Analysis of Endodontic Complications Following Fixed Prosthodontic Rehabilitation

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Purpose: The aim of this study was to determine endodontic treatment needs and types of endodontic disease following fixed prosthodontic treatment 24 hours after tooth preparation, 1 week after tooth preparation, 1 month after placement, and 6 months after placement. ***Materials and Methods:*** Study groups consisted of patients who attended a university dental hospital department of prosthodontics for fixed prosthodontic treatment from January 2011 to December 2013. All teeth were clinically and radiographically evaluated according to American Association of Endodontists evaluation criteria before preparation. Metal-ceramic fixed partial dentures were placed for all patients. A total of 1,633 abutment teeth were prepared with 1,100 pontics in 524 patients (214 female and 310 male). Participant age, sex, and tooth number were recorded. Endodontic treatment follow-up was scheduled for 24 hours after tooth preparation, 1 week after preparation, 1 month after placement, and 6 months after placement, and all teeth were evaluated after placement of FPDs according to a modified criteria. ***Results:*** 2,733 retainers were placed with 624 FPDs. Of the FPDs, 332 (53%) were placed in the posterior and 196 (31.5%) in the anterior region. The remaining 96 FPDs (15.5%) were placed anteroposterior. The abutment/pontic ratio was 1.44:1. The number of retainers per FPD was 4.37. Of 1,633 abutment teeth, 103 were endodontically treated after placement of FPDs. Most observed endodontic disease was symptomatic irreversible pulpitis. There were statistically significant differences in terms of teeth regions ($P < .001$). When follow-up times of 24 hours, 1 week, 1 month, and 6 months were evaluated, there was no statistically significant difference among all teeth groups ($P > .05$). ***Conclusion:*** A total of 2,733 retainers on 624 FPDs were evaluated over 6 months, and the mean endodontic treatment need ratio was 6.3%. *Int J Prosthodont 2016;29:565–569. doi: 10.11607/ijp.4601*

In modern dentistry, the majority of operators use metal-ceramic fixed partial dentures (FPDs), which require between 1.0 and 1.5 mm of enamel to be removed from the axial/occlusal surface.[1] Although the significance of this is slight when ultraconservative preparation methods and a restorative process are used, indisputable threats to pulpal integrity exist during fixed prosthetic treatment.[2] It has been reported that operators have injured the dentin-pulp complex when performing procedures that involve fixed prosthodontics.[3] Existing research in this field has revealed that the way dentin pulp reacts to FPD preparation should be an area of major concern for individuals involved in restorative and prosthetic dentistry, and studies indicate a positive correlation between the requirement for endodontic treatment and FPD preparation and procedures.[4,5]

In the event that the pulp is damaged or a patient experiences further complications after prosthetic treatment, endodontic treatment may be required. The need for such treatment can emerge during the preparation activity itself, immediately following the treatment, or even a long time later.[2,4,6–14]

The way the pulp of a tooth responds to a FPD is influenced by a number of factors. These include the amount of dentin removed from the tooth surface, the process by which the crown is prepared, the heat and friction generated during the stripping process, the nature of the cementation materials employed, the presence of bacterial infection, and the occurrence of chemical injury and/or excessive drying of dentin.[1,8,15–19]

Understanding the issues associated with treating and preventing pulp damage is of significant importance to operators. The aim of this study was to determine endodontic treatment needs after preparation, after temporary restoration placement, and after fixed prosthetic rehabilitation.

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Table 1 Endodontic Evaluation Criteria According to the American Association of Endodontists

Medical/dental history	Past/recent treatment, drugs
Chief complaint (if any)	How long, symptoms, duration of pain, location, onset, stimuli, relief, referred, medications
Clinical exam	Facial symmetry, sinus tract, soft tissue, periodontal status (probing, mobility), caries, restorations (defective, newly placed?)
Clinical testing: Pulp tests	Cold, electric pulp test, heat
Clinical testing: Periapical tests	Percussion, palpation, Tooth Slooth (biting)
Radiographic analysis	New periapicals (at least 2), bitewing
Additional tests	Transillumination, selective anesthesia, test cavity

Table 2 Preparation Depth, Materials, and Equipment Used

Preparation depth	1.4 mm for axial; 2.0 mm for occlusal.[23] Deep cutter diamond was used to obtain the same depth.
Handpiece	300,000 rpm,[21,22] 2.2 bar, 16W, RM: standard 4-hole, triple spray, LED+ (W&H, Alegra)
Provisionals	Performed with indirect technique by the same dental technician, polymethyl methacrylate (Dentsply)
Cement (permanent)	Zinc polycarboxylate cement (SpofaDental, Adhesor Carbofine)
Cement (temporary)	TempBond Temporary Cement Type I (Kerr)
Metal alloy	Fabricated with casting technique and Co-Cr alloy were used (Remanium Star, Dentaurum)
Ceramco 3	Layering ceramic (Dentsply)

Table 3 Control Procedures Used in this Study

1. Patient recall
2. Chief complaint
3a. If yes
1. Chief complaint history (how long, locaton, duration of pain, stimuli)
2. Clinical exam
a. Intraoral exam ▪ Soft tissue exam, periodontal exam, mobility, caries
b. Extraoral exam ▪ Facial asymmetry
3. Clinical tests (percussion, palpation, pulp tests)
4. Radiographic exam (periradicular, pulpal)
3b. If no
1. The integrity of the occlusal contact pattern (ascertained using articulating paper)
2. Signs of increased abutment mobility or sensitivity (ascertained by palpation, percussion, and directed air stream)
3. Signs of root cracks or fracture (ascertained by palpation, percussion, and periodontal probing and confirmed by radiographic examination)
4. Marginal integrity, including evidence of caries or loss of seal at the tooth-restoration interface (ascertained by probing and palpation)
5. Evidence of retreatment

Materials and Methods

This study has been approved by the Ethics Committee of Dicle University Faculty of Medicine. The study group consisted of patients who attended the University Dental Hospital Department of Prosthodontics for fixed prosthodontic treatment between January 2011 and December 2013. Metal-ceramic retainers were used for all patients. Abutment teeth were selected that had not undergone any prior root canal and periodontal treatment. All teeth were clinically and radiographically evaluated before preparation according to American Association of Endodontists evaluation criteria (Table 1).[20]

The teeth were prepared using rotary cutting headpieces with the same rpm for all patients, and the clinician ensured that the underwater flow and air cooling speed were consistent across all treatments.[21,22] All teeth were prepared by the same operator to the same depth[23] using the same handpiece and new, sterilized diamond burs. The prepared teeth were restored with provisional FPDs until cementation of definitive restorations. Provisional restorations were constructed using polymethyl methacrylate (Dentsply), and all were performed by the same dental technician. Temporary restorations were cemented with temporary cement (TempBond Type I, Kerr).

The final metal-ceramic FPDs were cast with Co-Cr alloy (Remanium Star, Dentaurum) and layered with Ceramco 3 ceramic material (Dentsply) (Table 2). All metal-ceramic FPDs were placed and cemented with zinc polycarboxylate cement (SpofaDental, Adhesor Carbofine) after 1 week. Follow-up evaluations were performed 24 hours after tooth preparation, 1 week after preparation, 1 month after placement, and 6 months after placement. A modified control procedure[13] was used for the present study (Table 3).

In total, 1,633 abutment teeth were prepared with 1,100 pontics on 524 patients. A total of 2,733 retainers were placed with 624 FPDs. The age and sex of the participants were recorded (Table 4). The age of the patients ranged from 21 to 73 years, and there were 214 women and 310 men. The collected data were analyzed using Cochrane Q test for intragroup and chi-square test for intergroup comparison.

Results

A total of 2,733 retainers were placed with 624 FPDs, of which 332 (53%) were placed in the posterior region of the jaws and 196 (31.5%) were

placed in the anterior region. The remaining 96 (15.5%) FPDs were positioned anteroposterior. The abutment-to-pontic ratio was 1.44:1. The number of crowns per FPD was 4.37. Of 1,633 abutment teeth, 103 were endodontically treated. Most treatment required was within 1 week for 40 abutment teeth, 24 hours for 26, 1 month for 20, and 6 months for 17. The region most likely to require endodontic treatment was the mandibular molars (7.43%). The maxillary premolars were least likely to require endodontic treatment, at 5.07% (Table 5).

In terms of endodontic diagnosis, symptomatic irreversible pulpitis, asymptomatic irreversible pulpitis, and pulp necrosis all occurred. The symptoms of symptomatic irreversible pulpitis were sharp pain on thermal stimulus, lingering pain, spontaneity (unprovoked pain), and referred pain. The pain may be accentuated by postural changes such as lying down or bending over. Diagnosis of asymptomatic irreversible pulpitis was based on subjective and objective findings indicating that the vital inflamed pulp was incapable of healing and that root canal treatment was indicated. Pulp necrosis was diagnosed when the pulp was nonresponsive to pulp testing and was asymptomatic. The most frequently seen endodontic diseases were symptomatic irreversible pulpitis (63.1%), asymptomatic irreversible pulpitis (19.4%), and pulp necrosis (17.5%) (Table 6).

In both jaws, the most frequently used abutment teeth were the maxillary second molars and the mandibular canines (Tables 7 and 8). The largest group by number of retainers was FPDs with three to five retainers, at 62% (Table 9). In all teeth groups, there were statistically significant differences in terms of follow-up intervals ($P < .001$). When follow-up times of 24 hours, 1 week, 1 month, and 6 months were each evaluated, there was no statistically significant difference among all teeth groups ($P > .05$).

Discussion

This study evaluated the rate of endodontic complications after tooth preparation by follow-up time. The study group consisted of patients who had been admitted to the University Dental Hospital Department of Prosthodontics for fixed prosthetic rehabilitation. All patients were treated by the same operator and with a handpiece of the same speed. Clinical and laboratory procedures were standardized as much as possible to eliminate the effect of changes in operator and technician on the outcomes.

Table 4 Patient Distribution by Age and Sex

Age (y)	Men (n)	Women (n)	Total (n)
21–35	53	44	97
36–55	179	109	288
56–73	78	61	139
Total	310	214	524

Table 5 Tooth Areas and Number of Teeth Requiring Endodontic Treatment by Follow-up Time

Teeth region/type	n	Endodontically treated teeth (n [%])				
		24 h	1 wk	1 mo	6 mo	*P**
Maxillary anterior	309	4 (1.29)	12 (3.88)	15 (4.85)	17 (5.50)	.001
Maxillary premolars	217	3 (1.38)	9 (4.15)	10 (4.61)	11 (5.07)	.001
Maxillary molars	316	5 (1.58)	14 (4.43)	20 (6.33)	23 (7.28)	.001
Mandibular anterior	325	5 (1.54)	11 (3.38)	16 (4.92)	21 (6.46)	.001
Mandibular premolars	197	3 (1.52)	7 (3.55)	8 (4.06)	11 (5.58)	.001
Mandibular molars	269	6 (2.33)	13 (4.83)	17 (6.32)	20 (7.43)	.001
	1,633	26	66	86	103	
	*P***	.961	.916	.767	.816	

*Cochrane Q test for intragroup comparison.
**Chi-square test for intergroup comparison.

Table 6 Endodontic Diagnosis by Follow-up Time

Pulp diagnosis	Follow-up time				Total (n [%])
	24 h (n)	1 wk (n)	1 mo (n)	6 mo (n)	
Symptomatic irreversible pulpitis	26	30	7	2	65 (63.1)
Asymptomatic irreversible pulpitis	0	6	8	6	20 (19.4)
Pulp necrosis	0	4	5	9	18 (17.5)
Total	26	40	20	17	103 (100)

Table 7 Distribution of Abutments and Pontics in Maxillae

Teeth	Left		Right	
	Abutments	Pontics	Abutments	Pontics
Central incisors	45	39	39	31
Lateral incisors	43	51	35	23
Canines	76	37	71	33
First premolars	58	63	55	49
Second premolars	55	57	49	56
First molars	37	54	34	59
Second molars	102	37	91	45
Third molars	29	0	23	0
Total	445	338	397	296

Table 8 Distribution of Abutments and Pontics in Mandibles

	Left		Right	
Teeth	Abutments	Pontics	Abutments	Pontics
Central incisors	38	39	46	42
Lateral incisors	34	28	34	30
Canines	86	19	87	6
First premolars	44	36	36	44
Second premolars	55	35	62	35
First molars	27	67	33	56
Second molars	79	14	76	15
Third molars	23	0	31	0
Total	386	238	405	228

Table 9 FPDs by Number of Retainers

Retainers (n)	FPDs (n)	FPDs (%)
3–5	386	62
6–10	188	30
≥ 10	50	8
Total	624	100

Table 10 Mean Results of Endodontic Complications After Preparation of Vital Tooth Abutments in Previous Studies from 1966 to Present

Authors	Vital abutments prepared (n)	Abutments requiring endodontic treatment after preparation (%)
Ericson et al[14]	668	2
Karlsson[12]	944	10
Cheung[31]	152	4.1
Jackson et al[2]	437	5.7
Valderhaug et al[4]	101	10
Walton[13]	688	2.7
Al-Khreisat[32]	616	6
Present study	1,633	6.3

All teeth were clinically and radiographically investigated before preparation. The teeth included in the study had not received any prior pulp treatment. Furthermore, the endodontic treatment needs of the patients involved in the study were determined according to the tooth condition as described by the patient, clinical signs and symptoms, and radiographic findings.[20] For the maxilla, 842 abutments and 634 pontics were used, for an abutment/pontic ratio of 1.32:1. For the mandible, 791 abutments and 466 pontics were used, with a higher abutment/pontic ratio of 1.69:1.

In the present study, 386 FPDs (62%) had 3 to 5 retainers, 188 FPDs (30%) had 6 to 10 retainers, and 50 FPDs (8%) had more than 10 retainers. According to these results, a high number of retainers is common. This increases the risk of decay, endodontic therapy, plaque retention, and technical failures.[24–27] Use of implants is growing dramatically, especially for partial edentulism, decreasing the potential for biologic and technical complications.[28,29] However, a tooth-supported FPD has been the most common choice to replace missing teeth for the past six decades and remains so today. Every dentist is familiar with the procedure, and it is widely accepted by the profession, patients, and insurance companies.[30]

The present study was carried out in a public hospital. Unlike implant therapy, the FPD therapy was compensated by general public health insurance for patients. Due to the purpose of the study, only patients who were treated with FPDs were included.

Many important processes might contribute to pulpal death during the placement of FPDs. These include excessive tooth reduction, heat, handpiece vibration, pressure during tooth preparation, chemicals, and bacterial infection.[1] Since 1966, many studies have been performed on this subject. However, only a few long-term studies have examined the survival rates of teeth treated with FPDs (Table 10).

A published study using a roentgenographic technique found that 13 of 668 teeth exhibited periapical alteration after 1 year, and that there was no statistically significant difference among teeth. The mean endodontic treatment need rate was 2%.[14] A study at a prosthodontic special practice by Walton used an observation period of 5 to 10 years and found a mean endodontic treatment need rate of 2.7%.[13] In the present study, clinical and radiographic examinations were performed, and the mean endodontic treatment need rate was 6.22%. The differences in results for mean endodontic treatment requirements between these studies may be attributed to the examination technique used and the length of the observation period.

A study performed on FPDs constructed from porcelain-fused gold alloy 10 years after insertion found that the endodontic treatment need rate on vital abutments was 10%.[12] A further study performed for pulpal evaluation on teeth restored with FPDs showed that 25 of 437 vital teeth (5.7%) required root canal treatment after the restoration was cemented.[2] Although there are differences in follow-up times and type of materials used, the present results were similar to those outlined in these studies.

Cheung et al found that 4.1% of vital abutment teeth received endodontic treatment within 7 years.[9] These results are better than those found in the present study, but the observation period is much longer. A different study that examined early endodontic complications following FPDs found that the early endodontic complication rate was 6% after final cementation. In order of prevalence, mandibular molars,

maxillary molars, and mandibular anterior teeth were most commonly used as abutment teeth.[10] The endodontic complication rate and abutment teeth most frequently used were similar to those identified in the present study. By contrast, Raustia et al found that the teeth most commonly used as abutments were canines, maxillary molars, and then mandibular molars.[6]

Existing literature and research in this area indicates that a number of precautions should be taken during treatment procedures to reduce the risk of pulp damage. The operator should ensure that the provisional fits well and the crown is cemented in place as soon as possible. Once the superficial layer is removed, the dentinal surface should be adequately treated with antibacterial solution, thoroughly cleaned, and covered with a linear until final cementation. It is important that the dentin area is kept moist until the final cementation of the crown.[8]

Conclusions

Around 6.3% of abutment teeth required endodontic treatment during the first 6 months. It is difficult to determine which clinical factor is most important in avoiding endodontic complications, but all factors mentioned need to be considered while placing FPDs.

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