The Influence of Gender and Age on Fixed Prosthetic Restoration Longevity: An Up to 18- to 20-Year Follow-up in an Undergraduate Clinic

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Purpose: This study investigated the possible relationship between the survival of complete crowns (CCs), 3-unit fixed dental prostheses (3uFDPs), and fixed dental prostheses (FDPs) versus gender and age at initial treatment over a period of 18 to 20 years in an undergraduate clinic. ***Materials and Methods:*** Complete treatment and follow-up records of 1,037 CCs (60.5% women/39.5% men; age range: 18 to 82 years), 134 3uFDPs (59.2% women/40.8% men; age range: 33.6 to 93.6 years), and 322 FDPs (62.1% women/37.9% men; age range: 33.6 to 94.2 years) were available for analysis. Failures of the fixed prosthetic restorations were defined as irreversible complications (finish line involved or loss of CCs, FDPs, or abutments). ***Results:*** The association between gender versus irreversible complications for the CCs (P = .481), 3uFDPs (P = .814), and FDPs (P = .410) groups was not statistically significant. The relationship between age versus irreversible complications for the fixed prosthetic restorations was statistically significant for all test groups. The patients with the failing restorations (66.2 years; mean range: 64.8 to 67.5 years) were 4.5 to 5.5 years older at initial treatment than the patients with the surviving restorations (61.3 years; mean range: 59.5 to 63.0 years). ***Conclusions:*** There was no relationship between gender and irreversible complications. There was a clear statistically significant association between age and irreversible complications. Receiver operating characteristic analysis for all study groups revealed that for age, no clear cutoff point exists with acceptable specificity and sensitivity. *Int J Prosthodont 2007;20:579–586.*

Studies on the long-term efficacy of fixed prosthetic restorations are limited in number.[1–21] Only with long-term studies is it possible to monitor the pattern and rate of possible changes and ascertain specific causes of failure. Some authors have reported on the significance of patient gender and age as part of a larger study.[6,7,9–11,14,17] Only 2 surveys referred to the influence of patient age at time of initial treatment.[22,23] The purpose of these surveys was to draw general conclusions regarding the prognosis of the various types of fixed prosthetic restorations, particularly in elderly patient groups. Patients want their fixed prosthetic restorations to last for a long period of time, regardless of their own age. A statistically significant difference has not been found for the long-term survival of fixed prosthetic restorations versus gender.[7,10,11,14,17] For the relationship between age of the patient and long-term survival of fixed prosthetic restorations, some authors found a statistically significant difference.[7,10,22] Karlsson found a trend with a higher failing rate in the oldest group (≥ 60 years),[6] and others found no significance at all.[9,11,14,17,23]

The purpose of this study was to analyze the results, derived from 3 retrospective investigations, on the relationship of gender and age at initial treatment of patients treated with complete crowns (CCs),[19] 3-unit fixed dental prostheses (3uFDPs),[20] and fixed dental prostheses (FDPs);[21] all were made at the same department according to the same principles.

Materials and Methods

All fixed prosthetic restorations were made over a period of 18 years between 1974 and 1992 in the under-

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Table 1 Recall Frequency and Survival or Failure for the CC Group

No. of recall visits	Survival (n)	Failure (n)	Survival (%)	Failure (%)
2/y	208	41	22.6	35.7
1/y	258	29	28.0	25.2
< 1/y	157	16	17.1	13.9
No recall	109	19	11.8	16.5
Private practitioner	188	10	20.4	8.7
Total	920	115	100.0	100.0

Table 2 Recall Frequency and Survival or Failure for the 3uFDP Group

No. of recall visits	Survival (n)	Failure (n)	Survival (%)	Failure (%)
2/y	31	6	27.4	30.0
1/y	39	6	34.5	30.0
< 1/y	12	4	10.6	20.0
No recall	7	2	6.2	10.0
Private practitioner	24	2	21.2	10.0
Total	113	20	100.0	100.0

Table 3 Recall Frequency and Survival or Failure for the FDP Group

No. of recall visits	Survival (n)	Failure (n)	Survival (%)	Failure (%)
2/y	62	33	24.8	46.8
1/y	87	16	34.8	22.7
< 1/y	36	8	14.4	11.6
No recall	13	8	5.2	11.6
Private practitioner	52	5	20.8	7.3
Total	250	70	100.0	100.0

graduate clinic of the department of Fixed Prosthodontics and Periodontology, University Ghent, Belgium. A total of 1,312 CCs were made during that period. Complete treatment and follow-up records of 456 patients (60.5% women and 39.5% men) with a mean age of 41 years (range: 18 to 82 years), mean survival evaluation time of 10.0 years (range: 0.3 to 25.0 years), and 1,037 complete crowns were available for analysis, representing 79% of the total number. A total of 165 3uFDPs were made during that period. Complete treatment and follow-up records of 98 patients (59.2% women and 40.8% men) with a mean age of 61.2 years (range: 33.6 to 93.6 years), mean survival follow-up time of 11.6 years (range: 2.8 to 24.7 years), and 134 FDPs were available for analysis, representing 81% of the total number. A total of 397 FDPs were made during that period. Cantilevered FDPs were not included in the present study. Complete treatment and follow-up records of 193 patients (62.1% women and 37.9% men) with a mean age of 63 years (range: 33.6 to 94.2 years), mean survival evaluation time of 11.4 years (range: 0.3 to 20.4 years), and 322 FDPs were available for analysis, representing 81% of the total number. In this group, 39.1% (n = 126) of the FDPs were placed in the maxilla and 60.9% were placed in the mandible (n = 196). Regarding the distribution of FDPs, 60.1% (n = 116) of the patients received 1 FDP, 22.3% (n = 43) received 2 FDPs, 9.8% (n = 19) received 3 FDPs, 6.2% (n = 12) received 4 FPDs, and 1.6% (n = 3) received 5 FDPs. This represented 1,308 fixed units with a total of 704 retainers and 604 pontics. The mean number of units per FDP was 4.1, and the pontic/abutment ratio was 0.86. On average, 2.2 abutments and 1.9 pontics were made per FDP. Sixty-five percent of the abutment teeth were vital at time of preparation, while 35% had a cast post and core.

The group of FDPs with 2 abutment teeth represented 84.5% of the total, while 12.4% consisted of 3 abutment teeth and 3.1% had 4 abutment teeth. Of the FDPs with 3 or 4 retainers, 10.5% had an intermediate abutment tooth and 5.0% included 2 retainers at the end.

In terms of the number of pontics, 42.5% of the FDPs had 1 pontic, 37.3% had 2 pontics, and the remaining 20.2% had 3 pontics (11.5%), 4 pontics (7.8%), 5 pontics (0.6%), or even 6 pontics (0.3%). The distribution of the units per FDP was as follows: 41.6% were 3-unit FDPs, 31.7% were 4-unit FDPs, 12.1% were 5-unit FDPs, 10.9% were 6-unit FDPs, and 3.7% were 7- to 9-unit FDPs.

The dropouts were the result of the following reasons: patients chose a private practitioner for maintenance, moved to another city, could not be traced, or died during the follow-up period. None of the patients in the dropout group were contacted by telephone and no questionnaires were sent to them or to their former or current clinicians to collect supplementary information. Nevertheless, demographic data on gender and age for the excluded records (19% to 21%) matched correctly with the study group records. Failure was defined as an irreversible complication,[19–21] which means that there was finish line involvement or the CC, FDP, or a tooth was lost as a result of caries, loss of retention, fracture of the framework, impaired esthetics, fracture of an abutment tooth, periodontal disease, or apical periodontitis.

The fixed prosthetic restorations consisted of full cast gold retainers or porcelain-fused-to-gold retainers. All impressions were made in a custom tray with a polyether material (Impregum, Espe). For the post-and-core abutment, an impression of the root canal was taken with the help of a lentulo, but no other devices, such as burnout posts, were used. All post-and-core CCs were cast gold posts fused with the crowns (in a single piece), but all cast gold posts and cores on the abutment teeth in FDPs were made separately from their retainer. Posts and cores were made of gold alloys (Degudent U, Degussa), the same alloys used for the retainers and pontics. All retentive surfaces of the

restorations were sandblasted (50 μm) during the last laboratory phase, prior to cementation. All CCs, 3uFDPs, FDPs, and post-and-core buildups were cemented with a zinc phosphate cement (Harvard, Richmond Harvard) under the same strict conditions.

All patients were invited and accepted to participate in a regular supportive maintenance program every 6 months. A number of patients interrupted this program or preferred to visit a private practitioner. Tables 1 to 3 present the compliance with recall at the prosthetic restoration stage for CCs, 3uFDPs, and FDPs. During these maintenance sessions, a number of diagnostic and therapeutic steps were undertaken: whole mouth plaque score after staining with a dichotomous reading, bleeding on gentle probing of the gingival sulcus, periapical radiographs, recording of new caries lesions or secondary caries, control of the retention of the restoration, and recording of mechanical failures. Probing depth at 6 or 8 sites per tooth was recorded using a Michigan periodontal probe. At each session, patients were reinstructed in plaque control. If the interdental morphology allowed, instruction in cleaning with interproximal brushes or superfloss was given. At each session, plaque and supra- and subgingival calculus were removed. Patients were scheduled for scaling and root planing when periodontally indicated.[19–21] The patients that interrupted this program or preferred to visit a private practitioner were sent an invitation by mail, on a single occasion, for a free checkup. During this last evaluation session, the aforementioned diagnostic and therapeutic steps were undertaken, thus reintegrating this patient group into the present study results. This project (EC UZG 2005/100) was approved by the Ethics Committee, OG 017, University Hospital, Ghent, Belgium.

Statistical Analysis

The survival rates were calculated using the Kaplan-Meier method.[24] The log-rank test was used to determine whether survival functions differ between groups.[25] The Mann-Whitney *U* test was used for the comparison of age between the 2 groups. Additionally, this was illustrated by a box-and-whisker plot to represent the position and spread of the different study groups. The basic elements of this graph are the median (horizontal line) and the quartiles, which mark the edges of the box. The whiskers are determined by the minimum and maximum value.

Categorical variables were analyzed using the chi-square test (Fisher exact test). The age values for the studied groups were the ages of the patients at placement of the fixed prosthetic restorations. Receiver operating characteristic (ROC) analysis was used to compute an optimum point for the sensitivity and specificity of the age variable. The significance level was set at $\alpha = .05$.

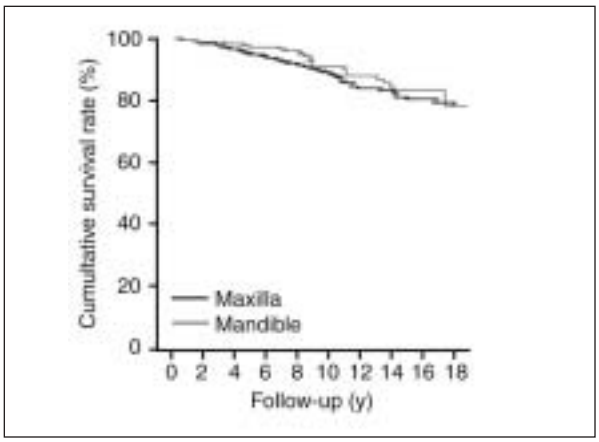

Fig 1 Kaplan-Meier survival curves for CCs after 18 years in the maxilla and mandible ($P = .150$).

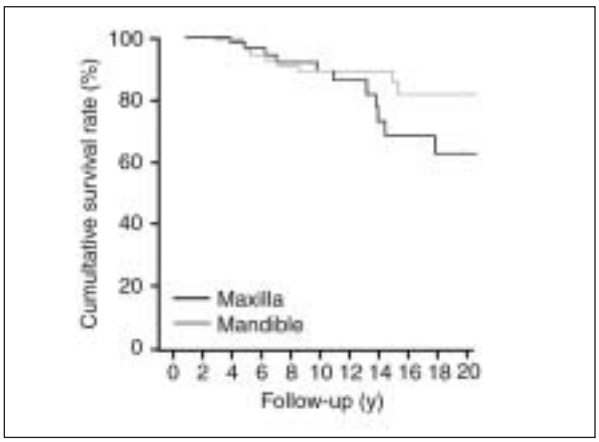

Fig 2 Kaplan-Meier survival curves for 3uFDPs after 20 years in the maxilla and mandible ($P = .236$).

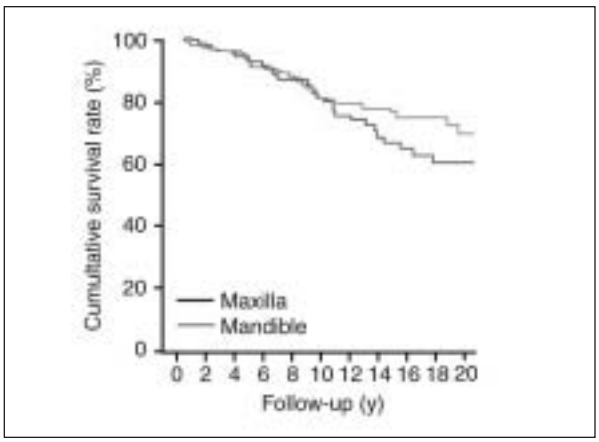

Fig 3 Kaplan-Meier survival curves for FDPs after 20 years in the maxilla and mandible ($P = .270$).

Results

Kaplan-Meier survival estimations for the maxilla and mandible were calculated, and the curves are presented for CCs (Fig 1), 3uFDPs (Fig 2), and FDPs (Fig 3). For the CCs, there was no statistically significant dif-

Table 4 Frequency Distribution of CCs Placed Per Patient and the No. of Failed or Surviving CCs Within the Same Patient

CC/patient	No. failed	No. of patients
1 (48.5%)	0	189
	1	32
2 (21.5%)	0	84
	1	11
	2	3
3 (12.5%)	0	43
	1	9
	2	3
	3	2
4 (7.0%)	0	28
	1	1
	2	2
	4	1
5 (3.7%)	0	9
	1	6
	3	2
6 (2.6%)	0	7
	1	4
	2	1
7 (1.3%)	0	4
	1	1
	3	1
8 (1.3%)	0	2
	1	1
	2	1
	3	1
	5	1
9 (0.4%)	0	1
	1	1
10 (0.7%)	0	2
	2	1
11 (0.2%)	1	1
15 (0.2%)	0	1

Table 5 Frequency Distribution of 3uFDPs Placed Per Patient and the No. of Failed or Surviving 3uFDPs Within the Same Patient

3uFDP/patient	No. failed	No. of patients
1 (70.4%)	0	59
	1	10
2 (24.5%)	0	17
	1	6
	2	1
3 (3.1%)	0	2
	1	1
4 (2.0%)	0	1
	2	1

Table 6 Frequency Distribution of FDPs Placed Per Patient and the No. of Failed or Surviving FDPs Within the Same Patient

FDP/patient	No. failed	No. of patients
1 (60.1%)	0	94
	1	22
2 (22.3%)	0	32
	1	8
	2	3
3 (9.8%)	0	9
	1	4
	2	5
	3	1
4 (6.2%)	0	4
	1	5
	2	1
	4	2
5 (1.6%)	0	1
	1	1
	3	1

ference between the maxilla and mandible after 18 years (log-rank: $P = .150$), with 78.1% and 78.2% survival, respectively. There was no statistically significant difference between the survival curves of the 3uFDPs in the maxilla and mandible after 20 years of function ($P = .236$). The survival rates for the maxilla and mandible were 62.5% and 81.6%, respectively. For FDPs in the maxilla and mandible, 60.1% and 69.8% of the restorations survived after 20 years, respectively. Again, no statistically significant difference was found between the survival of restorations in the maxilla and mandible ($P = .270$).

The number of CCs, 3uFDPs, and FDPs placed per patient, number of failed or survived restorations within the patient, and frequency distribution in the study population are illustrated in Tables 1 to 3. Of the 456 patients treated with a CC, only 86 (18.9%) had one or more irreversible complications (Table 4). Of the 98 patients treated with a 3uFDP, only 19 (19.4%) had 1 or 2 failing 3uFDPs (Table 5). Of the 193 patients treated with an FDP, only 53 (27.5%) had one or more failing FDPs (Table 6).

The possible relationship between gender and the long-term survival of the fixed prosthetic restoration was statistically assimilated for the 3 study groups. The cross tabulations for gender versus irreversible complication for the CCs ($P = .481$), 3uFDPs ($P = .814$), and FDPs ($P = .410$) are presented in Table 7. None of these groups showed a statistically significant difference (Fisher exact test).

The relationship between the age of the patients versus irreversible complication was studied using 2 different statistical approaches. The first option was the Mann-Whitney *U* test for the comparison of age between failing and surviving restorations (Table 8). This approach revealed that within the CC group (Fig 4), the mean age for patients with surviving restorations was 59.5 years (SD: 12.6), while for patients with failing restorations the mean age was 64.8 years (SD: 12.1). This difference was highly statistically significant ($P < .001$). The mean ages for the 3uFDP group (Fig 5) were 61.6 years (SD: 11.7) for patients with surviving restorations and 67.1 years (SD: 9.9) for patients with failing restorations. This dif-

Table 7 Cross Tabulation for Gender Versus Irreversible Complication of CCs, 3uFDPs, and FDPs*

	CCs (%)		3uFDPs (%)		FDPs (%)	
Gender	Surviving	Failed	Surviving	Failed	Surviving	Failed
Female	570 (89.3)	68 (10.7)	66 (83.5)	13 (16.5)	152 (76.0)	48 (24.0)
Male	351 (87.9)	48 (12.1)	47 (85.5)	8 (14.5)	98 (80.3)	24 (19.7)
Total	921 (88.8)	116 (11.2)	113 (84.3)	21 (15.7)	250 (77.6)	72 (22.4)

*P = .481, P = .814, and P = .410 for CCs, 3uFDPs, and FDPs, respectively.

Table 8 Mann-Whitney U Test for the Comparison of Age Between Failing and Surviving Restorations for CCs, 3uFDPs, and FDPs*

	CCs	3uFDPs	FDPs
Surviving			
n	921	113	250
Mean (SD)	59.5 (12.6)	61.6 (11.7)	63.0 (11.1)
Median	58.9	62.8	64.4
Range	33.1–94.2	33.6–93.6	33.6–94.2
Failing			
n	116	21	72
Mean (SD)	64.8 (12.1)	67.1 (9.9)	67.5 (11.0)
Median	65.2	68.8	66.1
Range	41.0–95.0	46.7–88.6	41.6–88.6

*P < .001, P = .041, and P = .005 for CCs, 3uFDPs, and FDPs, respectively.

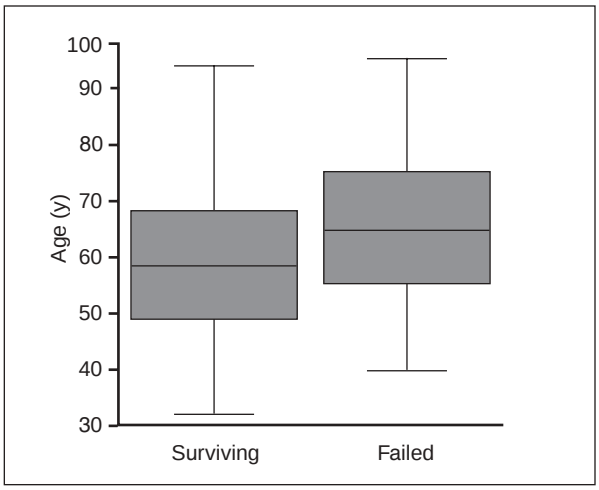

Fig 4 Box plot for CCs (P < .001).

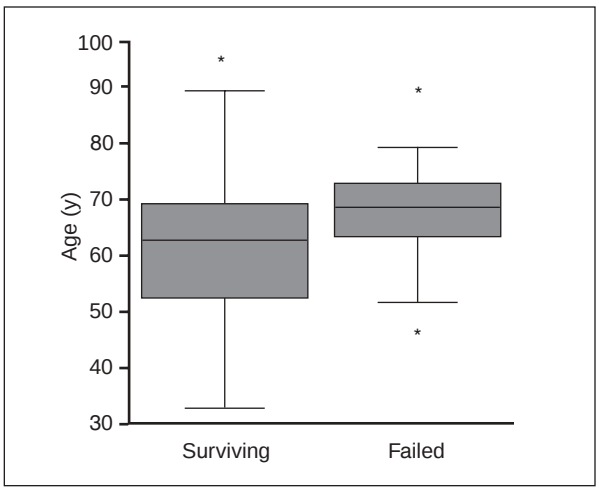

Fig 5 Box plot for 3uFDPs (P = .041).

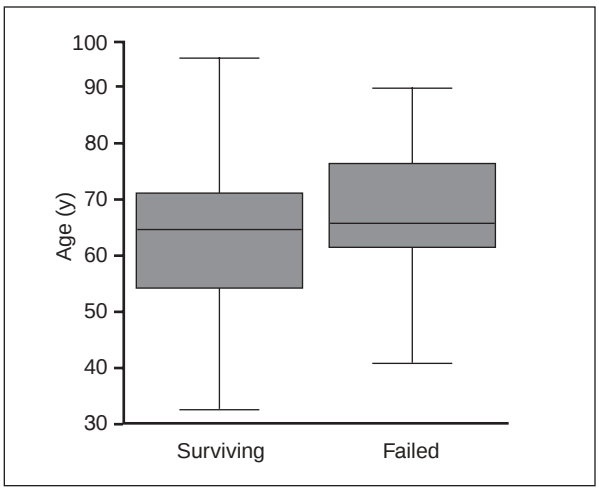

Fig 6 Box plot for FDPs (P = .005).

ference was statistically significant (P = .041). The mean ages for the FDP group (Fig 6) were 63.0 years (SD: 11.1) for patients with surviving restorations and 67.5 years (SD: 11.0) for patients with failing restorations. Again, this difference was statistically significant (P = .005).

The second approach was based on the consideration of age as a dichotomized variable and was only used to be in line with the current literature. The patients were split into 2 age groups: less than 60 years old and 60 years or older at placement of the fixed prosthetic restoration.

Table 9 Cross Tabulation for Age Groups Versus Irreversible Complication of CCs, 3uFDPs, and FDPs*

	CCs (%)		3uFDPs (%)		FDPs (%)	
Age	Surviving	Failed	Surviving	Failed	Surviving	Failed
< 60 y	485 (92.6)	39 (7.4)	43 (91.5)	4 (8.5)	94 (85.5)	16 (14.5)
≥ 60 y	436 (85.0)	77 (15.0)	70 (80.5)	17 (19.5)	156 (73.6)	56 (26.4)
Total	921 (88.8)	116 (11.2)	113 (84.3)	21 (15.7)	250 (77.6)	72 (22.4)

*$P < .001$, $P = .135$, and $P = .016$ for CCs, 3uFDPs, and FDPs, respectively.

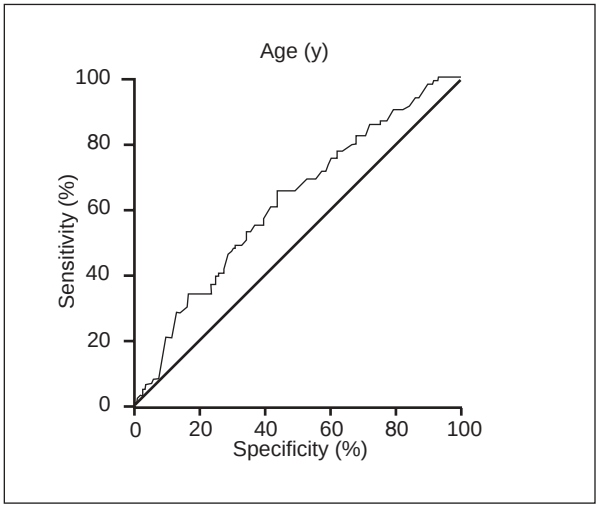

Fig 7 ROC analysis for the CCs.

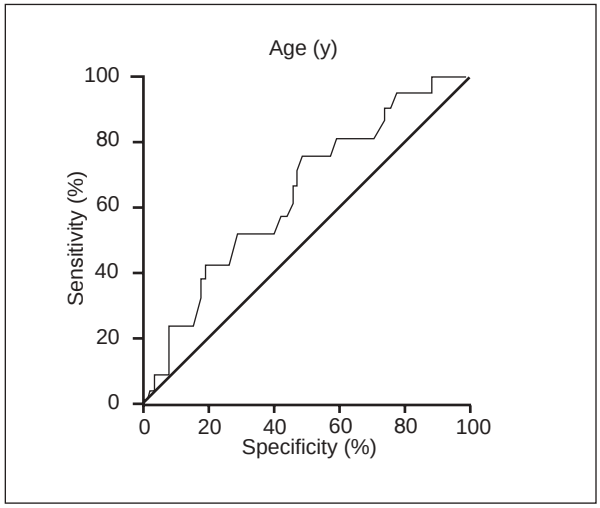

Fig 8 ROC analysis for the 3uFDPs.

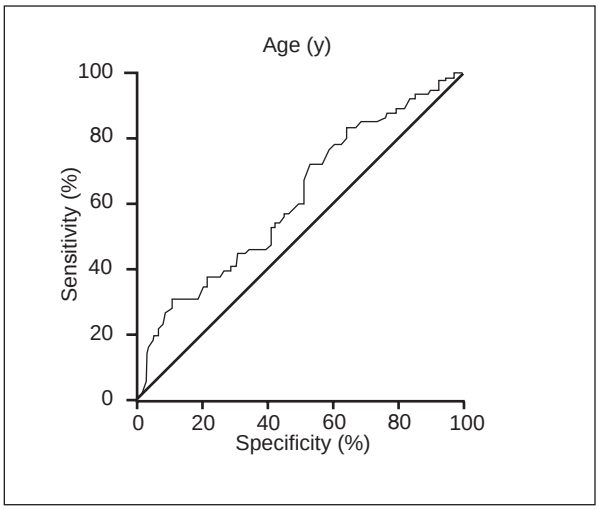

Fig 9 ROC analysis for the FDPs.

The results for the CCs, 3uFDPs, and FDPs are presented in Table 9. There was a highly statistically significant difference (Fisher exact test) for the CCs ($P < .001$) and FDPs ($P = .016$), but not for the 3uFDPs ($P = .135$).

For the 3 studied fixed prosthetic treatment groups, ROC analysis was performed to test the sensitivity and specificity of the relationship between age versus the surviving or failing prosthetic restorations. Figures 7 to 9 illustrate these ROC curves for the CC, 3uFDP, and FDP groups. For all groups, the results revealed that the specificity and sensitivity of the statistical significance were of low value. In the CC group, the optimal cutoff point was 61.0 years, the sensitivity was 65.5%, and the specificity was 55.8%. In the 3uFDP group, the optimal cutoff point was 62.8 years, the sensitivity was 76.2%, and the specificity was 51.3%. In the FDP group, the optimal cutoff point was 62.8 years, the sensitivity was 72.2%, and the specificity was 46.8%.

Discussion

The survival rates for CCs over an 18-year period and FDPs over a 20-year period, fabricated by undergraduate students at a university clinic, were 78.1% and 66.2%, respectively. These results are comparable to the results of other studies of CCs[7,8,10,26] and FDPs,[10,13–15] as well as to the results of studies with general practitioners. For the 3uFDPs, the survival rate of 73.1% after 20 years is favorable.

The Kaplan-Meier survival rates between the maxilla and mandible for the CCs, 3uFDPs, and FDPs were, for all studied groups, not statistically significantly different. This is in agreement with some studies[4,10,20,21] but in contrast with others.[7,27,28]

In the present study, there was no relationship between the gender of the patients and the long-term survival of the fixed prosthetic restoration for the 3 study groups. These results are comparable with the results of earlier studies.[7,10,11,14,17] From 1991 to 2006, no long-term survival studies found a statistically significant difference, but Palmqvist and Söderfelt[27] found that the gender of the patient was a crucial variable associated with FDPs in their multivariate analyses of factors influencing the longevity of FDPs.

The relationship between the age of the patient and the survival or irreversible complication of the fixed prosthetic restoration has been studied by several authors.[6,7,9–11,14,17,22,23] For statistical analysis, all of these researchers divided their test groups into several age groups. Some authors found no statistically significant difference between age groups,[9,11,14,17,23] one author found a trend of a higher failure rate in the oldest group,[6] and 3 authors did find a statistically significant difference.[7,10,22] Roberts[22] described a very high failure rate occurring in the youngest patient group ($<$ 20 years); Kerschbaum et al[7] found an odds ratio of 2.2 for irreversible complications in the age group 50 to 69 years and an odds ratio of 5.0 in the group $\geq$ 70 years; Palmqvist and Swartz[10] found a statistical difference between the age groups $<$ 30 years and 30 to 49 years but not between the latter group and the oldest age group ($\geq$ 50 years). Palmqvist and Söderfelt[27] found in their multivariate analyses of factors influencing the longevity of FDPs that the age of the patient was a crucial variable associated with FDPs.

In the present survey, this relationship was studied using 2 different statistical approaches: the assessment of 2 age categories (Fisher exact test) and of the untransformed age variable (Mann-Whitney *U* test). The authors prefer the use of the Mann-Whitney *U* test, but to be comparable with the current literature, a second approach was used. Comparing the age groups $<$ 60 years and $\geq$ 60 years, the Fisher exact test revealed a statistically significant difference for the CC and FDP groups. For the 3uFDP group, there was no statistical significance, most likely because of a lack of power in combination with a loss of information following the dichotomization procedure of the age variable. Nevertheless, these results are comparable with the results of Kerschbaum et al.[7] Comparing the continuous age versus the survival or irreversible complication, the Mann-Whitney *U* test exposed a statistically significant difference for the CC, 3uFDP, and FDP groups. In all fixed prosthetic restoration groups, patients with failing restorations (66.2 years; mean range: 64.8 to 67.5 years) were 4.5 to 5.5 years older at initial treatment than patients with surviving restorations (61.3 years; mean range: 59.5 to 63.0 years). Despite this significant association with age, no reasonable age cutoff value with acceptable sensitivity and specificity could be assigned (ROC analysis).

Conclusion

The survival rates for CCs over an 18-year period and 3uFDPs and FDPs over a 20-year period made in a university clinic by undergraduate students were favorable: 78.1%, 73.1%, and 66.2%, respectively. The Kaplan-Meier survival rates between the maxilla and mandible for the CCs, 3uFDPs, and FDPs were not statistically significantly different. No relationship was found between gender and the long-term survival of the fixed prosthetic restorations. A statistically significant difference was found in all study groups for the relationship between age versus irreversible complication of the fixed prosthetic restorations. Because of the severe amount of overlay of the age variable comparing surviving restorations and restorations with irreversible complications, the significant differences in age do not mean that the cutoff age point at 60 years is strong enough to be used in clinical practice.

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Literature Abstract

The effects of abutment wall heights, platform size, and screw access channel filling method on resistance to dislodgement of cement-retained, implant-supported restorations

This study evaluated the effect of implant abutment height, platform size, and screw access channel filling method on the retention of cemented castings using TempBond. Four narrow-, regular-, and wide-platform 15-degree Nobel Biocare abutments were used. The abutments were attached and mounted vertically in acrylic resin. The screw access channel walls were left untreated, one third removed (3 mm), two thirds removed (6 mm), or completely removed (9 mm). Castings were then fabricated with attachments using type III gold. TempBond was then used to cement the castings on their abutments with the access opening completely or partially blocked (1 mm above the screw) with polyvinyl siloxane material. A universal testing machine was used to measure the force required to remove the casting. This procedure was repeated 20 times for completely and partially filled access openings. Analysis of variance and the Bonferroni adjustment were used to detect and analyze the differences. The results showed that increasing the surface area (platform or height) increased the retention of the casting (wide > regular > narrow platform; one third removed > unadjusted = two thirds removed > completely removed). The results also showed that the retention was better with a partially filled access opening. These results reemphasize the need for optimizing the surface area of the abutment. They also stress the influence of minor adjustments to the abutment to improve retention and resistance.

Emms M, Tredwin CJ, Setchell DJ, Moles DR. *J Prosthodont* 2007;16:3–9. **References:** 11. **Reprints:** Dr Christopher J. Tredwin, Eastman Dental Institute, University College London, 256 Grays Inn Rd, London, WC1X 8LD. E-mail: c.tredwin@eastman.ucl.ac.uk—*Majd Al Mardini, Hamilton, Canada*