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Research Article

Survival Rates of Fixed Partial Dentures: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Abstract

Teeth are an integral part of the facial structure and in most cultures they symbolize youth, health, beauty, and dignity. Loss of teeth can, therefore, create physical and functional problems and missing teeth can cause psychological and social disturbances. Thus, the desire to replace missing teeth with an implant having a long durability has become an urging need. For that, we have performed a comprehensive search for studies assessing the survival fixed partial dentures (FPDs) with at least five years of follow up. Only randomized controlled trial published in the last 10 years were included, with no limits on language or age of participants. A total of eight studies were finally included following screening of the 2042 preliminary retrieved non-duplicates. The meta-analysis results showed an overall 5-year survival of 99.13% and a 10-year survival of 95.38%. There was no heterogeneity detected in neither of these analyses. This high survival rates of FPDs make them a good choice in the indicated patients.

Keywords: *Survival; Implants; Fixed Partial Dentures; FPDs*

Introduction

The osseointegrated implants, initially introduced by Per-Ingvar Bränemark, have a significant effect on all of dentistry fields [1]. Treatment of complete edentulism was the main reason for developing dental implants; nevertheless, they are currently used for treatment of partial edentulism as well [2]. The specific methodology and treatment plan for connecting the implants to the natural tooth are still big dilemmas [2]. Different conclusion about these different methods and their durability has been derived, since the first use of combined implant and tooth during the mid-1980s [3]. Many of these studies have shown that implant-supported fixed partial dentures (FPDs) have a good durability and prognosis [3-10]. In contrast, many others have showed osseointegration loss, significant bone loss and even failure of FPDs (when supported by a combination of endosseous implants and natural teeth) [2].

The combination of implants with teeth has the issue of mobility pattern differences, which may be very challenging to the entire splinted system [11-15]. The axial displacement of a natural tooth, with a healthy periodontal ligament, can range from 15 to 20 μm, while the horizontal one ranges from 150 to 200 μm [16,17]. However, the mobility of osseointegrated implants, with a rigid bone attachment, can be only 10 μm [11,18,19]. This can be explained by the flexibility of the implant system and the associated bone elasticity [20-22]. These multiple discrepancies in patterns of mobility can cause physiological and biomechanical issues with effect on the survival duration [2].

A possible solution for the mobility differences, as suggested by many authors, was the use of rigid connectors to overcome the issue [23-25]. Another suggested option was to modify the design of the prosthesis with extending the cantilevers form abutments sides and joining them at the prosthesis middle part [25]. This design supposed to decrease the torque and stress applied to the implants; however, this will overload the natural teeth [25]. There was no consensus regarding the effectiveness of these connectors or the possible dangers they add to the tooth intrusion [6]. In this study, we perform a comprehensive analysis of the survival rates among FDPs to test durability beyond five years.

Methods

Search strategy and study selection

We performed an extensive literature search of the Medline, Cochrane, and EMBASE databases on 25 October 2019 using the medical subject headings (MeSH) terms "Denture, Partial, Fixed" [Mesh]. Three independent reviewers scanned the titles and abstracts against our inclusion and exclusion criteria to select potential articles. Papers assessing survival rate of fixed partial dentures for a follow up of at least five years were considered. Only randomized controlled trial published in the last 10 years were included. There were no limits on language or age of participants.

Full texts of initially eligible articles were then retrieved and reviewed for final inclusion. In both steps of the screening, a decision made by all three reviewers was considered conclusive. Controversies during the process were resolved by discussion and consensus. When necessary, disagreements and discrepancies were resolved by consensus with senior reviewers.

Data extraction

Based on a pilot review and extraction, a data extraction form was developed by two authors, using Microsoft Excel file. Three reviewers independently extracted data from included studies using the excel sheet. Data rechecking was carried out by at least two different authors and re-checked by a third reviewer for accuracy. All the disagreements and discrepancies were resolved by discussion and consensus. Papers published by the same research group were checked for potential duplicate data with reference to the year of patients' recruitment and the hospital where the patients were recruited. "Survival" was defined as FDPs remaining in-situ with or without modifications.

Quality assessment

Three independent reviewers evaluated the risk of bias in included studies. Methodological quality assessment was done using chochran's tool for risk of bias [26].

Statistical analysis

R software version 3.6.1 was used to conduct the analyses [27]. To calculate survival rate, a random-effects model was chosen due to the presence of heterogeneity between studies. Heterogeneity was evaluated using the Q statistic and I^2 test [28,29]. Publication bias, Egger's regression test was not performed because of the small number of studies per analysis (less than 10) [30,31].

Results

Search results

Database search yielded 2258 reports and four additional reports were found with the manual search of references. Following the removal of 220 duplicates via endnote software, the total number passed to the title and abstract screening was 2042; of which, 267 were relevant to out inclusion criteria. Following the extensive full-text screening, only 8 studies were included in the meta-analysis (Figure 1).

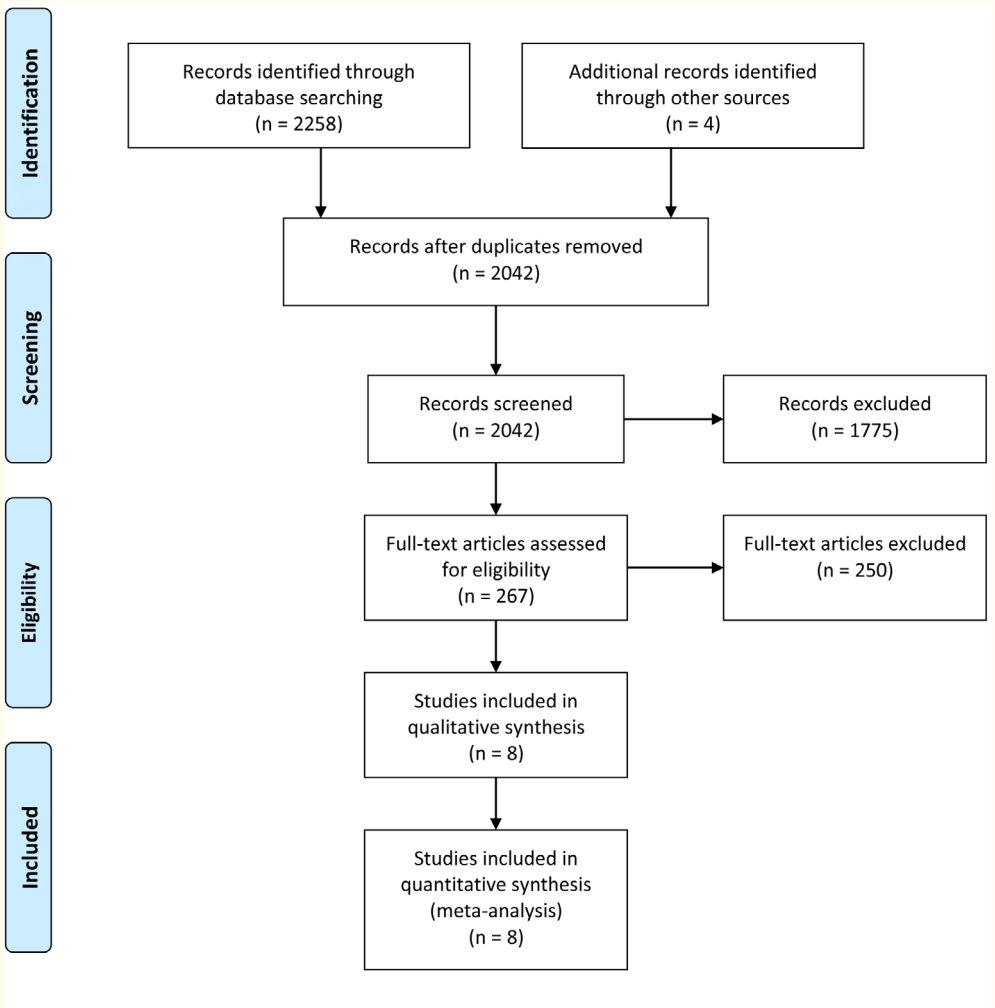

Figure 1: *Search strategy and results of identification, screening for eligibility, and inclusion of publications considered for systematic review and meta-analysis.*

Quality assessment and characteristics of included studies

Eight studies with 935 implants were included in the analysis. The total number of FDPs assessed at final follow up point for all studies were 603. Moreover, the overall survival rate of FDPs ranged from 90% up to 100%. The mean age of the included patients was variable; ranging from 50.5 to 60.9 years old and male percentage ranged from 32% to 60%. However, many studies did not report either age or gender distribution (Table 1).

Study	Case Group				Control Group				Total Implants	FPDs		
	Definition	Implants (N)	Age; Mean (SD)	Male (%)	Definition	Implants (N)	Age; Mean (SD)	Male (%)		5-Years Survival (%)	10-Year Survival (%)	FDPs Examined at Follow Up
Cortellini 2011 [32]	Application of a regenerative strategy to 25 hopeless teeth	25	46.3 (8.9)	60%	The extraction of the 25 hopeless teeth and their replacement with conventional or implant-supported fixed partial dentures	25	51.2 (8.7)	60%	50	100%	NA	24
Reitemeier 2013 [33]	Noble metal ceramic single crowns	190	The age group 35 to 44 was predominant (34.7%)	32%	Fixed dental prosthesis retainer crowns on vital posterior teeth	276	The age group 35 to 44 was predominant (31.9%)	33%	466	NA	94.40%	276
Sasse 2014 [34]	Fixed dental prostheses	57	NA	NA	Shortened dental arch	67	NA	NA	124	92.10%	NA	52
Botelho 2016 [35]	Two-unit cantilevered (CL2) resin-bonded fixed partial dentures (RBFPDs)	15	50.5 (12.4)	40%	Three-unit fixed–fixed (FF3) resin-bonded fixed partial dentures (RBFPDs)	14	50.8 (11.5)	57%	29	100%/100%*	100%/90%*	23
Larsson 2016 [36]	Implant-supported all-ceramic fixed dental prostheses (FDPs) with Denzir (DZ) system	13	NA	NA	Implant-supported all-ceramic fixed dental prostheses (FDPs) with In-Ceram Zirconia (InZ) system	12	NA	NA	25	NA	100%	17
Sailer 2017 [37]	Posterior zirconia-ceramic (ZC) fixed dental prostheses (FDPs)	40	52.7 (13)	54%+	Metal ceramic (MC) fixed dental prostheses (FDPs)	36	57.0 (12.1)	54%+	76	100%/100%#	NA	69
Sailer 2018 [38]	Posterior zirconia-ceramic (ZC) fixed dental prostheses (FDPs)	40	60.9 (range 36.5–86.9 years)+	53%+	Metal ceramic (MC) fixed dental prostheses (FDPs)	36	60.9 (range 36.5–86.9 years)+	53%+	76	NA	91.3%/100%#	53
Ioannidis 2019 [39]	Fixed dental prostheses (FDP) with implants diameter range of 3.0 to 5.0 mm and from 6 to 16 mm in length (S2 Group)	48	NA	NA	Fixed dental prostheses (FDP) with implants diameter range of 3.3 and 4.8 mm and from 6 to 15 mm in length (S2 Group)	41	NA	NA	89	96.1%/100%¥	NA	89

Table 1: *Characteristics of included studies.*

**Two-unit cantilevered/Three-unit fixed-fixed; +Both groups; #ZC/MC; ¥S1 Group/S2 Group.*

The methodological quality of the included studies was questionable with a presence of high risk of bias in multiple aspects and unclear reporting of others. Blinding status was not reported by any study neither for the patient side nor for the assessor side. Random sequence generation method was not reported in three studies; however, it was of low risk of bias among studies reporting it. Furthermore, selective reporting and incomplete outcome data were almost absent among included studies (Figure 2).

Figure 2: *Quality assessment of the included studies. A: review authors' judgements about each risk of bias item for each included study; B: review authors' judgements about each risk of bias item presented as percentages across all included studies.*

Survival rate of FPDs

Five studies with 262 implants were assessed for a 5-year survival rate. The overall 5-year survival rate was 99.13% with a 95% CI of 97.62% to 100%. Moreover, there was no heterogeneity with the results with $I^2 = 30\%$ and P-value = 0.218. As for the 10-year survival rate, four studies with 369 implants were included. The overall 10-year survival rate was as high as 95.38% with a 95% CI of 93.21% to 97.60%. Similarly, there was no heterogeneity at all within the results with $I^2 = 0$ and P-value = 0.616.

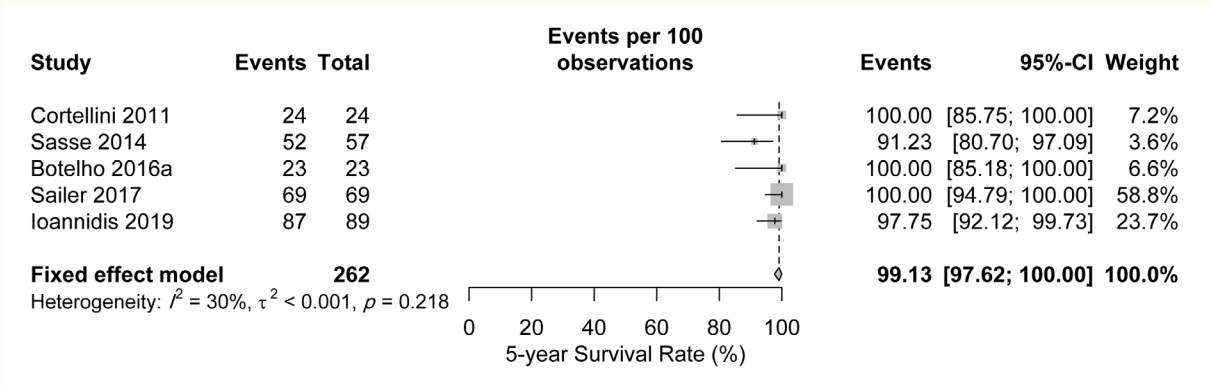

Figure 3: *Forest plot of 5-year survival rates.*

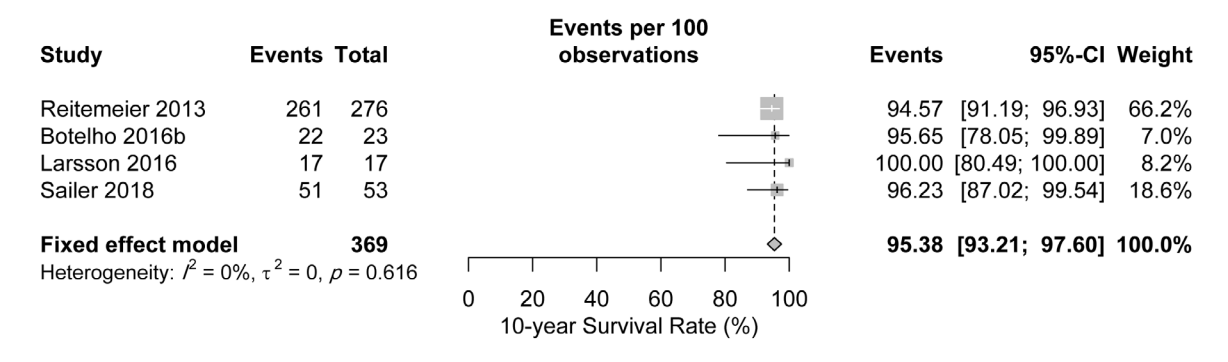

Figure 4: *Forest plot of 10-year survival rates.*

Discussion

The current study has evaluated the evidence of the last ten years assessing durability of FDPs. Eight studies were included and have showed a very good survival rates lasting up to ten years. The results were quit solid regarding the fact that no heterogeneity were present. However, the methodological quality of the included studies has some flaws.

Our results are consistent with the previous systematic reviews and meta-analyses conducted within the same topic, in regards to the 5-year survival rates [40-42]. The pooled survival rates ranged from 90.1% [40] and reaching up to 97.2% [41] when only rough surface implants were included. In contrast, the previous studies have reported a slightly lower survival rates during the 10-year follow

up assessment [40,41,43-45]. The reported 10-year survival rates ranged from 80.1% [41] and up to 89.1% [43] for FPDs. A possible explanation is that those studies were published between years of 2004 and 2012 [40-45]. This means the most recent study have included studies with patients treated back to 1994 and the last possible would be at 2002. The implant materials have many improvements over time in dentistry field which is a significant factor on aspects like durability [46].

Many biomechanical factors could have a great contribution in the survival and durability of the implants; hence, affecting the long term success rates [2]. These factors may include; 1) the mobility pattern differences comparing the natural teeth to the osseointegrated implants, 2) pattern of the occlusion force (that is the magnitude, duration, frequency, distribution and direction of the forces during the function), 3) prosthesis different characteristics (rigidity, connector type (rigid, non-rigid), connector position (near the tooth, near the implant), length of span, the features of materials of which the prosthesis is made etc.), 4) the implant system different characteristics (implant shape, length, diameter, surface macrostructure, implant-to abutment connection), 5) the characteristics of the bone surrounding the teeth and the implants (the quality and the quantity of the bone), 6) number of connected teeth and implants [2,3,13,47,48]. The overall interaction of all of these factors is the main determinant of the stress applied to the surrounding bone; hence, the overall durability.

The current study has some limitations. The small number of included studies is the main limitation in gaining a solid evidence. Although the study included RCTs which is the highest level of evidence, the studies have possible flaws that may affect the quality of the evidence.

Conclusion

FPDs have a very good durability with survival rates reaching up to 100% for both 5-year and 10 –year assessments. This makes them a perfect candidate for suitable patients whenever implants are indicated.

Funding

None.

Conflicts of Interest

No conflicts related to this work.

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