BIOLOGICAL AND MECHANICAL-TECHNICAL COMPLICATIONS OF POSTERIOR METAL-CERAMIC IMPLANT-SUPPORTED FIXED PARTIAL DENTURES: A RETROSPECTIVE STUDY

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Abstract
The study aimed to assess the biological and mechanical-technical complications rates of the 3-5 units posterior metal-ceramic implant-supported fixed partial dentures (FPD). Materials and method. The research was designed as a retrospective study on 67 edentulous patients (mean age 63,88 ± 11,70 yr) with implant-prosthetic treatment (mean follow-up 7,89-year). Biological complications (peri-implantitis) and mechanical/technical complications were assessed at implant, FPD and patient levels. Results. Implants survival rates were 96,6%. The rates of biological complications (peri-implantitis) were 13,5% at implant level (17,9% at patient level; 15,8% at FPD level). The rates of mechanical/technical complications were 28,7% at implant level (35,8% at patient level; 35,5% at FPD level); the most frequent were loss of screw access hole material (23,6%), followed by ceramic veneers fracture/chipping (11,8%), and screw loosening (8,4%). Conclusions. Despite of high survival rate (96,6%) of the implants supporting metal-ceramic FPD, 13,5% of implants had biological complications (peri-implantitis), and 28,7% of implants had at least one mechanical complication. Diagnostic of complications and additional intervention are requested in early stages to prevent the failure of the implant-prosthetic therapy.

Key words: *fixed partial dentures, implant suports, biological comlications, technical complications*

INTRODUCTION

Retrospective and prospective research brought substantial evidence showing that implant-supported fixed partial dentures (FPD) are a reliable treatment option for the replacement of missing posterior teeth. Numerous research groups reported high rates of surviving implants, regardless of the functional status of the implant-supported FPD or patient satisfaction (Hanif et al, 2017). However, the implants osseointegration and the long-term success rate of the implant-supported fixed partial dentures may be affected by various biological, mechanical or technical complications (Hanif et al, 2017; Lee et al, 2017; Heydecke et al, 2012). (Academy of Osseointegration, 2010). Biological complications are negative events that affect the peri-implant tissues (pain, infection, suppuration, mobility, peri-implant bone resorption, dysesthesia.); mechanical/technical complications are negative events that affect the exoprosthesis, either to the prefabricated components (mechanical complications) or to the covering material (technical complications) (Academy of Osseointegration, 2010). The relation between biological and mechanical/technical complications is bidirectional (biologic complications can lead to mechanical/technical complications and vice versa) (Moreno, 2021).

In this context, 8th European Workshop on Periodontology recommended the inclusion of the biological and mechanical-technical complications rates in

the goals of the research focused on the assessment of the implant-prosthetic success (Tomasi & Derks, 2022; Tonetti et al, 2012). Inflammation (47%) and overloading (53%) are the main causal factors of the early and late implants failure (Han et al, 2014). Complications are considered minor if they require 60 minutes or less for repair, and major if more time is needed for repair or if the implant-prosthetic component need to be sent to the dental laboratory (de Boever et al, 2006). Biological complications are a result of bacterial infections, microbial plaque buildup, and progressive bone loss (Berglundh et al, 2002; Quirynen et al, 2002). Early biological failures are attributed to the placing of dental implants under improper aseptic measures while late complications (peri-implantitis) are associated to microbial plaque buildup because of poor oral hygiene and non-compliance of patients to the periodontal and peri-implant maintenance sessions (Hanif et al, 2017). While dental practitioners have a lot of data regarding the risk of biological complications (peri-implantitis) in implant-prosthetic therapy, the number of studies focused on the mechanical risks (risk of a complication or failure of a prefabricated component due to mechanical forces) and technical risks (risk of a complication or failure of the laboratory-fabricated superstructure or its materials) (Silva & Brägger, 2009) are significantly lower. Mechanical complications are usually a consequence of biomechanical overloading (Hanif et al, 2017). Risk factors in the onset of the biomechanical overloading include improper implant position/angulation (cuspal or implant inclination, horizontal or apical offset of implant), insufficient posterior support as well as inadequate poor volume of alveolar bone or the presence of excessive forces in patients with bruxism (Haifa et al, 2017). The technical complications are a relevant issue in implant-prosthetic therapy by implant-supported FPD as compared to the implant-supported removable prosthesis (Heydecke et al, 2012).

AIMS OF STUDY.

- Assessment of the implants biological complications rates in partially posterior edentulous patients with implant-supported fixed partial dentures (FPD);
- Assessment of the implants/FPD mechanical-technical complications rates in partially posterior edentulous patients with implant-supported fixed partial dentures.

MATERIALS AND METHODS.

The research was designed as a retrospective study with a study group of 67 patients (age parameters: mean age 63,88 ± 11,70 yr, range 40-86 yr ; gender : males- 20, females- 47) with maxillary and mandibular posterior partial edentations treated by 3-5 units implant-supported fixed partial dentures (76 FPD; 178 implants) with mean follow-up 7,89 yr (range 3-17 yr) (Table I). Inclusion and exclusion criteria are exposed further. Inclusion criteria: patients' age over 18 yr; maxillary and mandibular edentation (class Kennedy I and II); prosthetic treatment with implant-supported fixed partial dentures; follow-up >3 years from prosthetic reconstruction. Exclusion criteria: systemic diseases affecting abutment implants (non-controlled diabetes, osteoporosis, metabolic disorders); non-compliance to periodontal maintenance sessions.

The study was performed accordingly to the requirements of the 1975 Helsinki Declaration revised in 2008 and CONSORT Guidelines. Written informed consent was obtained from all patients before enrollment.

The data regarding biological complications of implants and technical complications of implants and implant-supported FPD were collected from patient files and radiographic examens. The biologic and technical complications rates as well as the implants survival and success rate were calculated for overall patients as well as in relation to demographic and individual patients' parameters. Implant "survival" is defined as implant still in mouth at the examination session, regardless of the prosthesis status or patient satisfaction. Any implant requiring additional treatment is considered "surviving" implant (Negm, 2016). Implant "success" is associated with implants that are functional and satisfactory. Criteria for implant success are as follows: immobility, absence of peri-implant radiolucency, width of the attached gingiva ≥2mm, absence of peri-implant infection (Kartha et al, 2013).

Biological complications refer to adverse soft tissues' reactions, sensory disturbances, progressive marginal loss (associated to peri-implantitis) and loss of implant osseointegration (Hanif et al, 2017). The definitions of peri-implantitis and peri-implant mucositis were adopted from Lanz (2015), Heitz-Meyfeld et al (2018) and Renvert et al (2019). Peri-implantitis was recorded for sites where there was bleeding on probing associated with peri-implant pocket depth ≥ 5 mm, and radiographically visible peri-implant bone lysis ≥ 2,5 mm. Peri-implant mucositis was diagnosed by the presence of peri-implant soft tissue inflammation with bleeding on probing, associated with a peri-implant sulcus depth <5 mm and no peri-implant bone loss.

The definitions of the mechanical and technical complications were adopted from Hanifa et al (2017). The technical complications (FPD) include fracture/chipping of veneering ceramic and fracture of framework of fixed partial denture. The mechanical complications (FPD, implants) are considered the loss of screw hole access material, screw loosening, screw fracture or implant fracture (Haifa et al, 2017).

Table I. Distribution of patients in study group

	N (%)
Overall	67 (100%)
Age group, N(%)	
40-60 yr	19 (28,4%)
>60	48 (71,6%)
Smoking status, N(%)	
Non-smokers	49 (73,1%)
Smokers	18 (26,9%)
Periodontal history, N(%)	
Yes	18 (26,9%)
No	49 (73,1%)
Oral hygiene (mPI), N(%)	
0	37 (55,2%)

1	24 (35,8%)
2	3 (4,5%)
3	3 (4,5%)
Follow-up (yr), N(%)	
3-5 yr	32 (47,8%)
6-10 yr	18 (26,9%)
>10 yr	17 (25,4%)
Edentation location, N(%)	
Mx	37 (55,2%)
Md	24 (35,8%)
Md + Mx	6 (9,0%)

RESULTS

The results regarding the implants survival and success rate as well as the rates of the biological and technical complications are exposed in table II and figures 1-3.

Implants survival rates were 96,6% (91% at patient level; 92,1% at FPD level). Implants failures rates were: 4,5% at patient level; 7,9% at FPD level; 1,7% at implant level.

The rates of biological complications (peri-implantitis) were 13,5% at implant level (17,9% at patient level; 15,8% at FPD level). The prevalence of peri-implant mucositis was 21,9% at implant level (17,9% at patient level; 23,7% at FPD level). The rates of mechanical/technical complications were 35,8% at patient level, 35,5% at FPD level, and 28,7% at implant level; the most frequent were loss of screw access hole material (31,3% at patient level; 31,6% at FPD level), followed by ceramic veneers fracture/chipping (13,4% at patient level; 11,8% at FPD level), screw loosening (13,4% at patient level; 15,8% at FPD level; 8,4% at implant level), screw fracture (4,5% at patient level; 3,9% at FPD level; 1,7% at implant fracture), implant fracture (4,5% at patient level; 3,9% at FPD level; 1,7% at implant level), FPD framework fracture (4,5% at patient level; 3,9% at FPD level).

Table II. Biological and mechanical/technical complications rates (at patient/FPD/implant level)

	Patients	FPD	Implants
N	67 (100%)	76 (100%)	178 (100%)
Biological complications (peri-implantitis)	12 (17,9%)	12 (15,8%)	24 (13,5%)
Mechanical/technical complications	24 (35,8%)	27 (35,5%)	51 (28,7%)
Ceramic veneers fracture/chipping	9 (13,4%)	9 (11,8%)	
FPD framework fracture	3 (4,5%)	3 (3,9%)	
Loss of screw access hole	21 (31,3%)	24 (31,6%)	42 (23,6%)
Screw loosening	9 (13,4%)	12 (15,8%)	15 (8,4%)
Screw fracture	3 (4,5%)	3 (3,9%)	3 (1,7%)
Implant fracture	3 (4,5%)	3 (3,9%)	3 (1,7%)

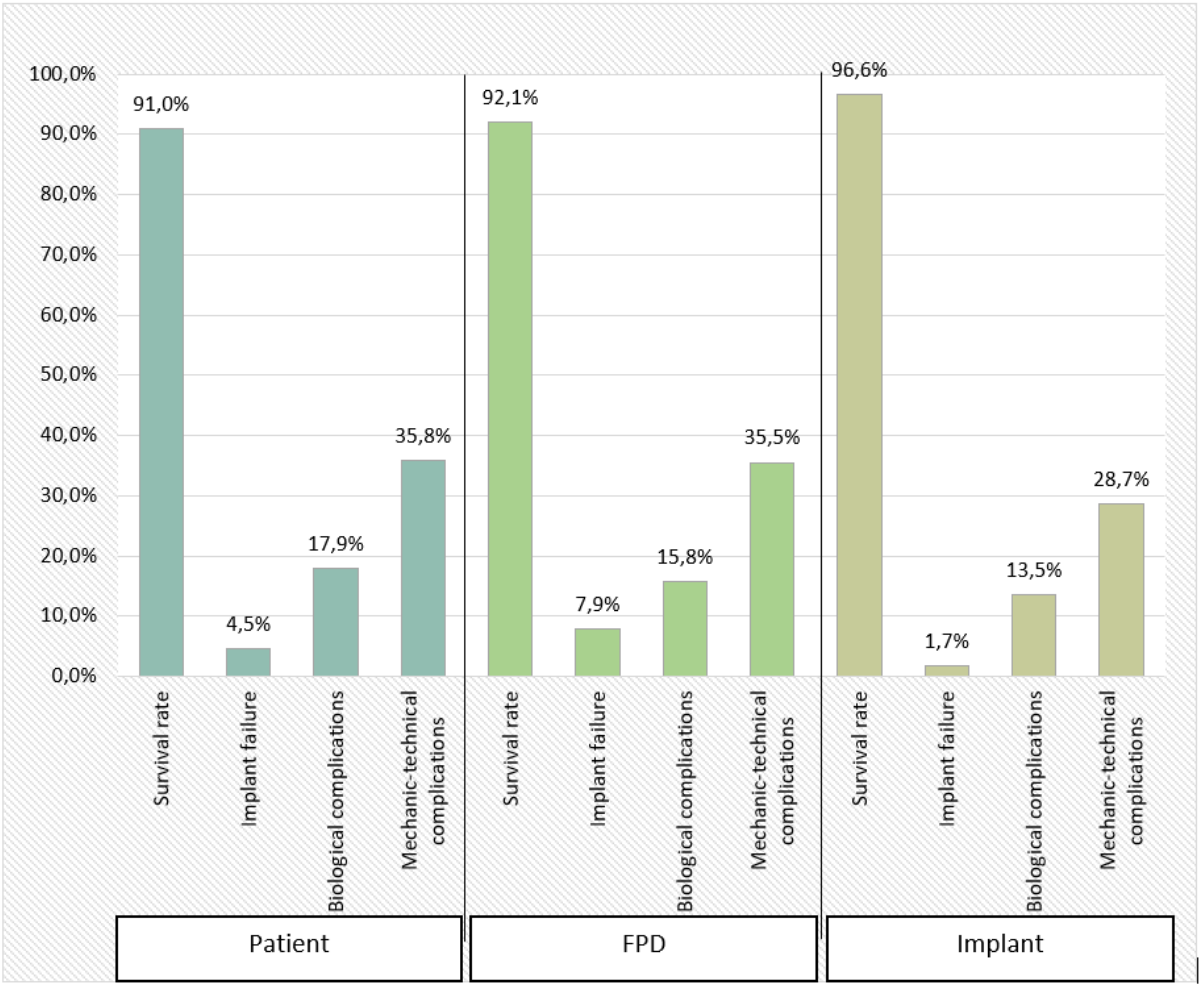

Figure 1. Data regarding implant survival/failure rate,
biological and mechanical/technical complications (at patient/FPD/implant level)

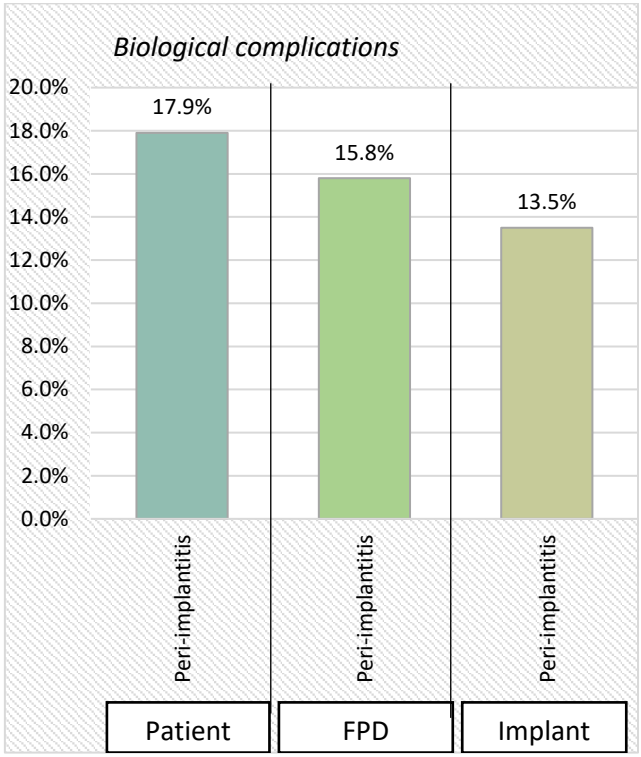

Figure 2. Data regarding biological complications (peri-implantitis) at patient/FPD/implant level

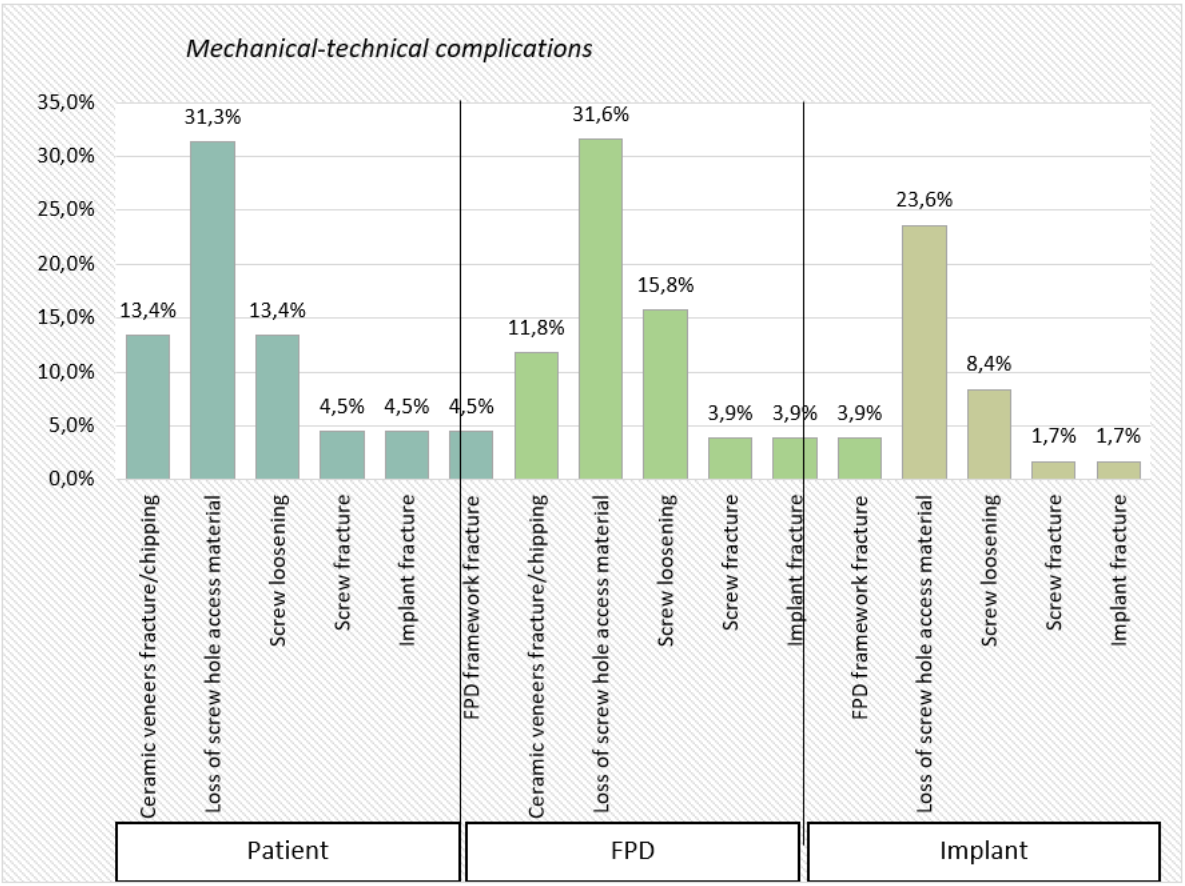

Figure 3. Data regarding mechanical/technical complications at patient/FPD/implant level

DISCUSSIONS

Biological and mechanical/technical complications in metal-ceramic implant-supported fixed partial dentures have a direct influence on the decrease of the success rate of the implant-prosthetic therapy. This personal study evaluated the rates of the biological and mechanical/technical complications at implant, FPD and patient level.

The rates of peri-implantitis (13,5% at implant level; 17,9% at patient level) reported in our study were in range with literature data for implant-supported FPD with mean follow-up >5-year.

Lee et al (2017) performed a systematic review of the prevalence of peri-implant pathology at the implant and patient level, including only clinical trials with a mean follow-up period of at least 3 years. The weighted average prevalence of peri-implantitis at implant and subject level was 9,25% and 19,83%, respectively. The weighted mean prevalence of peri-implant mucositis based on implant and patient was 29,48% and 46,83%, respectively. The research group concluded that the prevalence of peri-implantitis has increased over time; the prevalence of peri-implantitis and peri-mucositis does not show a high level of association, these values being influenced by distinct variables. The reported rates of the biological complications in fixed partial dentures with implant support were reviewed by Wada et al (2021). The prevalence of peri-mucositis ranged from 23,9% to 88,0% at the patient level and from 9,7% to 81,0% at the implant level, while peri-implantitis prevalence varied between 8,9%-45,0% at the patient level and 4,8%-23,0% at the implant level. The highest rates of peri-implantitis were reported by Derks et al (2016) with 24,9% at implant level and 45% at patient level (mean follow-up 8,9yr), followed by Aguirre-Zorzano et al (2015) with 9,8% at implant level and 15,1% at patient level (mean follow-up 5,3yr), and Dalago et al (2017) with 7,3% at implant level and 16,4% at patient level (mean follow-up 5,6yr).When biological complications in the implant-supported fixed partial dentures are reported as "soft tissue inflammation", the range of frequencies is higher (20,2% to 53,0%) at 5 years follow-up (Heydecke et al, 2012).

Mechanical and technical complications are a major risk in implant dentistry leading to increased rates of repairs and remakes as well as the drainage of time and financial resources for patients (Salvi & Brägger, 2009).

In our study, the prevalence of the mechanical and technical complications was 28,7% at implant level, and 35,8% at patient level. These data confirmed reports of reviews of literature (Heydecke et al, 2012, Hanif et al, 2017; Sailer et al, 2018). The frequency of the loss of screw access hole material, fracture or chipping of ceramic veneers, screw loosening, screw or implant fractures was reported by a few studies with a minimum 5-years follow-up. Kreissl et al, (2007) found screw loosening (6,7%) followed by screw fracture (3,9%) as the most frequent mechanical complications, while fracture/chipping of the veneering ceramic was the most frequent technical complication (5,7% of FPD). A systematic review performed by Heydecke et al (2012) highlighted the

ceramic veneers fractures as the most frequent complication in implant-supported FPD (frequency up to 58,1%) at 5 years follow-up, followed by abutment screw loosening and/or abutment screw fracture (3,2%- 16,0%). Sailer et al (2018) reported for 5-year follow-up 11,6% rate of ceramic veneers fracture/chipping but only 0.2% of the metal-ceramic implant-supported FPD failed and had to be replaced due to this technical complication.

Despite these data, practitioners must consider the possibility to prevent most of these complications by proper selection of patients, individualized treatment planning considering the specific risk factors as well as interdisciplinary collaboration in the treatment of the complex cases (Negm, 2016).

Comparison and interpretation of the reported data must be done with caution due to the heterogeneity of definitions and studies design proposed by different research groups (Heydecke et al, 2012; Lee et al, 2017; Wada et al, 2021).

CONCLUSIONS

- Implants abutments of 3-5 units fixed partial dentures exhibited very high survival rates (96,6%); however, rates of biological complications (peri-implantitis) were 13,5% at implant level and 28,7% of implants had at least one mechanical complication.
- The most frequent mechanical/technical complications were the loss of screw access hole material, followed by ceramic veneers fracture/chipping, and screw loosening.
- Diagnostic of complications and additional intervention are required in early stages to prevent the failure of the implant-prosthetic therapy.

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