

Article

A Modified Approach for the Treatment of Molars with Advanced Furcation Involvements (Sandwich's Technique) - (III) Combined use of TPP, SRP, RSR and CSCTD

Guey-Lin Hou^{1,2}

¹ Former professor and Chairman, Periodontal-Prosthetic Therapeutic Center & Periodontal Dept, Chang Gung Memorial Hospital, Kaohsiung Medical Center, Taiwan

² Former professor, Graduate Institute of Dental Sciences and Department of Periodontology, School of Dental Medicine, Kaohsiung Medical University, Taiwan

* Correspondence: Guey-Lin Hou (hougl2001@yahoo.com.tw)

Abstract: The purpose of this study was to assess different periodontitis groups affected with mild, moderate and severe alveolar bone levels and treated using the Sandwich's procedures. A total of 53 subjects, who had taken two sets of full-mouth standardized paralleling radiographs with mean observation time was 10.18 ± 3.89 years and (ranges: 5.1 to 18.3 years) were collected for the past 20 years. The radiographic alveolar bone levels (RABL) at mesial and distal aspects of teeth were assessed by measuring the distance between cemento-enamel junction (CEJ) and the bone crest using an electronic digimatic caliper (EDC) under 7.5 magnified radiographs. The patients, who presented with SAP, were between 24 and 84 years of age, with a mean age of 54.8 ± 10.2 years. Although, the treatment of angular defects in molars with guided tissue regeneration, emdogain has been reported and has exhibited significant and predictable results, however, afforded very limited and less predictable results in the treatment of advanced class II and III maxillary furcation defects. The majority of root resection procedures are commonly recommended for treating advanced molar furcation, in particular located at molars with class III furcation involvement, there is still some controversy regarding the long-term prognosis after different treatment modalities. In general, the root resection procedure is a surgical approach for simultaneously performing a periodontal flap operation at first and followed by the amputation and/or resection of maxillary root(s). There are some complications and disadvantages, such as post-operative pain and bleeding, swelling, infection, etc. The present report is to describe the combination of therapeutic provisional prosthesis (TPP), fixed prosthesis, non-surgical procedure using root separation and/or resection (RSR) and for the treatment of advanced Class II and III furcation-involved molars. In addition, evidenced-based clinical trials of retrospective and longitudinal data were also prescribed here. The purpose of this study was to present treatment procedures of Sandwich's technique and retrospectively to evaluate the long-term clinical trials of this method in treating molar teeth with SAP and molar FI who were diagnosed as guarded and/or hopeless prognosis.

Keywords: Molar FI, TPP, SRP, RSR and CSCTD

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1. Introduction

The longitudinal observations of the various studies have evaluated the different treatment modalities of molars with advanced furcation involvement using scaling and root planning (SRP), traditional flap operation with and/or without bone grafts, root resection techniques, regeneration therapy with and without guide tissue regeneration (GTR), obturation therapy with bio-adhesive materials, and growth factor's therapy.

However, each of their reports exhibits some great discrepancies for the long-term evaluation of subsequent complications, which are susceptible to failure and eventually requiring extraction.

Although, root resection procedures are most commonly recommended for treating advanced molar furcation involvement, in particular located at molars with inaccessible furcations, some previous reports have met with limited degree of success. Therefore, there is still some controversy regarding the results among different investigators who evaluated the long-term prognosis after different treatment modalities [1-8]. The majority of the discrepancies center around the complications, such as root caries, root fracture, recurrent invasion of FI, incomplete personal and/or professional plaque control over the residual root concavity [7], narrow furcation entrance dimension [9-11], long root trunk [12-14].

Müller and Eger [1] documented that about 44% of molars with Class III furcation involvement were extracted after periodontal surgery, irrespective of recall visits and subgingival scaling. They also concluded that the decision for selecting a treatment modality appears to depend on the degree of molar as well as tooth type. In addition, Muller and Eger reported that among a total of 1134 furcation lesions, only 15.9% (180 lesions) were conceivably suitable for GTR procedure based on their retrospective study [1]. Although, the treatment of angular defects in molars with using GTR has been reported and has exhibited significant and predictable results at the mandibular molars with Class II FI [18-23]; it has, however, afforded very limited and less predictable results in the treatment of maxillary Classes II and III furcation defects [24-27].

In monitoring the fact that it seems to be impossible to effectively and predictably remove mechanically all bacterial deposits from advanced furcation-involved molars with furcation entrance dimension (FED) less than 0.75 mm. It suggested that there appears to be little or no procedure that provides any predictable results except employing the root separation and/or resection (RSR) procedure. A recent longitudinal study on the treatment of advanced molar FIs, that employing the CSCTD as the periodontal prosthesis, confirmed the fact that a remarkable improvement in periodontal parameters has been documented in molars with root separation/resection (RSR) as compared to those without RSR [6-11]. This study strongly suggested that the use of periodontal prosthetic design with RSR and CSCTD appears to be suitable for treatment of molars with advanced FI with anatomical problems, such as narrow FED and long root trunk, related to high risk of periodontally-diseased molars.

Based on the conclusions indicated by most of researchers, the success rate of treatment modalities seems to depend essentially on the class of molar FI and root morphology, irrespective of the operator's skill, and severity of the periodontal disease [1, 6-8, 19, 23, 25]. Therefore, complete successful treatment was directed and evaluated by how well the clinician reaches sufficient access to facilitate patient plaque control efforts. In addition, long-term success is predicted on tooth function and arresting further periodontal destruction over the furcation areas. Leon and Vogel found that ultrasonic debridement was more effective than hand scaling in Classes II and III FIs at reducing spirochetes and motile rods [23]. They speculated that curettes (width of working ends between 0.75 mm ~1.1 mm) did not negotiate the furcal roof as well as ultrasonic tips (width means = 0.56 mm). In addition, some other studies also suggested roof size discrepancy of FED less than 0.75 mm could preclude effective debridement [14-18].

In order to resolve furcation-involved problems resulted from morphologic complications, the complete removal of molars with periodontally bi-furcal and tri-furcal involved areas is necessary for establishing a plaque-free environment using a professional plaque control procedures, such as surgical root amputation and/or root resection. Surgical root resection procedure is a combined technique of root separation and/or resection (RSR) and following the flap operation.

Provisional crown has been recommended as a therapeutic provisional prosthesis (TPP) in the treatment of advanced periodontitis with guarded prognosis [6, 24]. The present article is one of extension of our serial study on the field of periodontal prosthetic therapy for the treatment of individuals with severely advanced periodontitis (SAP, alveolar bone loss > 60 %) using the combined procedures of TPP, SRP, and CSCTD. In addition, an additional procedure entitled non-surgical RSR was incorporated into the combination of TPP, NSPT, and CSCTD when patients affected SAP and molars with inaccessible and advanced furcation lesions [6-8, 26].

The purpose of this study was to evaluate the treatment periodontal bone fills or loss affected molar FI using the Sandwich's technique and retrospectively to evaluate the long-term clinical trials of this method in treating teeth, with SAP, who were diagnosed as guarded and/or hopeless prognosis.

2. Materials and Methods

2.1. Samples

The present study was based on retrospectively pooling data of a total of 217 teeth in 26 patients treated, using ultrasonic scaling and root planning alone, by the experienced periodontists, during 1981 through 2002. The patients, who presented with SAP and secondary occlusal traumatism, were between 24 and 84 years of age, with a mean age of 54.8 ± 10.2 years. A total of 38 CSCTD (21 maxillary; 17 mandibular) were fabricated; the mean observation time was 10.18 ± 3.89 years and 9.21 ± 3.79 years (range: 5.1 to 18.3 years), respectively.

2.2. Therapy

Figure 1 indicated the treatment flowchart of Sandwich's technique on the both non-molar with SAP and SOT and molar with Classes II and III furcation involvements. Initial therapy included supragingival and as far as possible, subgingival scaling and root planning were meticulously performed, by periodontists, in a series of bi-weekly sessions for 3 months. Periodically supportive therapy was scheduled individually, depending on residual probing pocket depth, anatomic-related and general risk factors [25]. Majority of patients were recalled in 1- to 3-month intervals for maintenance therapy at sites with a probing ≥ 5 mm, exudates and bleeding on probing as well as over the abutments of CSCTD.

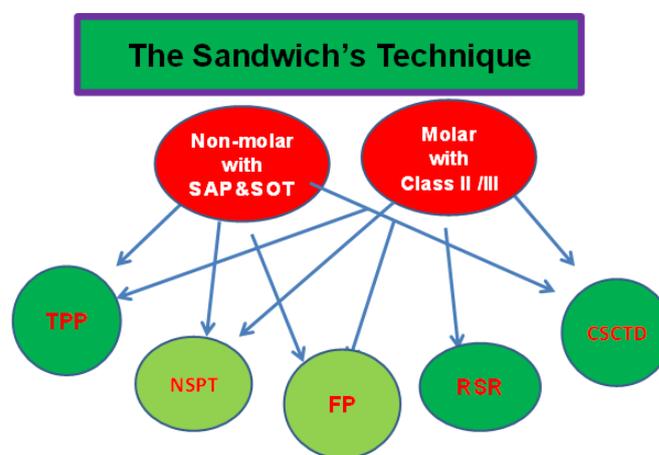


Figure 1. Indicated the treatment flowchart of Sandwich's technique on the both non-molar with SAP and SOT and molar with Classes II and III furcation involvements (Abbreviation: TPP: therapeutic provisional prosthesis; SRP: scaling and root planning; RSR: root separation and resection; molar FI: molar furcation involvement; CSCTD: crown and sleeve-coping telescopic denture).

Ultrasonic scaling and root planning were performed at sites with persisting PPD \geq 5 mm, exudates and bleeding on probing. Teeth and molar FI lesions were treated with following procedures:

1. TPPs were fabricated for splinting the teeth, which involving hypermobility, teeth with less bone support, pathological migration, pus discharge, impaired occlusal function, and with SAP* and secondary occlusal traumatism.
2. Ultrasonic scaling and root planning were performed by periodontists, in a series of bi-weekly sessions for 3 months and recalled in 1- to 3-month intervals for maintenance therapy throughout the end of study.
3. Root separation and/or resection (RSR) were performed, non-surgically, if molars affected with advanced class II and III furcation involvements.
4. Crown and sleeve-coping telescopic dentures (CSCTD) were fabricated 9-12 months following a series of TPP, NSPT, and RSR procedures.
5. Routine periapical radiographs were taken on the delivery day and in one- to two-year intervals and through the end of study.

2.3. Measurements

For multi-rooted molars, molar FIs were assessed according to the method described by Hamp et al. ² with a curved Naber's probe (PQ 2N, Hu Friedy) or liquid (chlorhexidine gluconate 0.12%) irrigation test through furcation entrances, if necessary. The cervical margin of TPP-resin stent and inner crown of the CSCTD, as reference marks, at each abutment, were measured and were subsequently used for standardized angulation of the X-ray beam in each radiographic examination during the entire observation period.

2.4. Oral Hygiene Program

All patients were received oral hygiene instruction at initial 3 months as well as continuous reinforced personal plaque control were performed at home care. A meticulously professional plaque control procedures included subgingival scaling and root planning, administered every 1-3 months to ensure maximal healing.

Flowing chart of treatment procedure using the TPP, NSPT and CSCTD:

1. The TPP was placed following baseline data of periodontal parameters including GI, PII, CAL, PPD, teeth mobility, and periapical radiographs.
2. Reconstruction of molars with loss of vertical dimension and/or posterior bite collapse and pathological migration of hypermobile teeth with secondary trauma from occlusion.
3. Subgingival ultrasonic scaling and thorough planning of root surface.
4. Routine oral prophylaxis by personal plaque control at home care, including reinforced OHI, inter-proximal brushing, and dental flossing, and twice-daily rinses with chlorhexidine gluconate (0.12%) for 8 weeks. Patients initially were recalled for professional plaque control including thorough subgingival scaling and root planning, by periodontist, weekly or bi-weekly for 3 months at least.
5. Following above procedures, patients were seen 1- to 3-month intervals for maintenance therapy throughout the end of study.

3. Results

Table 1 showed that the baseline and the end of study using the Sandwich's technique therapy to treat long-term radiographic alveolar bone levels (RABL) (% and mm) on the both maxillary first (#16), second (#17) molars and mandibular first (#36.) and second (#37/) molars affected with Classes II and III molar FI for 5-14 years with a mean (SD) of 9.23 \pm 3.75 years. The RABLs (%) of maxillary first molars (#16) was 46.6 \pm 12.4% before periodontal and prosthetic therapies using the Sandwich's technique therapy. The RABL (%) was 62.2 \pm 16.6% after Sandwich's technique therapy. The bone fills (%) was 12.1 \pm 14.7%, 15.5 \pm 13.4% and equal to +1.2 \pm 1.6 mm and

+1.8±1.6 mm bone fills (mm) at both maxillary first and second molars, respectively. Result indicated that the RABL(%) and bone fills (mm) at both maxillary first and second molars were significant ($p<0.05$) and remarkable ($p<0.001$) improvements after periodontal and prosthetic therapies using the Sandwich's technique. In addition, similar results of RABL and bone fills were found at both mandibular first and second molars after periodontal and prosthetic therapies and with a significant ($p<0.05$ and $p<0.01$) statistical analysis using periodontal and prosthetic therapies via the Sandwich's technique.

Table 1. showed baseline and final treatment data % and mm of RABLs and bone fills on both of maxillary and mandibular molars.

Molar location	16&26(n=12)	17&27(14)	36&46(10)	37&47(8)
RABL (before)%	46.6(12.4)	48.2(14.8)	50.8(11.4)	49.6(9.2)
RABL (after)%	62.2(16.6)	66.5(13.6)	60.8(17.2)	61.1(9.9)
Bone fills (%)	+12.1(14.7)	+15.5(13.4)	+9.9(9.6)	+11.5(10.1)
Bone fills(mm)	+1.2(1.6)	+1.8(1.6)	+0.9(1.1)	+1.2(1.0)
pair t-test	$p<0.05^*$	$p<0.001^{***}$	$p<0.05^*$	$p<0.01^{**}$

*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Table 2. indicated mesial and distal RABL changes in 1 year after using Sandwich's technique.

Molar location	16 & 26(n=12)	17 & 27(14)	36 & 46(10)	37 & 47(8)
M-RABL				
Bone fills(mm)	+1.55(1.10)(8)	+1.90(1.47)(13)	+1.22(1.11)(5)	+1.33(0.66)(10)
Bone loss(mm)	-0.59(0.86)(8)	-0.89(1)	-0.95(0.30)(4)	-
D-RABL				
Bone fills(mm)	+1.42(1.20)(4)	+1.66(1.04)(11)	+0.84(0.53)(9)	+1.11(1.04)(5)
Bone loss(mm)	-0.88(0.94)(4)	-1.32(1.56)(3)	-0.15(1)	-0.47(0.20)(5)
pair t-test	$p<0.05^*$	$p<0.001^{***}$	$p<0.05^*$	$p<0.01^{**}$

*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Table 2 Angular RABL of bone fills at mesial surfaces of maxillary first molars (#16) was +1.55±1.10mm and distal surfaces was +1.42±1.20mm; where there existed bone loss at mesial surface was -0.59±0.86mm as compared to the distal surface was -0.88±0.94mm in the end of study group. Results showed there were a significant ($p<0.05$) greater bone gain and less bone loss at the mesial surface in the end of study group.

Angular mesial and distal RABL of bone fills was +1.90±1.47mm and +1.66±1.04mm on the maxillary second molars; in addition, the mesial and distal bone loss was -0.89 and -1.32±1.56 mm in the end of study group compared to the baseline group could contribute to the greater angular RABL bone gain and less bone loss on the maxillary second molar with a remarkable significance ($p<0.001$) using the pair t-test in the end of study.

Table 3. The long-term changes of RABL of Sandwich's technique in treating molars affected angular bony defects among mesial, distal, and molar FI defects for 5-14 years.

Angular bony defects(n)	RABL changes Ranges (mm)	Bone gains (mm)	Pair t-test
Mesial defects (43)	-2.87~+3.77	+0.97(1.37)	$p<0.0001$
Distal defects (23)	-1.59~+6.53	+1.44(1.92)	$p<0.0005$
FI defects (26)	-0.19~+4.30	+1.33(1.11)	$p<0.0001$
Total defects (66)	-2.87~+6.53	+1.13(1.59)	$p<0.0001$

Table 3 indicated that long-term changes in the radiographic parameters at the mesial, distal, and molar furcation involvements (FI) for the ranges of RABL bone gains (mm)

after the end of study. While the RABL gain increased in the end of study group at the mesial, distal, and molar FI were $+0.97(1.37)$ mm, $1.44(1.92)$ mm, and $+1.33(1.11)$ mm, respectively. A similar trend was observed for the vertical RABL, with the end of study group exhibiting a greater gain compared to the baseline group. Changes in the radiographic parameters after the end of study are presented in Table 3. It revealed a remarkably statistical significance of bone gains at the mesial defects ($p<0.0001$), distal defects ($p<0.0005$), and molar FI ($p<0.0001$). In addition, result also showed a remarkable significance ($p<0.0001$) of bone gains at total angular bony defects.

Table 4. Clinical evaluation of RABL on molars affected with secondary occlusal traumatism (SOT) injury between treated and untreated non-surgical periodontal treatment (NSPT) for 6 years.

Molar teeth	Treated group n RABL (mm) Mean (SD)	Untreated group n RABL (mm) Mean (SD)	pair t-test
Mesial surface Ranges	$+1.54(2.56)$ 24 -2.73~+4.31	$-3.15(5.11)$ 14 -13.88~+1.20	$p<0.0001$
Distal surface Ranges	$+0.78(1.67)$ 24 -2.06~+2.91	$-3.31(2.47)$ 14 -7.15~+0.06	$p<0.0001$

Table 4 illustrated the clinical evaluation of RABL on both of the mesial and distal molars affected with secondary occlusal traumatism (SOT) injury between treated and untreated non-surgical periodontal treatment (NSPT) for 6 years. Results indicated that the mean (SD) of RABLs(mm) at both of the mesial and distal surfaces were $+1.54\pm 2.56$ mm and $+0.78\pm 1.67$ mm in the treated group; where there was the mean(SD) of RABLs (mm) at both of the mesial and distal surfaces were -3.15 ± 5.11 mm and -3.31 ± 2.47 mm in the untreated group. There existed a prominent significance ($p<0.0001$) in both of RABLs of treated and untreated groups of molar teeth at the mesial and distal surfaces, respectively.

4. Discussion

The study of Hou et al. [6] used root separation or resection(RSR) and CSC telescopic dentures to treat molars with molar FI lesions, and after follow-up for a mean of 6.67 years (5~13 years), it was found that the mean attachment gains of molars with molar FI lesions of the maxilla was 0.72mm after RSR and 1.07mm for the mandible, while the mean attachment gain obtained was lower than those without RSR, and the mean periodontal attachment gains of the maxilla was 0.21mm and the mean attachment gains of the mandible 0.56mm [6]. The study by Hong et al. [26], it was found that for severe molar FI using RSR for treatment, after one year of observation, the mean periodontal attachment gain was $0.34 (\pm 0.66)$ mm; and in this study, long-term observation was done according to the same method of RSR and CSCTD, and it was found that teeth with severe molar FI lesions were obtained a mean $1.08 (\pm 0.90)$ mm alveolar bone gain, the results showed that patients who received the treatment of both RSR and CSCTD with periodic recall visit to the clinics had good treatment results.

Kornman and Robertson [27] summarized nearly 50 years of literatures on the success and failure of periodontal alveolar bone defects treatment, and evaluated the role and importance of various factors in the success treatment of alveolar bone desruction. Among them, tooth morphological factors characteristic of diseased sites were listed as important influencing factors. The root furcation form of molars is the most complex of all tooth anatomys, and there are at least the following anatomical types associated with molar FI lesion [28].

The fixation effect of splinting and shortened lever splints mainly provides the weak support of the periodontitis patients with severe periodontitis. When the periodontal support is not enough, fixed the mobility of the affected tooth is used, for patients with severe advanced periodontitis must face the biggest problem of "insufficient support for the alveolar bone and excessive rocking of the supporting teeth", then the CSC telescopic denture (CSCTD) design, undoubtedly will be one of the best choices. In addition, by reducing the crown-to-root ratio to reduce the lever action of the supporting teeth with too high external forces, the torque produces secondary periodontal injury, and the fulcrum line is also reduced due to the reduction of the crown-to-root ratio. In addition, the addition of the design of the inner crowned self-releasing tapered and the combination of rotation gap and splint fixation can reduce the leverage of periodontal-support more effectively. The above are all aspects of the protection provided by the CSCTD for the fragile teeth of patients with severe periodontitis, and the effective treatment of molars with root furcation lesions by root splitting or excision are all factors that improve the success rate of supporting teeth. In addition, since the molar furcation involvement lesion completely eliminates the plaque accumulation and cleaning dead space in the molar furcation involvement area after non-surgical root separation and resection (RSR), especially the use of the above CSCTD, so that patients can completely clean the lesion area with cleaning tools, and the dentist or periodontist can regularly clean and remove the plaque in the remaining molar FI area after root separation and/or root resection, which should be one of the main reasons why the use of Sandwich technique treatment can achieve a higher success rate after long-term tracking. This result further confirms that personal and professional plaque controls are the only way to successfully treat severe periodontal disease with periodontal venement design [6]. However, due to the short average retrospective period of this study, further observation remains to be seen.

Steffensen and Weber [29] studied vertical angular bony defect and found that in nonfurcated teeth, a defect angle of less than 45 degrees can achieve a mean 1.22 mm bone gain, and the larger the angular defect, the worse the repair effect. Tonetti et al. [30] showed that the bone gain of vertical bone destruction is related to the original defect area, the height of the defect, and the length of the bone surface. Most studies have compared the effects of different materials and procedures on vertical bone destruction, but less mention is given about the effect of initial destruction on the changes obtained after treatment. In this study, regression analysis was performed on the location of initial vertical bone destruction, and it was found that both cumulative RABL changes and annual RABL changes were related to the original radiation alveolar bone height (IRABL), and the larger the IRABL, the less the change. In other words, the lower the height of the original radiographic alveolar bone, the more alveolar bone height can be obtained after treatment. In addition, the change in alveolar bone height is obtained the most in the first year, and then decreases year by year, so the observation period of temporal provisional prosthesis (TPP) for treatment in this study is as long as 9~12 months.

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