F. ROSSI[1], M.E. PASQUALINI[2], L. GRIVET BRANCOT[3], D. COLOMBO[4], M. CORRADINI[5], B. LORÈ[6], L. CALABRESE[7]

[1] Private practice Busto Arsizio, Italy.
[2] Private practice Milano, Italy.
[3] Private practice Torino, Italy.
[4] Private practice Como, Italy
[5] Private practice Trento, Italy
[6] Chair in Maxillo Facial Surgery University Tor Vergata of Roma.
[7] Director of Maxillo Facial Surgery University Tor Vergata of Roma.

Minimally invasive piezosurgery for a safe placement of blade dental implants in jaws with severe bone loss

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ABSTRACT

Aim Severe atrophies of edentulous jaws require major reconstructive bone surgery in order to allow the placement of root-form implants with standard diameter. These bone augmentation techniques represent the best option reported in the literature, but they are often rejected by patients because of their high economic and biological costs in addition to the possibility of failure in the short and/or long term. In the maxilla regenerative methods (onlay, inlay, and distraction) have high success rates, whereas in the mandible, especially in the distal atrophic area, they are not so predictable. In such situations an alternative technique for fixed prosthethic rebilitation is the insertion of platform blade implants, which have their elective indication for atrophic bone ridges with reduced width, owing to their reduced thickness. The aim of this study is to assess the effectiveness of the use of piezoelectric ultrasonic handpieces, in order to simplify the placement of blade implants, making it safer and less traumatic than with conventional surgical procedures.
Materials and methods Platform blade implants are extension implant functionally and aesthetically reliable, even if they require a more difficult surgical technique compared with the one currently in use for screw implants. A minimally invasive procedure by means of piezosurgery that was performed on 142 subjects is presented and a case is reported which highlights the successful results.
Results and conclusion The use of piezoelectric ultrasonic handpieces simplifies the surgical procedure for the placement of blade implant, making it safer and less traumatic.

KEYWORDS Blade implants, Inferior alveolar nerve; Minimally invasive surgery; Piezosurgery; Posterior mandibular atrophy.

INTRODUCTION

The scientific progress in oral implantology gave rise to enhanced surgical techniques aimed at increasing the volume of atrophic ridges in view of the subsequent placement of implants. These bone regeneration procedures are achieved mainly by means of bone grafts (onlays-inlays) or of distraction osteogenesis (1-7). However, they imply different levels of stress that risk patients can not afford. Furthermore, their outcomes are not enough predictable and complications are numerous (8-18). Consequently, bone regeneration procedures can be performed only in selected cases. In particular, in the lower jaw the use of standard diameter root-form implants often results in problems during insertion owing to insufficient bone volume.
Atrophic areas, being generally highly mineralized and poorly vascularized, do not respond positively to the various grafting techniques because of the possibility of failure and their high biological cost. For these reasons, according to EBM (Evidence Based Medicine), these techniques are not sufficiently predictable (19 -22).
An alternative to augmentation techniques in posterior areas of the jaw with severe horizontal and vertical resorption and with bone width less than 3 mm, is offered by the placement of platform or blade implants with reduced thickness.
Blade implant were developed by Linkow and Roberts at the end of the 60s of the last century, when they created an endosseous implant with an all-in-one abutment with a fixture of variable form, for the adaptation in different bone sites. Over the years, Leonard Linkow modified and improved both the shape and the implant surface (23-26).
In 1972 Ugo Pasqualini presented the "polymorphic blade", which is the only implant that can be shaped according to the morphological characteristics of the bone in which it has to be inserted.
The polymorphic blade is a one stage implant, structured with an emerging threaded part which prevents that external mechanical stresses (caused by swallowing,

	AGE	N. IMPLANTS	5 YEAR SUCCES RATE	AVG SUCCESS RATE
Male (59)	51-60	3	94,8	93,4
	61-70	31	93,1	
	> 71	25	92,4	
Female (83)	51-60	12	95,3	94,2
	61-70	39	94,6	
	> 71	32	92,7	
TOTAL		142	93,8	

TABLE 1 The table summarizes the 142 cases of mandibular distal atrophy treated with blade implants.

tongue and jaw muscles) reach the submerged structures. In 1972 Ugo Pasqualini wrote: «The best conditions for rapid healing of surgical wounds, unavoidable for the insertion of implants, with bone recovery around, above and through implants themselves, occur only when these have been completely submerged, without communication with the outer site. This is useful not so much to eliminate the dreaded but unlikely risk of microbial contamination, but rather to prevent that the lever arm of the external abutment transfers dangerous mechanical stresses to the inner part, thus subjecting the implant to continuous mobilizations that could affect the achievement of including osteogenesis (that is osseointegration)» (27-30).

Conventional blade implant insertion is performed in open flap surgery, in order to expose the bone ridge where a sagittal cut is performed for the placement of the submerged part of the blade (minimum bone thickness required is 2 mm). Grooves are made by means of a fissure bur (according to the length of the shank) mounted on a handpiece. They should accommodate all the intraosseous part of the blade. The drilling of the bone requires simultaneous cooling of the surgical site by means of irrigation with saline solution. The blade is manually placed on the groove, and then locked in place by gently hammering it with a mallet. The blade should lie at least 2 mm below the edge of the ridge, in order to be completely covered by bone tissue during the healing period (31-33).

This technique requires considerable surgical skill during groove preparation, the cut has to be very accurate and precise. In order to overcome problems connected to inaccuracy of the operator's hand or unpredictable movements of the patient, Linkow recommended to perform a series of small holes on the cortical surface and subsequently merge them using a fissure bur. We recommend the use of Geyer's cog wheel, which is a low speed contra-angle bur, made of an indented disk 1 mm thick and 5 mm in diameter, which is used to draw a grove along the cortical bone, and then the cut is deepened through the bone with a fissure bur (34-36).

Recently thanks to piezosurgery, the placement of blade implants has become more precise and safer since deeper soft tissues, particularly those inside the mandibular canal, are not traumatized (37-38).

A protocol was devised using an ultrasonic surgery device and, in order to assess its advantages, in terms of selective micrometric, precise and secure cutting, a multicenter study was performed.

MATERIALS AND METHODS

In order to assess the procedure, a multicenter study was carried out in five Italian private practices (Busto Arsizio, Milano, Torino, Como, and Trento) on 142 subjects with atrophic edentulous posterior jaw (Table 1), between 2005 and 2008, and the 5 years follow up in 2013. The study was carried out in accordance with the ethical standards specified in the Declaration of Helsinki and written informed consent was obtained from all participants, prior to their inclusion in the study.

Inclusion criteria were the following: atrophic edentulous posterior jaw requiring implant-supported prosthetic rehabilitation.

All subjects were treated following the same surgical procedure, local anesthesia included. Local anaesthesia was performed by injecting a reduced dose (0.90 ml x 1) of articaine 40 mg/ml with adrenaline 1: 100,000 on both sides of the bone crest, or with the use of intraligamentary anaesthesia (Peripress) along the edentulous ridge (39).

These topical anesthetics allow to keep a deep sensitivity, which is perceived by the patient even close to the mandibular nerve, and it guarantees the absolute respect of the vascular-nervous structure. Nerve-block anesthesia is absolutely contraindicated even with any other implant technique.

Surgical procedure

The flap should be raised on the ridge without vertical incisions, allowing for adequate blood supply to the atrophic bone and direct observation of the entire morphology and topography of bone itself. Once the bone is exposed, the muco-periosteal tissues are dissected with the periosteal elevator and gently folded down. A surgical gap is achieved, using the flat serrated insert (ES071) of the Ultrasonic Bone Surgery unit (Italia Medica Srl; Milano, Italy). After radiographic and anatomic analysis by means of OPT and Cone Beam CT, a blade implant of adequate size is inserted (in the case presented it is 12 mm in length).

The surgical gap should meet the following requirements: equal or slightly longer than the mesio-distal length of the implant selected, a width in the buccal lingual sense slightly narrower than the width of the upper edge of the implant blade (blade's shoulder thickness 1.4 mm, lower edge thickness 0.5 mm), so as to prevent its passive insertion in the furrow but for some millimeters, in order to immediately achieve primary stability, after implant insertion (press-fit). The depth should be equal to the height of the implant blade, from its lower edge to the basis of the screw abutment. The height of commercially available blades generally varies from 5 to 12 mm (in this case it is 9 mm). The implant blade is inserted into the grove by locking it in place with a special chisel awl; the groove is prepared by means of a special serrated piezosurgery device. The shoulder of the implant must lie at least 2 mm below the edge of the bone crest. The mucosa is then sutured with interrupted sutures (40).

Post-surgical procedure

In our multicenter study, polymorphic one-stage blade implants were used with screwable abutments (approved with CE 0301, CE 0476 Single-stage blade, CE 0476 Mini blade, Single-stage double-abutment blade EC 0068/ QCO-DM038-2009, validated in the European Union).

After a period of at least 3 months, healing caps are removed, the final abutments are placed and the prosthetic phase can start. The prosthesis may include a natural tooth when it is not possible to connect the blade with another implant, according to the American Dental Association (ADA) which has established the validity of this procedure (41). It should be noted that in 2013, the FDA (Food and Drug Administration), in the United States, has proposed the requalification of the blade implant, bringing the surgical risk from grade 3 to grade 2 as for all other standard root form implants (42).

CASE REPORT

Here we report the case of a 46 years old female patient with severe atrophy of the right mandible.

CAT (computerised axial tomography) highlighted the severe atrophy of the edentulous area with the presence of an impacted third molar and an ankylosed residual root, which was asymptomatic and kept in situ according to the wish of the patient (Fig. 1). After the millimetric controls for the choice of the fittest polymorphous blade for the specific site and having exposed the ridge bone into plain sight, osteotomy was performed using exclusively the specific insert ES071 applied to the piezoelectric handpiece for ultrasonic surgery (Fig. 2).

This surgical technique allowed a selective micrometric, precise and secure cutting (Fig. 3), ensuring a good view of the operative field, furthermore the healing of the bone and soft tissue occurred without any

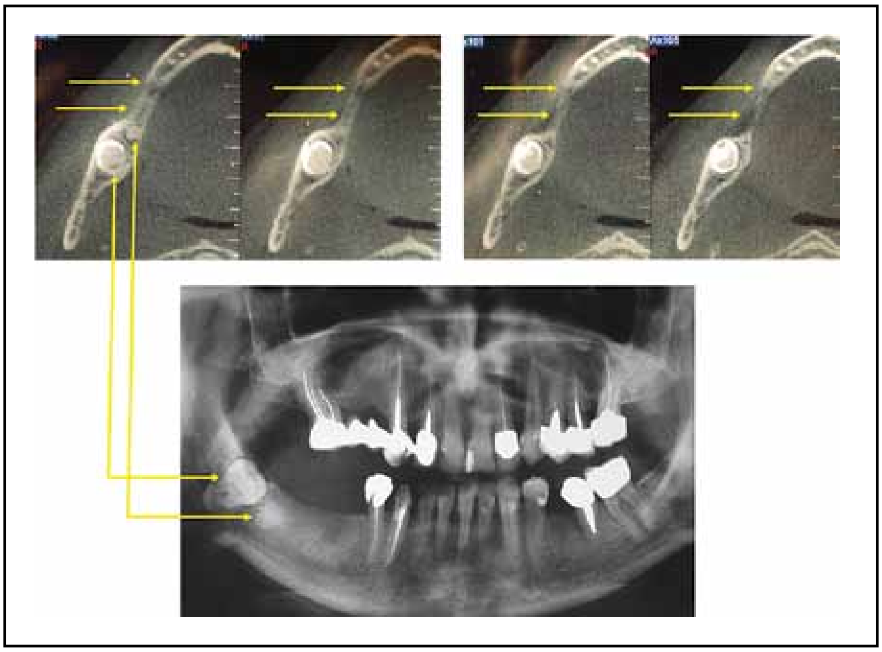

FIG. 1 CAT scan series, highlighting the bone atrophy, and the panoramic radiograph. Yellow arrows mark the implant area, the impacted third molar and the ankylosed residual root.

FIG. 2 A The serrated insert working in depth. B Profile of the polimorphic blade with Pasqualini's screw abutment, just inserted. C Osteotomy with the correct insertion of the implant.

FIG. 3 A The definitive prothesis in gold and porcelain. B Final radiographic control (2008).

FIG. 4 Soft tissues and the X-ray evidence the success of the implant-prosthetic rehabilitation with blade and natural teeth after 5 years (2013).

complications and with minimal pain.
After a healing period of three months, enough for the complete achievement of osseointegration, the prosthetic rehabilitation was started, which included two natural teeth, that had previously undergone endodontic treatment (Fig. 4).
At the 5-year follow-up, periodontal and peri-implant soft tissues health was assessed, as a result of the periodic check ups and the adequate hygiene, and a stable occlusal harmony was achieved (Fig. 5, 6).

DISCUSSION AND CONCLUSION

Blade implants are part of the evolution of prosthetic implants started in the late 60's with its maximum development in the 70's, during which blade implants were modified and improved, playing for a certain period the role of the most widely used implant system in the world. With the advent of root form implants, blades went into gradual disuse: only a few operators still use this technique, which is the elective procedure in terms of success and reliability in the rehabilitations of atrophic edentulous distal areas of the mandible, without discrediting the insertion techniques used for biphasic implants. This elective use, however, does not exclude the excellent behavior of blade implants in areas with severe deficiency of bone thickness in the upper jaw (43-45).
The conventional surgical technique still is a complex procedure where the slightest mistake inevitably leads to failure. Most blade implant failures reported in the literature are in fact related to the surgeon's inadequate skill in performing the technique. Indeed, it requires strict patient selection and adherence to its crucial steps. When properly used, blade implants can be very successful in atrophic conditions with reduced thickness, for which they were in fact originally devised (46, 47).
These difficulties are greatly reduced by piezosurgery, which results in: less invasive procedures, micrometric and selective cuts are more easily performed, advantages determined by the cavitation effect, extreme precision and safety with respect of the soft tissues, in particular the vascular-nervous components, reduced tissue heating, provided that the serrated insert is gently pressed and abundant irrigation with saline solution is supplied. Moreover, clear view of the surgical field, reduced rehabilitation time, pain reduction are also provided. As drawbacks, there are extended surgical times, which need sensitiveness and patience from both the surgeon and the patient. However, the increased working comfort amply compensates for the extended surgical time.

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