Review

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Terapias de extração parcial (TEP): uma revisão da literatura

Partial extraction therapies (PET): a review of the literature

Bruno Machado de **Carvalho**[1] 0000-0002-6403-0204
Helen Silvia Fernandes da Silva **Oliveira**[1] 0000-0002-3436-8634
Phaloma Silva **Pereira**[2] 0000-0001-6987-4839
Sarah Faria de Assis **Viana**[1] 0000-0002-6390-3886

ABSTRACT

One of the most common dental procedures is tooth extraction; however, the bone defect resulting from the process is only partially restored, leading to considerable bone loss. To rehabilitate a fully or partially edentulous patient, we must handle these sites with delicate surgical procedures. There is a large literature presenting attempts to overcome the negative effects of a dental extraction, with the aim of reducing tissue volume loss or restoring the alveolar architecture. In this context, Partial Extraction Therapy (PET) represents a subgroup of interventions to prevent bone loss after extraction using the tooth itself to prevent alveolar bone loss. This literature review aims to make a survey of the published articles on PET, with an emphasis on socket shield technique, and to explain the other techniques such as root burial, pontic-shield and proximal socket-shield, their indications and counter indications in order to deepen the knowledge of these techniques. To identify the

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[1] Instituto de Pesquisa e Pós-graduação em Odontologia do Espírito Santo, Essence. Vila Velha, ES, Brasil.
[2] Centro de Estudos e Pesquisas, Ceddar. Av. José Rocha Bomfim, 214-221, Jardim Santa Genebra, Campinas, SP, Brasil. Correspondence to: PS Pereira. E-mail: <phaloma.s.p@gmail.com>.

included or considered studies, we adopted a detailed search strategy for MEDLINE and Cochrane Library focused in the last 31 years, whose language was English, Spanish or Portuguese. This text presents an analysis of current data regarding the alternatives for alveolar preservation and the installation of immediate implants in these areas, presenting the possibility of a different surgical technique. However, due to the immaturity and lack of conclusive scientific evidence regarding the predictability of the procedures, it is considered that the use of the socket shield technique must be done in an extremely cautious way.

Indexing terms: Alveolar bone loss. Bone resorption. Dental implantation. Tooth socket.

RESUMO

Um dos procedimentos odontológicos mais comuns é a extração dentária, contudo, , o defeito ósseo decorrente do processo é apenas parcialmente restaurado, levando a uma perda ossea volumétrica consideravel. Para reabilitar um paciente totalmente ou parcialmente desdentado, devemos manusear estes sitios com intervenções cirúrgicas delicadas. Há uma vasta literatura apresentando tentativas de transpor os efeitos negativos de uma extração dentária, com o objetivo de diminuir a perda volumétrica tecidual ou restaurar a arquitetura alveolar. Neste contexto, a Terapia de Extração Parcial (TEP) representa um subgrupo de intervenções para prevenir a perda óssea após exodontia, usando o próprio dente para prevenir a perda óssea alveolar. Essa revisão de literatura tem por objetivo fazer um levantamento dos artigos publicados sobre as TEP, com ênfase na técnica de socket shield, e explanar a cerca das demais técnicas como sepultamento radicular, *pontic-shield* e *proximal socket-shield*, suas indicações e contra-indicações, a fim de aprofundar o conhecimento dessas técnicas. Para a identificação dos estudos incluídos ou considerados, adotamos a estratégia de busca detalhada para os bancos MEDLINE e Biblioteca Cochrane nos últimos 31 anos, cujo idioma fosse o inglês, espanhol ou o português. Este texto, apresenta uma análise de dados atuais a respeito das alternativas para a preservação alveolar e instalação de implantes imediatos nestas áreas, apresentando a possibilidade de uma técnica cirúrgica diferenciada. No entanto, devido a imaturidade e falta de comprovação cientifica contundente a respeito da previsibilidade dos procedimentos, considera-se que o emprego da técnica de socket shield deve ser feito de forma cautelosa.

Termos de indexação: Perda do osso alveolar. Reabsorção óssea. Implantação dentária. Alvéolo dental.

INTRODUCTION

The alveolar process is a tissue dependent on the presence of the tooth, where its development follows the stages of tooth eruption [1]. The volume and shape of the alveolar process are determined by the shape of the tooth, its axis of eruption and eventual inclination [2]. Tooth extractions are accompanied by multiple dimensional changes in the remaining alveolar bone, beginning an atrophy process, with the disappearance of the dental alveolus and the hard lamina [3,4].

One of the most common dental procedures is tooth extraction and even in a successful bone repair process, the subsequent bone defect is considerable [5]. Maintaining the volume of the structure after an extraction procedure is one of the main challenges faced by professionals today and, due to these changes, the predictability of appearance obtained in soft and hard tissues after surgical interventions is very limited [6,7], leading to a reduction in size of the rapid residual ridge in the first 6 months, with resorptive activity continued throughout the patient's life [8].

Currently, there is a vast literature showing attempts to overcome the negative consequences resulting from tooth extraction, with protocols to reduce this tissue volume loss (alveolar preservation techniques) or to restore the alveolar architecture (bone and gingival tissue increase) [6,9].

In this context, Partial Extraction Therapy (PET) represents a subgroup of interventions to prevent bone loss after extraction, which uses the tooth itself for this purpose, by preserving the tooth root in the socket [9]. It is expected with this literature review, to acquire information about partial extraction techniques and their therapeutic possibilities, to improve the clinical judgment capacity regarding its application and selection of techniques, offering a treatment with greater predictability to the patient.

METHODS

In order to identify the studies included or considered in this review, a detailed search strategy was carried out for the MEDLINE and Cochrane Library banks in the last 31 years. The following keywords were used: alveolar process, tooth and oral surgery. Because it is a new technique, search terms that were not found within the Health Descriptors were used, such as socket shield, partial extraction therapies, root submergence, ponticshield, proximal socket shield.

Inclusion criteria were: clinical, laboratory and review articles that studied Partial Extraction Therapy. The exclusion criteria were articles with flaws in the methodology, which did not explain the technique clearly and with dubious results, in addition to articles with patients with some systemic alteration. Initially, it was decided to include only randomized controlled studies, however, due to the lack of clinical trials, cohort and randomized studies, it was decided to include clinical case reports.

RESULTS

A total of 31 articles were found using the keywords selected for the search strategy. The titles and abstracts of these articles were separated and after an analysis, according to the inclusion and exclusion criteria, 25 articles presented in charts 1, 2, 3 and 4 were selected and discussed. The data were analyzed, crossed and debated for the writing with the conclusive results.

Currently, the concept of PET as a collective treatment group for the maintenance of alveolar bone and its subsequent post-extraction resorption does not exist, the techniques are considered relatively new and have no proven efficacy in an emphatic way in the current literature. Consequently, it can be difficult for the clinician to discern the indications and contraindications for each one [9].

The indications overlap, however, each therapy is adequate for a certain purpose [9], considering that the common objective between them, is always related in some way to the possibility of preserving the socket as an applicable technique, with the possibility of maintaining the dimensions of a certain shape [6]. Again, we must emphasize that with the materials currently available, the complete preservation or total regeneration of structures after tooth extraction has not yet been documented [6].

Trying to elucidate the complications in choosing the technique, Gluckman et al. [9], proposed a classification and indication table to guide clinicians, which are described in chart 1.

Chart 1. Partial Extraction Therapies (PTE) and their indications [9].

TEP	Clinical situations indicated
Root burial	Crown or dental root irretrievable or indicated for extraction
	Absence of apical pathology
	Pulp amputated healthily or complete endodontic treatment
	Intention to preserve the alveolar process
	Design of removable full or partial dentures
	Maintenance of alveolar bone under fixed prostheses
	Maintenance of alveolar bone under cantilever
	Planning dental implants in patients still in the growth phase who had a condemned tooth
	Preservation of the alveolar process in conjunction with other PET
Socket-shield	Crown or dental root that cannot be restored or indicated for extraction
	Dental root with or without apical pathology
	Intention to preserve the alveolar process, especially to preserve the buccal bone plate
	Installation of Immediate Implants
	Preservation of the alveolar process in conjunction with other PET
Pontic-Shield	Crown or tooth root irretrievable or indicated for extraction
	Dental root with or without apical pathology
	Intention to preserve the alveolar process
	Maintenance of alveolar bone under fixed prostheses
	Maintenance of alveolar bone under cantilever
	Preservation of the alveolar process in conjunction with other PET
Proximal socket-shield	Dental crown or root irretrievable or indicated for extraction
	Dental root with or without apical pathology
	Intention to preserve the interdental papillae
	Installation of two or more adjacent immediate implants
	Preservation of the interdental papilla in conjunction with other PET

Description of techniques

A common point for all PET is the removal of the dental crown from the tooth diagnosed as irretrievable or indicated for extraction, in addition to preserving all or part of its root, as well as the periodontal tissues associated with it [9].

The preservation of part or all of the root contour around the region where the implant is positioned, shows a promising alternative to existing and less expensive methods. In the following, we will describe, in a simple and succinct way, the step-by-step for the execution of each of the PET techniques.

Radicular burial

This technique requires the absence of apical, periodontal pathologies or that its endodontic treatment has been successfully performed. The separation of the dental crown at the bone level and the cervical portion of the worn root are carried out, in order to imitate the future oval pontic that will remain on it, followed by soft tissue closure, ensuring regeneration by first intention. The site will have to be repaired for a period of 3 months before any pontics will put pressure on it. Theoretically, the technique makes it possible to preserve the entire structure of the existing alveolar bone in a vertical and horizontal way [9].

Socket-shield

In the socket-shield technique, the separation of the dental crown 1mm above the bone crest is performed with a long-tapered, multi-laminated drill indicated for odontosection. The root is then sectioned longitudinally, with the same drill, as apical as possible, in the mesio-distal direction, generating two separate root segments, one buccal and one palatal / lingual.

The palatal root segment must be removed, in an atraumatic manner, together with any apical pathology that may be present, then we wear the palatal face of the vestibular segment, with a long diamond drill bur, refining it and shaping it concave [10].

Pontic-shield

The pontic-shield technique involves the same preparation as the socket-shield and the part corresponding to the palatal root fragment, grafted with a slow-resorpting bone substitute. The socket should be sealed, preferably with a soft tissue graft. The operated site must have a repair period of 3 months, when, then, it can suffer a gradual pressure from the pontic on it [9].

Proximal socket-shield

This technique recommends the preservation of the interproximal region of the bone and soft tissue around the implant (papillary region), following the same preparation parameters used to perform the socket shield and ponticshield technique, but it keeps treated fragments from the mesial and distal region [11,12].

DISCUSSION

The first mentions of the “socket shield” technique were in the studies by Hürzeler et al. [13], by intentionally leaving a buccal portion of the tooth root, covered by an enamel matrix derivative (Emdogain, Straumann). With the “alveolar shield” prepared, the periodontal ligament-hard lamina set is kept intact, its vascularization and the support of the buccal bone plate for the implant and its crown [9,11,13].

The most important findings of the histological analysis made by Hürzeler et al. [13], were the covering of the inner portion of the root remnant with a new cement and periodontal ligament and the

presence of cement on the implant surface, when it was installed in direct contact with the root fragment, a fact that may be related to the use of an enamel matrix derivative.

Subsequently Baümer et al. [5], conducted a study in animals in a similar way, however, using a larger sample (a total of 12 implants) and without using an enamel-derived matrix (Emdonain). This was intended to assess whether the technique can also work in cases where the vestibular remnant has a vertical fracture; details on the articles made on animals found are described in chart 2.

Chart 2. Studies conducted on animals [14].

Authors	Sample	Relationship of the implant with the remaining root	Type of installation and loading protocol	Adverse effects	Time of study duration
Parlar et al. [15]	9 dogs 9 implants	proximity	Immediate	Formation of cement in 2/4; Formation of tissue similar to PDL; Fibrous tissue formed around the implant, fails to osseointegrate.	4 months
Hurzler et al. [13]	1 dog 4 implants	2 proximity 2 Contact	Immediate	2/4 formed cementum tissue - in contact with the root); formation of tissue similar to LPD	4 months
Baumer et al. [5]	3 dogs 4 implants	Contact	Immediate	None	4 months
Guirado et al. [16]	6 dogs 36 implants	G1: root thickness <2mm, bone <3mm; G2: root 2-4mm, bone <3; G3: root> 4mm, bone <3mm; G4: root <2mm, bone> 3mm; G5: root 2-4mm, bone> 3mm; G6: root> 4mm, bone> 3mm.	Immediate	Best results when we have a bone remnant greater than 3mm and a thickness of root remnant less than 2mm.	3 months

As the vertical fracture cannot be left in the remainder, a modification to the technique was proposed, consisting of separating the vestibular segment into two parts. The samples were evaluated histologically and volumetrically; what showed a vestibular region of the alveolar bone higher in height than the lingual region; the apical region of the root remnant did not show resorption and showed the presence of a new bone formation between the implant and the root remnant.

Along with this experiment, a case report [6] was presented, which was evaluated volumetrically between the time of preparation for the implant installation and 5 months later; which showed an average bone loss of 0.66 mm in the vestibular region, another assessment was made between the removal of the scar and the placement of the final restoration, presenting an average of 0.22 mm more of resorption. The results found were in agreement with those found in a study by Hürzeler et al. [13].

Recently, another study conducted, with a total sample of 36 implants, divided into groups and installed in 6 dogs, presented interesting results evaluating two aspects prior to the installation of the implants: the thickness of the bone and root remnants. The evaluation of these aspects, showed that the probability of better results, when a structure of bone remnant greater than 3mm is combined with a thickness of root remnant less than 2mm, which would make the use of the technique in this scenario more predictable [17].

Only one case-control study has been published so far, showing good results in terms of bone loss, aesthetics and soft tissue volume, with an average bone loss of 0.8mm (2%) in 24 months [15]. In addition to these [6,9,11,13,17] several case reports presented (charts 3 and 4) based on the alveolar shield technique have been published, most of which report the use of the technique for single implant restorations in the anterior aesthetic region.

Chart 3. Clinical case studies not mentioned by the literature review presented [14].

Authors	Sample	Relationship of the implant with the remaining root	Type of installation and loading protocol	Adverse effects	Time of study duration
Gluckman et al. [9]	1 pacient 2 implants	Not specified	Immediate (healing abutment) 4 months after the procedure (definitive)	None	2 years
Mitsias & Mahajan et al. [20]	1 pacient 1 implant	proximity	Not specified	None	Not specified
Al-Dary et al. [10]	1 pacient 1 implant	Not specified	Immediate provisional crown implant in the left CI After 5 months, zirconia crown	None	5 months

Chart 3. Clinical case studies not mentioned by the literature review presented [14].

Authors	Sample	Relationship of the implant with the remaining root	Type of installation and loading protocol	Adverse effects	Time of study duration
Fonseca & Nunes [21]	1 pacient 1 implant	Not specified	Immediate	None	8 months 1 month after placing the final 1 implant 6 months 2.4 years
Baumer et al. [5]	10 pacients 10 implants	Not specified	6 with healing abutment 4 Temporary crown Loading 5 months after	None	5 years
Saeidi Pour et al. [22]	1 pacient 1 implant	Not specified	healing abutment Loading after 3 months	None	Not specified after installing the final crown.
Roe et al. [23]	1 pacient 1 implant	proximity	Immediat Loading after 6 months	None	12 months 24 months

All clinical data collected in humans, cited by Gharpure and Bhatavadekar [14], show short-term follow-ups, therefore, with weak evidence strength; both the case reports presented in the studies by Hürzeler et al. [13] and Baümer et al. [5], and nine of the twelve studies described in chart 4, were followed up for a maximum of 12 months.

The only study shown in series cases, with an evaluation time greater than 1 year was the one presented by Simorphas et al. [17], but a significantly different technique was used, in which the osteotomy was performed on the root of the tooth intact. An important observation made by the authors [19], concerns the choice of implants, which is not standardized and which apparently did not influence the results found.

In addition to the studies analyzed by Gharpure and Bhatavadekar [14], others were found and described in chart 3, as is the case presented by Al Dary and Al Hadadi (2015), describing a case in which a modified technique was used to obtain the shield alveolar, using a “bonetrephine” instead of a “fussurbur” to prepare the alveolar shield, which proved to be of great advantage to prevent iatrogenesis.

Chart 4. List of the first case control study and 12 other clinical case studies that describe the socket shield technique [14].

Authors	Sample	Relationship of the implant with the remaining root	Type of installation and loading protocol	Adverse effects	Time of study duration
Hurzeler et al. [13]	1 pacient 1 implant	contact	immediate immediate	None	6 months
Baumer et al. [5]	1 pacient 1 implant	proximity	immediate 6 months after the procedure	None	6 months
Abadzhiev et al. [24]	25 pacients 26 implants	Not specified	immediate immediate	0.8mm (2%) bone loss	24 months
Roe et al. [23]	1 pacient 1 implant	contact	immediate immediate	None	12 months
Chen et al. [8]	1 pacient 1 implant	proximity	immediate 4 months after the procedure	0.72mm vestibular horizontal bone loss	12 months
Cherel and Etienne [12]	1 pacient 2 implants	Not specified	immediate immediate	Small portion of the visible root fragment after removal of the temporary crowns	11 months
Siormas et al. [17]	46 pacients 46 implants	proximity	immediate immediate	Average alveolar bone loss from 0.18 to 0.09 in the mesial and 0.21 to 0.09 in the palate 1 case of resorption of the root remnant	24 a 60 months

Chart 4. List of the first case control study and 12 other clinical case studies that describe the socket shield technique [14].

Authors	Sample	Relationship of the implant with the remaining root	Type of installation and loading protocol	Adverse effects	Time of study duration
Glocker et al. [25]	3 pacients 3 implants	proximity	6 months after the procedure Not specified	None	6 months
Troiano et al. [11]	7 pacients 10 implants	contact	immediate 3 months after the procedure	1.3 to 0.2 bone loss	6 months
Gluckman et al. [26]	1 pacient 1 implant	contact	immediate immediate	None	12 months
Al Dary e Al Hadadi [10]	1 pacient 1 implant	Not specified	immediate immediate	None	5 months
Wadhwani et al. [27]	1 paciente 1 implante	Not specified	immediate 4 months after the procedure	None	4 months
Legas et al. [19]	16 pacients 16 implants	proximity	10/16 Immediate	1 failure due to infection 1 case showed deficiency of the alveolar contour	0.5 to 2.85 years
Mitsias et al. [28]	1 pacient 1 implant	contact	immediate immediate	4mm depth of probe around the implant, after 3 months	36 months
Holbrook 2016	1 pacient 1 implant	contact	immediate immediate	None, confirmed by RCB after 1 year.	12 months

Numerous changes have been made by different authors over the years; like the proximal socketshield technique, for example. When presenting the technique, these authors [12] confirmed their idea that the retention of the vestibular portion of the root with the immediate installation of implants is capable of achieving osteointegration effectively; within the known limitations of a preliminary study [13].

According to the group's previous study, Baümer et al. [5] also found similar results, when reporting the non-occurrence of bone remodeling in the vestibular follow-up. However, unlike the results of the study by Hürzeler et al. [13], observed that between the implant surface and the dental fragment, the formation of bone structure occurred instead of connective tissue or cement, a finding that was attributed to the non-use of enamel matrix derivatives in the area as in the previous study.

Two more articles [17,24] presenting experiments carried out on animals, were found during the research. One of them presented by Guirado et al. [16], emphasized that the technique does not guarantee a higher survival rate of the implant, but it brings the possibility of minimizing perimplant bone loss. The main differentiating factor of this study in relation to the others was the introduction of different dimensional measures of the preserved fragments (chart 2), which led to a conclusion that is in agreement with the previous studies, but with a caveat related to the thickness of the root remnant that, according to researchers, when it exceeds 2mm is not as beneficial as expected. On the other hand, when the perimplant bone remnant exceeds 3mm, the behavior of the observed surrounding tissue was of higher quality.

It is worth noting that, even before the initial description of the technique, a study preceded the idea with a similar surgical technique, Parlar et al. [16], when analyzing implants installed in 9 dogs that had their canines prepared similarly to the technique described above [6,13], with the intention of evaluating the possibility of formation of periodontal structures on titanium surfaces; however, this study, unlike the previous ones [6,13], presented some negative occurrences, such as: formation of fibrous capsule around the implants and failure in osseointegration.

All studies previously listed [6,13,17,24] had a short observation time, so the durability of the installed implants cannot be observed; in the study by Parlar et al. [15], the failure of some implants was evident, unlike the implants of Hürzeler et al. [13], Baümer et al. [5], and Guirado et al. [16], who observed the formation of connective and bone tissue structures, described in Chart 2.

A systematic review was found, carried out by Gharpure and Bhatavadekar [14], relating a series of studies carried out in humans evaluated up to the year of publication, which shows short-term follow-ups, therefore, with weak evidence strength; both the case reports presented in the studies by Hürzeler et al. [13] and Baümer et al. [5] and nine of the twelve studies described in Chart 4, were followed up for a maximum of 12 months, all with promising results, demonstrating cases in which there was preservation of structure and little resorption with only one case, reported by Cherel and Etienne [12].

Among the studies that lasted more than 12 months, similar results were found, but with a higher incidence of adverse effects, such as: resorption of the root remnant that occurred in one of the cases of Simorphas et al. [17], who presented the only case study in series, but with a slightly different technique; one failure due to infection and one due to deficiency in the alveolar contour, in the study by Lagas et al. [19], which included 16 patients and 16 implants in total; and finally, a case in which a drilling depth of 4 mm was observed around the implant after three months of installation [20].

Only one case-control study has been published to date, showing good results in terms of bone loss, aesthetics and soft tissue volume, with an average bone loss of 0.8mm (2%) in 24 months, without showing adverse effects significantly bad [16].

Chart 3 shows a list of case reports based on the socket shield technique recently publishe with different evaluation times, presenting extremely promising results, but without significant scientific evidence.

CONCLUSION

Through histological analysis, it was observed the coverage of the inner portion of the root remnant with a new cementum and periodontal ligament and the presence of cementum on the implant surface, when installed in direct contact with the root fragment.

We can also consider the probability of better results, in relation to the preservation of bone and soft tissue; when a bone remnant structure greater than 3mm is combined with a root remnant thickness less than 2mm, which would make the technique more predictable. According to the analyzed articles, the type of implant did not influence the results found.

Due to the immaturity and lack of overwhelming scientific evidence regarding the results and predictability of the procedures, it is considered that the use of the socket shield technique should be done with caution, considering the need to present papers with more evidence to prove their efficiency.

Collaborators

BM Carvalho, study design. HSFS Oliveira, analysis and interpretation of data. PS Pereira and SFA Viana, analysis and interpretation of data. Analysis and interpretation of data.

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