discomfort within the laser (L) group. A highly significant differences ($p<0.05$) were recognized between the VAS scores of pain and discomfort on the 1st, 3rd and the 7th day postoperatively.

Table 4 represented the mean VAS scores of pain and discomfort, for both laser and conventional surgical groups, observed on the 1st, 3rd and the 7th day of the study with the laser group showed lower VAS scores than those of the conventional surgical group. This differences were statically significant at ($P <0.05$).

3.3. Vestibular Depth

Table 5 showed the vestibular depth in the Laser Group and Conventional Surgical Group at one, three and six months postoperatively. The values in the congenital surgery group were considerably lesser than that of Laser Group ($P < 0.05$). The difference in relapse between the two Groups was not statistically significant at one month, three and six months postoperatively (Table 6). In both techniques the vestibular depth at the first month was significantly higher than that of the 3rd, and 6th months postoperatively. The average relapse after six months was higher than that of the 1st and 3rd months. After six months, the tissues resulting appeared as non-keratinized and fixed to the underling bony bed in both laser and surgical techniques (Figure 8, Figure 9).

Table 2. VAS scores of pain and discomfort in the conventional surgical (S) group

Conventional Surgical (S) Group						
Interval	**Pain**	**Comparison**	**p-value**	**Discomfort**	**Comparison**	**p-value**
1st. day	87.6 ± 4.24	1st. day versus 3rd.day	0.107	84.6 ± 3.95	1st. day versus 3rd.day	0.109
3rd. day	79.11± 4.46	3rd. day versus 7th. day	0.0017*	76.1± 4.21	3rd. day versus 7th. day	0.0013*
7th. day	72.88 ± 4.35	1st. day versus 7th. day	0.0014*	69.88 ± 4.10	1st. day versus 7th. day	0.0011*

* The p-value was set as significant at p<0.05. (S): surgical Group

Table 3. VAS scores of pain and discomfort in laser group

Laser(L) Group						
Interval	**Pain**	**Comparison**	**p-value**	**Discomfort**	**Comparison**	**p-value**
1st. day	75.7 ± 3.72	1st. day versus 3rd.day	0.0016*	72.79 ± 3.39	1st. day versus 3rd.day	0.0012*
3rd. day	67.8 ± 3.24	3rd. day versus 7th. day	0.0014*	64.78 ± 3.05	3rd. day versus 7th. day	0.009*
7th. day	58.8 ± 3.47	1st. day versus 7th. day	0.008*	55.64 ± 3.09	1st. day versus 7th. day	0.006*

* The p-value was set as significant at p<0.05 significant. (L): laser Group.

Table 4. Intergroup comparison of VAS scores of pain & discomfort

Interval	**pain**			**Discomfort**		
	Conventional surgical	**Laser**	**p-value**	**Conventional surgical**	**Laser**	**p-value**
1st. day	87.64 ± 4.24	72.79 ± 3.39	0.0019*	84.6 ± 3.95	72.79 ± 3.39	0.0014*
3rd. day	79.11 ± 4.46	64.78 ± 3.05	0.0024*	76.1 ± 4.21	64.78 ± 3.05	0.0011*
7th. day	72.88 ± 4.35	55.64 ± 3.09	0.0015*	69.88 ± 4.10	55.64 ± 3.09	0.009*

* P-value was set as significant at p<0.05 significant.

Table 5. Mean vestibule depth in (mm) and standard deviation (SD).

Interval	**(S) Group**	**(L) Group**	**Mean difference ± (SD)**	**P value**
Immediately after surgery	10.46 ± 0.55	10.78 ± 0.90	-0.32 ± 0.23	0.007*
1 month postoperatively	9.53 ± 0.49	10.37 ± 0.96	-0.84 ± 0.59	0.0012*
3 months postoperatively	7.68 ± 0.48	9.91 ± 0.87	-2.24 ± 1.58	0.0017*
6 months postoperatively	6.66 ± 0.49	9.51 ± 0.86	-2.86 ± 1.30	0.0019*

* P-value was set as significant at p<0.05 significant.

Table 6. Mean relapse in (mm) and standard deviation (SD)

Interval	**(S) Group**	**(L) Group**	**Mean difference ± (SD)**	**P value**
1 month postoperatively	0.93 ± 0.61	0.41 ± 0.08	0.52 ± 0.36	0.1(NS)
3 months postoperatively	2.78 ± 0.51	0.87 ± 0.12	1.91 ± 1.35	0.15(NS)
6 months postoperatively	3.81 ± 0.34	1.27 ± 0.20	2.53 ± 1.79	0.06(NS)

* P-value was set as significant at p<0.05 significant. N/S: Non Significant. (S) Group: conventional surgical group. (L) Group: laser group.

Figure 8. Six months after conventional surgical vestibuloplasty

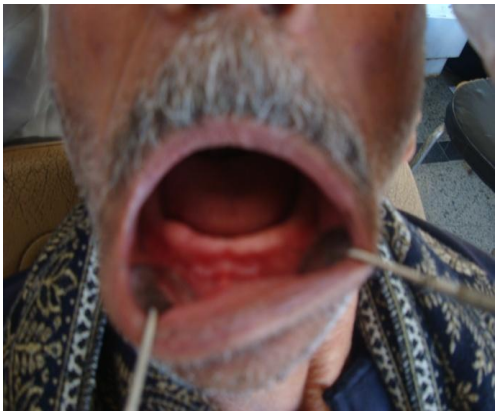

Figure 9. Six months after laser vestibuloplasty

4. Discussion

Dental lasers had been approved by the FDA. Among all commercially available dental lasers, Er: YAG laser produces wave length at 2940 nm in the mid-infrared electromagnetic spectrum and has the highest absorption peak in water which permit Er: YAG laser to carry out thermal mechanical tissue ablation with the least collateral thermal hazards [21].

Er: YAG laser (Pluser Er: Yag Doctor Smile Dental Laser) were used to deepen the mandibular vestibule. Two essential concepts should be taken into consideration namely the thermal expansion and heat transfer through conduction. The photobiology of this wavelength (2.940 nm) is unique and has distinct benefits for the practitioners.

Kazanjian, Clark's, Corn's and Edlanplasty vestibuloplasty techniques are well known surgical methods to increase the sulcular depth with reliable degree of success. On the other hand they have the disadvantages of the limited degree of manipulation, the need to suture the wound, subsequent postoperative discomfort, swelling, pain, decreased patient satisfaction and failure of the procedure [11,12,13,14]. Furthermore, in the Clark's vestibuloplasty procedure the exposed periosteum heals by secondary epithelialization retarding healing [11]. The application of a free gingival graft can improve and speed the healing process; but it has the drawbacks of having a second surgical site.

Unlike surgical techniques, Lasers had the advantages of minimal amount of local anaesthesia, high accuracy in cutting, less time, better inspection of the wound site and valuable hemostasis and decrease the necessity of suturing [25,26]. The penetration depth of Er: YAG lasers is 2mm allows sealing of the small lymphatic vessels decreasing postoperative edema, bleeding, pain and discomfort [27]. Furthermore, Lasers have bactericidal effect and thus create asepsis in the wound site [28]. Laser also improves wound healing through the formation of a layer of protein coagulum that shields the surgical site from microorganisms and friction from masticatory forces [29]. Laser increases vestibular depth as a result of decreased tissue rebound in comparison with the conventional surgical group [30].

The findings of this study exposed that less scars were formed in the laser group than the conventional surgical group. This was in agreement with the studies of Nammour et al., and Zeinoun et al [30,31].

The decreased VAS scores of pain and discomfort in the laser group in contrast to the conventional surgical group was explained as Low level laser therapy [LLLT] stimulates the induction of natural pain killers, p-endorphins and so decreases pain [32].

The findings of this study were parallel to the conclusions of Amid et al, Moghtader et al, Demir et al., and Neckel et al who had recommended the utilization of laser for superior postoperative healing outcomes over the conventional surgical procedures [15,33,34,35].

Gender comparison of VAS scores for pain and discomfort revealed that there was no significant correlation between VAS scores and the gender which was in conflict with the findings of Kelly et al., which revealed that the VAS scores for pain were influenced by the age and the gender [36].

5. Conclusion

Lasers are considered safe and good alternate option to conventional surgical procedures as they have better patient's perceptions of pain and discomfort and superior wound healing with successful enhancement of the patient's vestibular depth.. However, further researches with larger sample size and protocol are needed.

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