Review Article

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# Advantages and Limits of Implant-Supported Fixed Partial Dentures with Extension

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## Introduction

Implant therapy is a reliable treatment of choice for the functional and esthetic rehabilitation of edentulous teeth [1,2].

Supra-implant prosthetic restorations, in the case of multiple edentulous teeth, allow the preservation of the teeth bordering the edentulous tooth and, in the case of an edentulous tooth in extension, to avoid a partial removable prosthesis while respecting the principle of tissue economy [3].

We differentiate two types of implant-supported partial fixed prostheses: the implant-supported partial fixed prostheses without extension with or without intermediate (PFPI) and the implant-supported partial fixed prostheses with extension (PFPIE) which consist of a span embedded at one end by one or more implants while the other end is free, these extensions are generally limited to one tooth [4].

In order to determine the indications and choice of these types of prostheses, the advantages and disadvantages of each prosthetic solution must first be clearly established and a precise prognosis must be established in order to provide accurate information and obtain the free and informed consent of the patient.

The objective of our work is to evaluate the interest and limitations of the implant-supported partial denture with extension and to analyze the scientific evidence of its reliability.

## Review of the Literature

The reliability or not of partial implant-supported fixed prostheses in extension (PFPIE) is the object of several studies.

Studies of low scientific level, performed *in vitro*, show biomechanical complications at the level of implants supporting implant-supported partial fixed prostheses (PFPIE) [5,6]. However, numerous clinical studies have provided results that disprove these observations [7-10].

**The literature review reports:**

- A meta-analysis realized by Freitas da Silva published in "the Journal of Oral and Maxillofacial Implants" [7], including randomized clinical trials, prospective and retrospective clinical studies comparing the success and survival of implant-supported partial prostheses with or without extensions through the analysis of the implant survival rate and the level of marginal bone loss, and the presence of prosthetic complications.
- From a systematic review by Storelli in Clinical Oral Implants Research [11] comparing two groups, one with partial fixed prosthetic rehabilitation with extension (PFPIE) supported by multiple implants, and another rehabilitated with two caps with extension supported by a single implant. The studies included

were retrospective and prospective studies analyzing cohorts of a minimum of 10 patients and extended for at least 5 years.
- An article summarizing the conclusions reached at the 5th European Association for Osteointegration (EAO) consensus conference to establish recommendations for the use of PFPIE [12].

The information collected and compared in these studies includes age, gender, number of patients, number of implants, type of implant connector, diameter and length of implants, time of implant and prosthesis placement, and type of prosthesis performed. The average length of the extensions, the direction of the extension (mesial or distal), the type of arch and the area where the implants were placed, information on technical, mechanical (Storelli) and biological complications were also reported.

## Survival Rates

Studies comparing the longevity of different types of fixed denture and implant-supported prostheses show high survival rates for both types of prosthetic rehabilitation [13-17] (Table 1).

For the four studies included in Freitas da Silva's meta-analysis, no significant differences were observed in the prosthetic and implant survival rates of PFIE and PFPI (Table 2) p value.

In the Storelli review, for the group of fixed partial dentures with extensions supported by multiple implants, the prosthetic and implant survival rates were 98.4% and 99.2%, respectively, over 5 to 10 years of follow-up.

In the group of two cantilevered caps supported by a single implant, the prosthetic survival rate was 97.8% and the implant survival rate was 97.05%. However, due to the lack of data in these studies, no conclusions can be drawn regarding the reliability of this therapy.

## Indications

### Significant Bone Resorption

In the case of significant bone defects, a surgical addition of hard tissues will be performed in pre-implantation such as the realization of an apposition graft, an induced bone regeneration, a sinus filling. These complex therapeutic options include a non-negligible complication rate and have limitations in their use in implant practice, which is why adaptive implant treatments such as short or angled implants, or prosthetic treatments such as implant-supported partial dentures in extension can be considered [18,19].

### Failure of Osseointegration

In case of osseointegration failure, if the implant cannot be placed or if the prognosis for implant success is unfavorable, a fixed partial denture in extension will be considered depending on the clinical situation (position of the non-osteointegrated implant and edentulousness class).

### Unfavorable Anatomy

The anatomical constraints are different in the mandible and maxilla and in the posterior and anterior sectors.

**- Maxillary anterior sectors**

The palatal canal runs posterior to the incisors, if it is too large in rare cases, the number and/or ideal positioning of implants may be compromised [20]. The practitioner's decision may be to decrease the number of implants and use an implant-supported prosthesis with extension, paying attention to the prosthetic lever arm.

**- Posterior maxillary sectors:**

The sinus cavities will need to be analyzed by radiographic examination.

**- Mandibular posterior sector:**

The position of the inferior alveolar nerve is variable and it is necessary to properly identify its pathway in the inferior dental canal radiologically and visually during the surgical phase to avoid any intraoperative complications [20,21].

**Table 1:** Comparison of the Prosthetic and Implant Survival Rates at 5 and 10 Years for the Different Types of Dental and Implant-Supported Prosthesis.

| | Prosthetic survival rate | | Implant survival rate | |
|---|---|---|---|---|
| | at 5 years | at 10 years | at 5 years | at 10 years |
| Conventional all-ceramic bridge | 100 % | 87 % | | |
| Ceramic (lithium disilicate) | | | | |
| Bridge on implant with extension | 97 % | | 99 % | |
| Single crown on implant | 96 % | 89 % | 97 % | 95 % |
| Dental-implant supported bridge | 96 % | 78 % | | |
| Implant-supported bridge | 95 % | 80 % | 96 % | 93 % |
| Conventional bridge | 94 % | 89 % | | |
| Conventional bridge with extension | 90 % | 80 % | | |

**Table 2:** Implant and Prosthetic Survival Rates of Implant-Supported Fixed Partial Dentures with and Without Extension (Pfie; Pfpi) Based on Studies Included in the Meta-Analysis by Freitas Da Silva et al. (2018).

| Studies | Survival rate | | | | Follow-up period (in years) |
|---|---|---|---|---|---|
| | Implant | | Prosthetic | | |
| | PFPIE | PFPI | PFPIE | PFPI | |
| Wennström et al. (2004) | NR | NR | NR | NR | 5 |
| Hälg et al. (2008) | 95,7% | 96,9% | 88,9% | 96,3% | 5,3 |
| Palmer et al. (2012) | NR | NR | NR | NR | 3 |
| Kim et al. (2014) | 96,97% | 99,5% | 97,65% | 99,3% | 4,2 |

### - Insufficient Mesio-Distal Space

In the case of narrow mesio-distal anterior edentulousness, mainly involving a lateral incisor and a canine, a complex esthetic management situation is encountered. A treatment consisting of placing a single implant in the canine position and performing an implant-supported prosthesis with mesial extension would be a viable solution [22].

### Limits

As the length of the extension increases and the diameter of the implant decreases, the forces on the bone around the implant increase [23-25].

In the presence of an extension, lever arms can develop. These can lead to implant and prosthetic complications [26-29].

Many authors have stated that the maximum stresses are localized at the implant closest to extension: compressive stresses at implants close to extension and tensile stresses at implants farther away [30-34] (Figure 1).

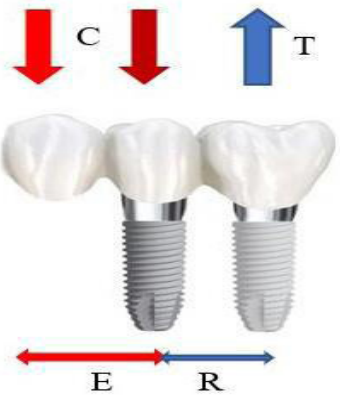


**Figure 1:** Diagram of the forces acting on the extension C: Compression force (red arrow) and E: Leverage arm (of the effort); T: Traction force (blue arrow); R: resistance arm.

In the literature, no consensus on the length of the extension has been described; however, studies agree that extensions limited in length decrease the number of implant-prosthetic complications.

In an *in vitro* study, Wang used a computer simulation method to analyze the mechanical stress/strain distributions under normal and overload conditions compared between implant-supported prostheses with and without extensions. Bone resorption due to overload was greater in the bone surrounding the implant neck supporting the extension prosthesis compared to the conventional prosthesis [6].

## Complications

### Technical Complications

In the Storelli study, they are classified according to their severity into major complications, leading to treatment failure: implant fracture, framework fracture, and minor complications in case of prosthetic screw fracture (in the intermediate abutment), screw unscrewing or cosmetic ceramic fracture [11]

In the same study, in the group of PFPIE supported by multiple implants, the total rate of prosthetic complications was 26.6%. This result was comparable to the total complication rate observed in the study by Pjetursson et al. (2012) [35]. The majority of complications were considered minor and involved cosmetic ceramic fractures. Three cases of implant fractures were reported which represents a very low rate of so-called major complications (0.31%) [11].

### Biological Complications

Freitas da Silva's study reported significantly more biological and technical complications for PFPIE compared to PFPI (p=0.08) [7].

One hypothesis to explain this difference would be that the presence of an extension would lead to a difficulty in access to hygiene for the patient, would influence the accumulation of biofilm in this area and consequently the evolution of biological complications [10].

In Storelli's review, 4 studies reported a 6.06% rate of peri-implantitis occurrence in the group of PFPIE supported by multiple implants.

### Level of Marginal Bone Loss

In the meta-analysis by Freitas da Silva, no significant difference was reported between PFPIE and PFPI regarding the level of marginal bone loss (p=0.14) [7]. Similar results are observed in the systematic review by Storelli [11].

## Conclusion

Extensions can be used in the fabrication of fixed prostheses and do not negatively interfere with the survival or success of the prostheses or the marginal bone loss around the implants. However, minor complications have been noted for prostheses without extensions or with short length extensions as shown in the meta-analysis by Freitas.

There are no recommendations in the literature regarding the performance of PFPI. What stands out in these studies is the correlation between the length of the extension and the increase in force distribution around the implants supporting the prosthesis. All agree that the success of using an extension in implant-supported partial dentures is multifactorial and depends on both the clinical situation and the experience of the practitioner [9,37-39].

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