Ten-Year Follow-up Study of Conical Crown-Retained Dentures

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This study reports the results of a long-term evaluation of conical crown-retained dentures. One hundred fifty-two restorations that had been in place for over 10 years were analyzed. Restorations were divided according to the Kennedy classification. Abutment and periodontal health, occlusion, retention, and frequency of relining and repair were among the factors evaluated. Good prognoses of removable partial dentures were shown in Kennedy Classes I, II, and III arches. However, some of the restorations placed on only a few remaining abutments showed rather unfavorable situations with almost all of the factors evaluated. *Int J Prosthodont 1997;10:149–155.*

The conical crown telescopic system advocated by Prof Dr K. H. Körber[1] has been used routinely for over 20 years following its introduction in Japan by the authors.[2] The technique uses the concept of "rigid support" in the treatment of partially dentate patients. The conical crown telescopic system has been widely accepted. It is viewed as a rational, clinically useful system that offers a good prognosis for removable partial denture (RPD) reconstruction. Some of the problems associated with the long-term clinical applications of this RPD design system have largely remained unreported.

The purpose of this investigation was to gather and analyze the basic data relative to the changes occurring in the remaining tissues following fabrication of conical crown-retained dentures (CCRDs).

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Materials and Methods

Patients

All patients restored using CCRDs in the form of RPDs and removable fixed partial dentures at the two departments of prosthetic dentistry from 1974 to 1992 were evaluated in this study. The restorations included 152 of 211 arches with prostheses placed a minimum of 10 years previously. The mean treatment interval was 12 years, the mean age of the patients was 62 years (43% males and 57% females). All the 152 arches were evaluated according to the Kennedy classifications. There were 29 Class I arches, 54 Class II arches, 45 Class III arches, and 24 configurations classified as few remaining abutments (FR) (Table 1).

Factors Analyzed and Criteria Used

The following 10 factors were used to analyze the prognoses of CCRDs in accordance with the former study.[3]

1. *Occlusal contacts on the denture teeth.* Occlusal contacts on the denture teeth were analyzed by horizontally pulling thin articulating foil (Hanel foil; Occlusions-Prüf-Folie, Nürtingen, Germany, 8.8 μ). The following evaluation criteria

Table 1 Distribution of Arches (Kennedy Classification)

Distribution	In use	Not in use	Unknown or dead	Total
Class I	29	3	7	39
Class II	54	5	7	66
Class III	45	4	7	56
Few remaining (FR)	24	15	11	50

were used: *(1)* articulating foil torn = tight and firm occlusal contacts; *(2)* foil difficult to pull but not torn = fairly firm occlusal contacts; and *(3)* foil easy to pull = no occlusal contact.

2. *Denture movement.* Denture movement was inspected both visually and digitally while the denture base was loaded intermittently by finger pressure. The evaluation was divided into four levels: *(1)* no perceptible movement = 0; *(2)* palpable movement = 1; *(3)* visible movement = 2; and *(4)* marked movement = 3.

3. *Incidence of denture relining following fabrication.* Incidence and time of relinings were ascertained. Direct relining was typically used.

4. *Denture retention.* The retention of dentures and removable fixed partial dentures were subjectively evaluated by patients as "under retained"; "optimal"; or "over retained."

5. *Fracture of dentures and abutments.* Fractures were analyzed according to occurrence.

6. *Oral and denture hygiene.* Oral and denture hygiene were evaluated as good or bad by applying plaque disclosing solution (New 2-Tone Disclosing Solution, Lorvic, St Louis, MO). After plaque disclosure, the teeth and/or prosthesis were rated as having good or bad oral hygiene.

7. *Residual ridge inflammatory changes.* Inflammatory changes of residual ridges under denture bases were evaluated as: *(1)* changed = Signs of inflammation such as deep recesses or redness; *(2)* no change = no signs of inflammation (such as shallow marginal imprint of denture).

8. *Abutments.* Inflammatory changes, periodontal pocket depth, tooth mobility, and incidence of secondary caries were evaluated.

a. *Inflammatory change of periodontal tissue.* Inflammatory changes were classified as four degrees by the score of Löe:[4] No apparent inflammation = 0; slight inflammation = 1; moderate inflammation = 2; and severe inflammation: = 3.
b. *Periodontal pocket depth.* The deepest periodontal pocket depth was measured at each abutment.
c. *Abutment tooth mobility.* Abutment tooth mobility was measured by ARPA (Arbeitsgemeinschaft für Parodontologie)[5] score and classified as: physiological movement (M0); movement judged by tactile sensitivity (M1); movement judged by observation (M2); and apparent movement (M3).
d. *Incidence of secondary caries on abutment.* The abutment was inspected for secondary caries using a mirror and probe.

9. *Number of lost abutments.* The number of abutments lost for various reasons was determined.

10. *Interruption of denture use.* The reasons for interruption of denture use were determined.

Results

1. *Occlusal contacts on denture teeth.* Fifty-four percent of the dentures supported by few remaining teeth (FR group) had loose occlusal contacts. Of the Kennedy Class I and Class II groups, 26% to 28% had loose contacts, while only 4% of Class III configurations were found to have loose contacts (Table 2).

2. *Denture movement.* Excess denture movement is a critical factor in maintaining CCRD function. Forty-six of the FR had excessive denture movement. In spite of the observation in the FR group, excess denture movement was not detected in other groups, with few incidences of slight movement (Table 2).

3. *Number of denture relines.* One third of all the restorations (55/152) were relined. A greater incidence of relining was observed in the FR group (22/24 cases: 92%). The incidence of distal extension base relines was 55% in Class I and 28% in Class II. Only 4% of Class III configurations were relined. There was no relationship between time interval after fabrication and incidence of relining. A somewhat higher incidence of relining was found for restorations after 2 to 6 years than for other fabrication periods (Table 3).

4. *Denture retention.* The retentive force of dentures was significantly deficient in 58% of the FR groups, and fairly deficient in 24% of the Class I group. Few incidences of insufficient retention were found in the Class II and Class III groups (Table 2).

5. *Fracture of dentures and abutments.* Restorations in 141 arches fractured repeatedly for various reasons. Denture and abutment fracture was frequent in FR and Class I groups, with fracture occurring in 146% and 152% of all restorations, respectively. That is, every restoration fractured an average of 1.5 times after placement. Fracture was much less frequent (60%) with Class II and Class III restorations. There was no apparent interrelationship between fractures and the four groups (Table 4).

Table 2 Factors of Inspection and Results

Factors	Criteria	Distribution Class I (n =29)	Class II (n = 54)	Class III (n = 45)	Few remaining (n = 24)
Occlusal contacts	Tight and firm occlusal contacts	14 (48%)	23 (43%)	8 (18%)	8 (33%)
	Fairly firm occlusal contacts	7 (24%)	17 (31%)	35 (78%)	3 (13%)
	Without occlusal contacts	8 (28%)	14 (26%)	2 (4%)	13 (54%)
Denture movement	Without any movement	9 (31%)	38 (70%)	41 (91%)	5 (21%)
	Palpable movement	17 (59%)	12 (23%)	4 (9%)	8 (33%)
	Visible movement	3 (10%)	4 (7%)	0	7 (29%)
	Marked movement	0	0	0	4 (17%)
Retention of dentures	Over	3 (10%)	8 (15%)	11 (25%)	0
	Optimal	19 (66%)	43 (79%)	32 (71%)	10 (42%)
	Under	7 (24%)	3 (6%)	2 (4%)	14 (58%)
Oral and denture hygiene	Good	11 (38%)	43 (80%)	33 (73%)	11 (26%)
	Bad	18 (62%)	11 (20%)	12 (27%)	13 (54%)
Inflammatory change of residual ridge	No Change	26 (90%)	44 (81%)	38 (84%)	6 (25%)
	Changed	3 (10%)	10 (19%)	7 (16%)	18 (75%)

Table 3 Incidence of Relined Dentures

Distribution	Time of relinings after fabrication (y) 0 to 2	2 to 4	4 to 6	6 to 8	8 to 10	10+	Incidence n	%
Class I	1	5	4	1	3	2	16 / 29	55
Class II	1	3	4	3	2	2	15 / 54	28
Class III	1	1					2 / 45	4
Few remaining	4	6	4	3	2	3	22 / 24	92

Table 4 Fracture of Dentures and Abutments

Distribution	Fracture Facings	Plates	Failure of artificial teeth	Skeletons	Failure of inner crown	Failure of dowel core	Fracture of devitalized abutments	Incidence n	%
Class I	6	5	8	7	6	5	7	44 / 29	152
Clas II	8	7	5	2	3	4	5	34 / 54	63
Class III	11	1	3	4	2	3	4	28 / 45	62
Few remaining	3	4	6	7	4	5	6	35 / 24	146
Total	28 (20%)	17 (12%)	22 (16%)	20 (14%)	15 (11%)	17 (12%)	22 (16%)		

6. *Oral and denture hygiene.* Oral and denture hygiene as revealed by plaque disclosing solution were evaluated as "bad" in 54% and 62% of FR and Class I groups, respectively, and in 20% to 30% of Class II and Class III groups, respectively (Table 2).

7. *Residual ridge inflammatory change.* Inflammation was observed in 75% of FR groups. In other groups, inflammation was found in less than 20% of all restorations (Table 2).

8. *Abutments.* There were 170 abutments with CCRDs in 29 Class I configurations, 148 abutments in 54 Class II restorations, 172 abutments in 45 Class III restorations, and 40 in 24 FR reconstructions.

a. *Periodontal inflammation.* Forty percent of the FR group abutments were judged to have moderate inflammation. Three percent to 11% of the other

Table 5 Results of Inspection of Abutments

Factors	Criteria	Distribution Class I (n = 170)	Class II (n = 148)	Class III (n = 172)	Few remaining (n = 40)
Inflammatory change	No inflammation	63 (37%)	38 (26%)	40 (23%)	7 (18%)
	Slight inflammation	102 (60%)	97 (65%)	113 (66%)	17 (42%)
	Moderate inflammation	5 (3%)	13 (9%)	19 (11%)	16 (40%)
	Severe inflammation	0	0	0	0
Periodontal pocket depth	less than 2 mm	93 (55%)	90 (61%)	87 (51%)	6 (15%)
	2 to 5 mm	73 (43%)	48 (32%)	73 (42%)	20 (50%)
	5 mm or more	4 (2%)	10 (7%)	12 (7%)	14 (35%)
Abutment tooth mobility	M0	81 (48%)	75 (51%)	75 (44%)	5 (12%)
	M1	84 (49%)	61 (41%)	94 (54%)	24 (60%)
	M2	5 (3%)	12 (8%)	3 (2%)	11 (28%)
	M3	0	0	0	0
Secondly caries (incidence)	No caries	158 (93%)	129 (87%)	156 (91%)	38 (95%)
	Decayed	12 (7%)	19 (13%)	16 (9%)	2 (5%)

Table 6 Distribution of Lost Abutments

	Distribution Class I	Class II	Class III	Few remaining
Lost	29	16	17	22
Remaining	170	148	172	40
Percentage lost	15	10	9	35

Table 7 Cause of Interruption of Denture Use

	Abutment periodontitis	Abutment fracture	Misfit	Caries	Total
Class I	2	1	0	0	3
Class II	1	3	1	0	5
Class III	4	1	1	0	6
Few remaining	10	3	0	2	15

three groups had moderate inflammatory changes, while inflammation surrounding the remaining abutments was slight or absent (Table 5).

b. *Periodontal pocket depth.* Pocket depths greater than 5 mm were observed in 35% of the abutments in FR group. However, pocket depths greater than 5 mm were seen in only 2% to 7% of abutments of other groups (Table 5).

c. *Abutment tooth mobility.* Substantial tooth mobility (M2) was observed in 28% of the abutments in the FR group. However, such mobility was found in only 2% to 8% of the abutments in other groups (Table 5). Abutment mobility had the same tendency as the periodontal status of abutments judged by inflammation, periodontal pocket depth, and tooth mobility. The FR group abutments had a poorer prognosis than the other three groups.

d. *Secondary caries incidence.* Caries was found in 5% to 13% of the abutments in every group (Table 5).

9. *Lost abutments.* Abutments were extracted in approximately 10% of the Class I, II, and III configurations. However, 35% of all the abutments in FR group were extracted (Table 6).

10. *Interruption of denture use.* Of the 27 restorations not in use, 15 were from the FR group. The primary reasons for interruption of use were periodontal inflammation (17) and abutment fracture (6). It was theorized that many of the unknown or deceased subjects would have had restorations in the interrupted use category (see Table 1, Table 7).

Discussion

The favorable prognosis of the CCRD requires that the distal extension bases provide adequate support. If this prerequisite is not met, the concept of rigid support will not be realized and the prognosis is poor. However, one of the clinical merits of CCRDs is that the incidence of relining should not be more frequent than that of conventional RPDs.

The long-term prognosis of the design of CCRDs with these characteristics is dependent upon adequate maintenance. The first factor that is detected and must be controlled is increasing denture movement. According to the results, denture movement was completely controlled in the Kennedy Class III group in over 91% of the restorations. Movement of Class II distal extension base restorations was controlled over 90% of the time. However, of those restorations with few remaining abutments (FR group), 29% had visible movement, 17% had apparent movement, and over half the restorations had excess movement.

Although the denture movement in the FR group seemed to be serious at the time of placement, over half (54%) of the FR group had controlled denture movement 10 years later. Few reports are available concerning RPD movement after long-term use[6,7] relative to the prognosis of conventional RPDs, but CCRDs exhibited controlled denture movement in Class I, II, and III restorations and frequently with the FR group.[6,7]

In a long-term study of CCRDs, Gernet et al[8] reported on 238 of 370 (64.3%) CCRDs fabricated during the previous 5 years. The analysis was based on the patients' subjective assessment using a questionnaire. Eighty percent of the patients were satisfied with the stability, function, esthetics, and fit of their CCRDs. Igarashi[3] reported on 60 distal extension base CCRDs after a mean period of 3.4 years. Only a small amount of denture movement, detectable by palpation, was found. The occlusion of CCRD prostheses was maintained to some extent, while conventional RPDs had lost some occlusal contact. Firm and stable occlusal contacts were observed in 48% of Class I restorations and 43% of Class II restorations, while loose contacts were found in 28% and 26% of the respective restorations.[9] The occlusion in Kennedy Class III configurations was more problematic than Class I and II configurations, and firm occlusal contacts were found in 18% of the units.

The retentive force of conical crown telescopic prostheses is derived from a wedging effect. Wear resulting from excessive denture movement will reduce the friction between the interlocking patrix and matrix of the telescoped crowns. Fifty-eight percent of the restorations in the FR group had deficient retentive force such that the denture movement was excessive. Only 4% of the Class III restorations and 6% of the Class II restorations had deficient retentive force when denture movement was restricted to within a normal range.

Gernet et al[8] examined 139 denture wearers (312 prostheses) and found the relationship between poor prognosis of abutments and an excess or insufficient retentive force. Abutments with insufficient retentive force tended to have poorer periodontal conditions. The authors pointed out that the so-called secondary splinting effect of abutments by removable dentures was insufficient if retentive forces were poor. The present study found the same tendency in the FR group with poorer abutment periodontal health associated with insufficient retention.

Oral and denture hygiene were worse in the Class I and FR group, as in conventional RPDs with large numbers of missing teeth. There was no evidence of a relationship between the restorative method and hygiene. Excess denture movement and poor oral hygiene were the causative factors, with 75% of cases in the FR group having various mucosal lesions.

Prostheses were relined for 28% of the Class II group, 55% of the Class I group, and 92% of the FR group in which some of the restorations were relined repeatedly. Only 4% of Class III tooth bounded restorations required relining. No correlation was observed between the term of fabrication and the time of relining.

The FR group, with a greater incidence of relining, had poor periodontal conditions. Igarashi reported the incidence of relined distal extension base CCRDs as 17% in all 60 restorations.[3] In the present report, 18.7% of the restorations required relining (20 of 107) 4 years after fabrication, similar to the above report.

Fracture of prostheses and abutments was the most prevalent failure with CCRD treatment. The incidence of fracture in the Class I and FR group was about 150% (repeated fracture of the same restorations)—twice that found with Class II and Class III configurations. Forty percent were fatal failures such as loss of secondary crowns, post cores, and root fracture. However, even such drastic failures with fracture do not usually cause the interruption of denture use—one of the great clinical advantages of CCRD's. Loss of facings on secondary crowns (20%) was the primary finding in denture fracture (60%). Such failure may be caused not only by the facing techniques but by the elastic deformation of secondary crowns themselves. Denture and abutment fractures may be caused by functional overloading. In a follow-up study on CCRDs with undesirable abutment topography, Heners and Walther[10] found fracture of primary crowns and post cores to be 7.4% and 2.2%, respectively. This report was based on prostheses with a maximum of 5 years postplacement evaluation.

After the 3.4 year follow-up study by Igarashi,[3] 75% of fractures were in the denture without any involvement of the primary crowns. Variations in the manifestation of fractures will occur with an extended postplacement period, as seen in this present study.

Ericson et al[11] reported the prognosis of patients wearing CCRDs for 48 to 67 months. They inspected fractures and loss of primary crowns with 25 incidents of crown recementation and 17 incidents of acrylic resin denture repair.

The most serious concern in planning CCRDs is that the abutments may be overloaded. This concern should be alleviated by the finding of 530 intact abutments within the 152 restorations over the 12-

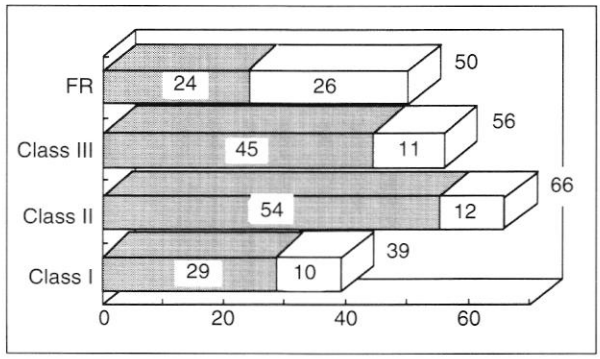

Fig 1 Distribution of dentures in acceptable function (Kennedy classification). FR = few remaining; shaded portion = number of dentures in use; unshaded portion = number of dentures not in use; total number = 211.

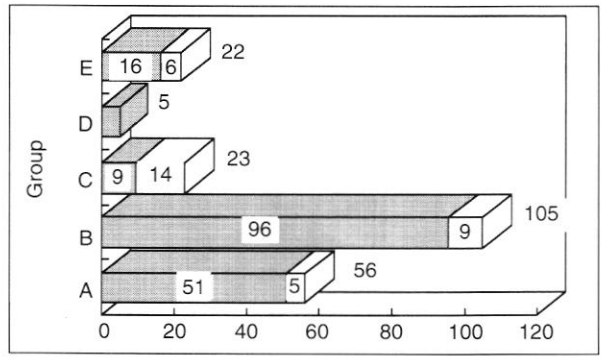

Fig 2 Distributions of dentures in acceptable function (Tübingen classification). FR = few remaining; shaded portion = number of dentures in use; unshaded portion = number of dentures not in use; total number = 211.

year postplacement period. This means that the abutments of CCRDs were able to bear the functional needs over a long period, with the exception of those prostheses fabricated on few remaining abutments.

It was shown that only a few Class I, II, and III configurations had 2% to 11% of periodontally involved abutments with moderate inflammation, pocket depths greater than 5 mm, and a tooth mobility score of M2. Abutments with M2 tooth mobility represented only 2% to 8% of all the restorations. However, a large proportion of the FR group had periodontally involved abutments: 40% had moderate inflammation, 35% had a pocket depth greater than 5 mm, and 28% had a tooth mobility score of M2.

The percentage of lost abutments from 9% to 15% in Classes I, II, and III, and rose to 35% in the FR group. The mean percentage for all groups was 13.7% (84/614 teeth). Loss of abutments did not always result in discontinued use of the CCRD.

Heners and Walther[12] reported the follow-up study of CCRDs with only anterior major connectors, and found the abutment loss to be 4.1% in the maxillae and 3.7% in the mandible for 1,798 teeth supporting 540 prostheses up to 5 years postplacement. In a group with few remaining teeth, 6.3% of 158 topographically malpositioned teeth were extracted. Although the present study reports a higher incidence of tooth loss, this study is much longer term (144 months) than that of Heners and Walther[12] (38.1 months for the maxillae and 48.9 months for the mandible).

In the present study, some prostheses were not being used, and 32 patients had died or were lost to the study. Fifteen of the units in the interrupted service group had been placed for patients in the FR group. This represented 30% of the FR group, compared to 7% to 8% in the Class I, II, and III groups.

Körber[13] reported the prognosis and success of the RPDs associated with abutment topography and the mode of denture support in conventional clasp-retained dentures. He advocated the classification of partially dentate arches to be restored according to the topography of the remaining teeth (1970) (Figs 1 and 2):

1. Group A: Completely tooth-supported bounded denture base
2. Group B: Combined tooth- and tissue-supported denture base with a stabilized fulcrum line
3. Group C: Combined tooth- and tissue-supported denture base with an unfavorable fulcrum line
4. Group D: Combined tooth- and tissue-supported denture base, with only an unstabilized fulcrum line
5. Group E: Few remaining teeth group

It was clearly pointed out that the prognosis of the CCRDs with a mean postplacement period of 12 years in this present study was much better than that of conventional RPDs with a mean postplacement period of 8 years. According to Körber's data, the percentage of the dentures in use 8 years after fabrication was 70% to 75% in groups A and B, 20% in group D, and 60% in group E. In contrast to the above data, this study found the percentage of use as 90% in groups A and B, 100% in group D, 75% in group E, and 40% in group C, which was not counted in the Körber study.

Amamori et al[6] pointed out that the number of the fabricated dentures not in use after 9 to 63 months was 28%. The percentage of dentures in the present study not in use was 12.8%—less than half of the number of conventional clasp-retained dentures with more than twice the period of service. Even the

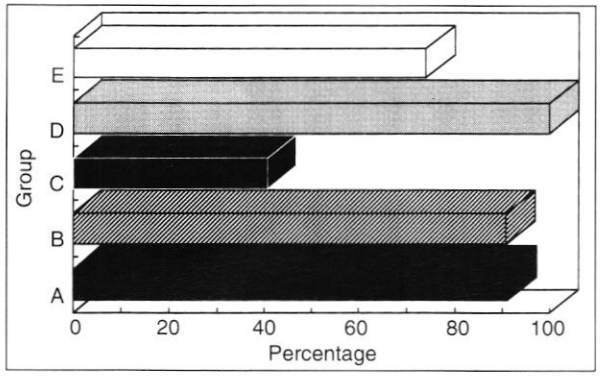

Fig 3 Prognoses of CCRDs after 12 years (Tübingen classification).

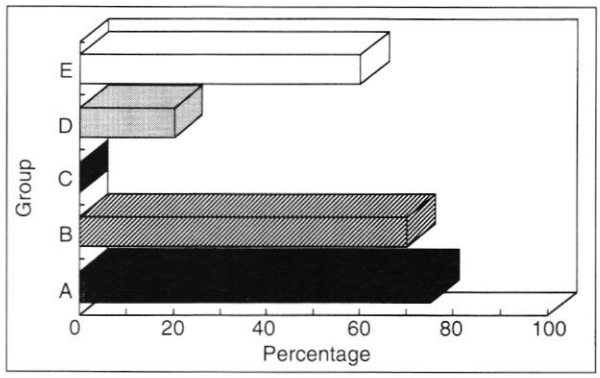

Fig 4 Prognoses of RPDs after 8 years according to Körber[13] (Tübingen classification).

FR group had the same out-of-use prognosis (30%) as conventional clasp-retained RPDs (Figs 3 and 4).

The study supports the concept that CCRDs are able to satisfy the modern concept of rigid support, which is one of the most rational and assessable prosthodontic concept for today's RPDs.

Conclusion

A long-term follow-up study on conical crown-retained dentures was undertaken to evaluate the concept of rigid support using conical crown-retained dentures. One hundred fifty-two restorations at least 10 years postplacement and with a mean service period of 12 years were studied. The mean patient age was 62 years. From this evaluation, the following conclusions were made:

1. A good prognosis was found for Kennedy Class I, II, and III removable partial dentures. However, some of the restorations with few remaining abutments were found to have unfavorable results for almost all the factors evaluated.
2. The cumulative mean abutment loss was up to 13.7%. For the group with few remaining abutments it was 35.5%. The number of dentures not being used was 12.8% for all restorations, while it was 30% in the group with few remaining abutments.
3. A high incidence of relining was observed with the configurations other than Kennedy Class III. Twenty-two of 24 restorations with few remaining abutments were relined with the group with many repeated relines. There was no apparent correlation between the time of relining and the period of use.
4. A marked problem with conical crown-retained dentures was found to be denture fractures (92.8%). Fatal fractures such as loss of the patrix crown and dowel post and root fracture were experienced in 40% of the restorations.

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The Effect of Alveolar Bone Grafting on the Prosthodontic/ Reconstructive Treatment of Patients With Unilateral Complete Cleft Lip and Palate

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This study compared the effect that the introduction of mixed dentition alveolar bone grafting and subsequent orthodontic treatment has had on the prosthodontic/reconstructive habilitation of patients with unilateral cleft lip and palate. Two groups, each consisting of 40 consecutive patients with unilateral cleft lip and palate, were compared at the end of their dental treatment. In the group treated prior to the advent of bone grafting, all subjects received a fixed partial prosthesis in the cleft area, and a total of 87 abutment teeth were prepared for complete coverage crowns. In contrast, in the group of patients for whom the alveolus was restored by bone grafting, it was possible to obtain a complete dental arch without prosthodontic intervention in 36 patients (90%). Thirteen subjects in the bone grafting group had the crown anatomy of anterior teeth modified using resin composite or resin-bonded porcelain veneers. Two patients had a premolar transplanted to the anterior region of the dental arch. On average the dental treatment was completed 3 years earlier in the bone grafting group. Thus, alveolar bone grafting with subsequent orthodontic treatment, together with advances in dental materials, have markedly reduced the need for prosthodontic procedures and have also allowed the completion of the dental treatment at an earlier age. *Int J Prosthodont 1997;10:156–163.*

In 1953 the Department of Plastic Surgery was established at the Oslo National Hospital in Oslo, Norway, and a cleft lip and palate (CLP) team was formed. The specialties of plastic surgery, orthodontics, prosthodontics, and speech therapy were represented. Protocols were developed based on recently acquired orthodontic and prosthodontic knowledge for cleft patient treatment.[1–3] A systematic and standardized surgical-orthodontic-prosthodontic treatment regimen was formed to ensure a predictably acceptable result for the majority of patients.[4]

In 1977 the management protocol was modified by the addition of alveolar bone grafting. One major objective was to establish a bony continuity across the cleft so that, if possible, spaces in the dental arch could be closed orthodontically without the need for prosthodontic tooth replacement.[5–7]

The purpose of this study was to compare the prosthodontic/reconstructive habilitation in two groups of subjects with unilateral complete cleft lip and palate (UCLP): one group was treated before the introduction of alveolar bone grafting, and the other group was treated after the introduction of alveolar bone grafting.

Sample and Methods

The two study groups were: *(1)* the pre–bone grafting group (pre-BG group) comprising patients treated before the bone grafting procedure was introduced at the Oslo CLP center, and *(2)* the bone grafting group (BG group), which included patients treated with alveolar bone grafting in the mixed dentition.

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