Oncology

Piezosurgery in head and neck oncological and reconstructive surgery: personal experience on 127 cases

Utilizzo della piezosurgery nella chirurgia oncologica e ricostruttiva del distretto cervico-cefalico: nostra esperienza su 127 casi

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SUMMARY

Piezoelectric bone surgery, known simply as piezosurgery, is a new technique of osteotomy and osteoplasty, which requires the use of microvibrations of ultrasonic frequency scalpels. The principle of piezosurgery is ultrasonic transduction, obtained by piezoelectric ceramic contraction and expansion. The vibrations thus obtained are amplified and transferred onto the insert of a drill which, when rapidly applied, with slight pressure, upon the bony tissue, results, in the presence of irrigation with physiological solution, in the *cavitation* phenomenon, with a mechanical cutting effect, exclusively on mineralized tissues. Personal experience with the use of piezosurgery in head and neck oncological and reconstructive surgery is relatively recent, having been developed in 2002-2006, and, so far, involves 127 cases; preliminary results are interesting and improving in the, hopefully, developmental phases of inserts with specific geometrics on account of the characteristics of the various aspects of surgical ENT operations. Furthermore, with piezoelectric surgery it has been possible to perform precise osteotomy lines, micrometric and curvilinear with absolute confidence, particularly in close proximity to the vessels and nerves and other important facial structures (*dura mater*). There can be no doubt, since this is a new cutting method, that piezosurgery involves a different learning curve compared to other techniques, requiring obstacles of a psychological nature to be overcome as well as that concerning surgical expertise. Given the numbers of cases treated and the relative power of this instrument, analysis of complications, intra-operative time (which would appear, on average, to be 20% longer) and, therefore, morbility, shows interesting potentiality of the technique. This new ultrasound cutting method will, no doubt, in the future, be increasingly used in ENT surgery, particularly with improvements in power and geometry of the inserts, with possible applications also in neurosurgery, paediatric surgery and orthopedics, branches in which a selective action upon the mineralized tissues is of fundamental importance.

KEY WORDS: Head and neck reconstructive surgery • Head and neck oncology • Piezosurgery

RIASSUNTO

La chirurgia ossea piezoelettrica, nota semplicemente con il nome di piezosurgery o piezochirurgia, è una nuova tecnica di osteotomia ed osteoplastica, che prevede l'impiego di microvibrazioni di scalpelli a frequenza ultrasonica. Il principio di funzionamento della piezosurgery è una trasduzione ultrasonica, ottenuta mediante la contrazione e l'espansione di una ceramica piezoelettrica. Le vibrazioni così prodotte sono amplificate e trasferite sull'inserto di un trapano che, applicato rapidamente e con lieve pressione sul tessuto osseo, determina, in presenza di irrigazione con soluzione fisiologica, il fenomeno della cavitazione, con un'azione meccanica di taglio esclusiva sui tessuti mineralizzati. La nostra esperienza personale di utilizzo della piezosurgery nella chirurgia maggiore (oncologica e non) e ricostruttiva del distretto cervico-cefalico è relativamente recente, essendosi sviluppata negli anni 2002-2006. Abbiamo impiegato la piezosurgery in 127 casi; le impressioni preliminari risultano interessanti e passibili di miglioramenti nell'auspicabile fase di sviluppo di inserti a geometria specifica per le caratteristiche dei vari interventi chirurgici ORL. Nella nostra esperienza, la chirurgia piezoelettrica ci ha consentito di eseguire linee di osteotomia precise, micrometriche e curvilinee in assoluta sicurezza, soprattutto in prossimità dei fasci vascolo-nervosi e di altre strutture nobili del massiccio facciale (dura madre). Indubbiamente la piezosurgery rappresenta, a nostro avviso, una nuova opzione chirurgica per eseguire osteotomie nell'ambito della chirurgia cervico-cefalica, anche se ulteriori miglioramenti dovranno essere apportati per consentire alla metodica di diffondersi e raccogliere consensi. Indubbiamente la piezochirurgia è una metodica di taglio innovativa, pertanto richiede una differente curva di apprendimento rispetto alle altre tecniche. Infatti il corretto utilizzo della piezosurgery prevede il superamento di ostacoli di ordine psicologico e di manualità chirurgica. In virtù della nostra casistica e della relativa potenza dello strumento, l'analisi delle complicanze, del tempo intraoperatorio (che sembra mediamente più lungo del 20%) e quindi della morbilità, dimostrano potenzialità interessanti della metodica. A nostro parere questa nuova metodica di taglio ad ultrasuoni potrà trovare in futuro uno spazio sempre maggiore in ambito otorinolaringoiatrico e maxillo-facciale, specie migliorando potenze e geometrie degli inserti, con possibili applicazioni anche nel campo della neurochirurgia, della chirurgia pediatrica e dell'ortopedia, discipline in cui un'azione selettiva sui tessuti mineralizzati risulta fondamentale.

PAROLE CHIAVE: *Chirurgia ricostruttiva cervico-cefalica • Oncologia cervico-cefalica • Piezosurgery*

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Introduction

Piezoelectric bone surgery, known simply as piezosurgery, is a new technique of osteotomy and osteoplasty, which requires the use of microvibrations of ultrasonic (US) frequency scalpels.

The principle of piezosurgery is US transduction, obtained by piezoelectric ceramic contraction and expansion. The vibrations thus obtained are amplified and transferred onto the insert of a drill which, when rapidly applied, with slight pressure, upon the bony tissue, results, in the presence of irrigation with physiological solution, in the *cavitation* phenomenon, with a mechanical cutting effect, exclusively on mineralized tissues.

Personal experience with the use of piezosurgery in head and neck oncological and reconstructive surgery is relatively recent, having been developed in 2002-2006.

Preliminary results are interesting and improving in the, hopefully, developmental phases of inserts with specific geometrics on account of the characteristics of the various aspects of surgical ENT operations.

Materials and methods

Piezosurgery principles

Piezosurgery was invented and developed, on account of the need, in bone surgery, to reach increasingly higher levels of precision, safety and rapidity in recovery.

Use of devices employing US were already well known, in the 1980's, in odontostomatologic surgery [1]. The first attempts at using US equipment, in bone surgery, showed good results in the cutting phase, but was not strong enough for performing osteotomy in the presence of highly mineralized bone or when thicker than 1 mm. In fact, repeated application of these instruments did, indeed, effect a cut, but was associated with an excessive increase in temperature, with the risk of subsequent bone necrosis.

These limits were overcome with the development of piezosurgery, a technique resulting from intense collaboration between the clinico-surgical world and that of technical engineering.

Piezosurgery employs a specific instrument, characterized by a cutting power three times greater than that of US instruments currently in use. The instrument transfers a significantly elevated level of US energy upon the bony surfaces thus allowing osteotomy to be carried out even when the bone is highly mineralized and thick [2-4].

The system comprises a platform (with a piezoelectric device, with a functional frequency of 25-29 kHz and the possibility of 30 Hz digital modulation) and a series of inserts, of different forms, with a linear vibration ranging from 60 to 200 μm.

To complete the system, a peristaltic pump, irrigating physiological solution (Fig. 1).

Inserts (Fig. 2) available can be classified as:

– sharp, covered with titanium nitrate (gold colour), which offers a harder surface, and, in turn, maximum efficacy in cutting;
– diamonds, which are used in the case of thin bone osteotomy or to complete osteotomies close to important anatomical structures. These offer a clinically less efficacious cut, are histologically more traumatic than the cutting inserts, but much safer.

Clinical application

Unlike traditional cutting instruments, piezosurgery offers the possibility of a cut with the following characteristics:

– *micrometric*, inasmuch as the insert vibrates with a range of 60-200 μm at a modulated US frequency, which, whilst cutting, maintains the bone constantly clean, thus avoiding excessive temperatures;
– *selective*, inasmuch as the vibration frequency is optimal for the mineralized tissues (in fact, to cut the soft tissues, different frequencies are required);
– *safe*, inasmuch as the reduced range of the micrometric vibrations offers the possibility to perform surgery with very great precision. The cut, in fact, can

Fig. 1. Piezosurgery system

be controlled as easily as if drawing an outline. This enables osteotomy to be performed even in close proximity to delicate structures, such as vasculo-nervous structures, in general, without damaging them.

Eventual contact with soft tissue does not mean that it is immediately cut, as normally occurs with hand or mechanical instruments. The only important aspect is that, once contact is made, the cutting should be immediately interrupted, in order to avoid unnecessary heat on the soft tissue. The mechanical energy not used for the cutting of the mineralized structures will, in fact, be found to be inactive upon the soft tissue, as far as concerns the mechanical profile, but heat is dispersed.

A

B

Fig. 2. Inserts available.

Surgical control with piezosurgery is maximum as the strength required by the surgeon to effect a cut is far less compared to that with a drill or with oscillating saws.

In fact, burrs controlled by a micromotor require greater strength, against the rotating couple of the instrument, obtained by applying increased pressure of the hand. As a result, surgical sensitivity is reduced, especially when there are structures presenting different mineralization or even more complex soft tissues, where one runs the risk of losing control of the latter on the drill's stem.

Also oscillating saws, with macrovibrations, require a contrast action which is necessary in order to perform a cut; even though guaranteeing excellent linearity, they do not allow control of the depth of the cutting, at the sides or in the centre, and, therefore, it is often necessary to complete the incision with a scalpel and hammer.

From a clinical point of view, the piezosurgery system offers three different power levels:

- *low mode* indicated for apical endocanalar cleaning in orthodontic surgery;
- *high mode*, useful for cleaning and smoothing the radicular surface;
- *boosted-mode*, indicated in bone surgery, necessary in performing osteotomy and osteoplasty.

This modality of work is further divided into *a*, *b*, *c*, according to the modulation of the correct frequency for the quality of the bone to be treated. As far as concerns the parameter of choice, this is based upon the sound produced by the insert during the cutting process.

It is worthwhile stressing the fact that piezosurgery is a new cutting method, therefore, compared to other techniques, a different learning curve is necessary. In fact, correct use of piezosurgery requires overcoming psychological obstacles, as well as familiarity with handling of the surgical procedures.

From a psychological viewpoint, it is necessary, above all, to recognise the limits of other osteotomy methods and then overcome the sense of lack of familiarity with the new technology.

As far as concerns handling of the surgical technique, in general, this involves a very sensitive motor action, emerging from a series of sensorial perceptions and automatisms, which are translated into engrammes of the muscles, which move the scalpel both rapidly and skillfully. The skill depends upon the exact knowledge of each single part comprising the movement and becomes important when it is mediated completely by the automatic extrapyramidal system.

Experience and repeating of the movements form the basis of surgical movements and this is the principal element to be taken into consideration when starting to use piezosurgery.

In fact, in piezoelectric surgery, the surgical handling required is completely different from that used with the drills and oscillating saws, as the piezoelectric cutting employs microvibrations. It thus follows that in order to increase the capacity of cutting, pressure of the hand should not be increased (as with bone drills or saws), since above certain limits, an increase in pressure prevents the microvibration of the insert; the energy not used for cutting is thus transformed into heat which, if prolonged, can cause damage to the tissue. Thus, in order to avoid a surgical obstacle, it is necessary to calculate the pressure according to the speed of the insert [5-8].

Head and neck reconstructive surgery

In a series of 33 patients (13 female, 20 male), submitted to buccopharyngectomy by demolitive transmandibular approach and subsequent reconstruction with fibula free flap, the piezoelectric drill was employed both during the harvesting of the flap (distal and proximal osteotomy of the fibula having been performed) and in the subsequent phase of modelling of the fibula, with perfect precision in the cutting and complete preservation of the vascular pedicles (peroneus artery + comitant veins).

Since the latter runs along the medial crest of the bone itself, in a fibrous channel, between the posterior tibial and the *flexor hallucis lungus* muscles, with the use of the piezoelectric drill, the harvesting phase of the flap itself has become much safer, without running the risk of damaging the vessels, even during subsequent subtractive cuneiform osteotomies, when it is mandatory not to modify the *periostium* (Fig. 3).

In our experience, the cutting lines were clean and precise. However, the length of the inserts employed, appeared, in our opinion, barely sufficient to perform the osteotomies in male patients in whom the fibula is quite thick.

Despite these inconveniences, the gain in safety in the phase of osteotomies made the slight increase in time, for this procedure, insignificant, compared to use of the oscillating saw, estimated to be approximately 20 – 25%.

Fig. 3. Use of piezoelectric drill during subsequent subtractive cuneiform osteotomies of fibula free flap, when it is mandatory not to modify the *periostium.*

No important complications occurred either intra-operatively or at a distance.

In 44 patients (29 male, 15 female), submitted to buccopharyngectomy or pelviglossectomy, by a conservative transmandibular approach, the piezoelectric drill was used in performing mandibulotomy.

Also in these cases, the cutting lines were clean and precise. Albeit, in the patients in whom parasynphysaries osteotomies were necessary, the length of the insert employed was only just sufficient.

No noteworthy complications occurred either intra-operatively or at a distance, thereafter.

The increased time to perform this procedure was greater than that observed in the previous group of patients, estimated to be 30% more compared to time spent using the oscillating saw.

In one male, submitted to total left parotidectomy, with sacrifice of the facial nerve + mastoidectomy + homolateral selective neck dissection and subsequent nervous reconstruction with sural nerve, due to multiple recurrence of pleomorphic parotid adenoma, the piezoelectric drill was found to be particularly useful in the otosurgical phase. In fact, it permitted accurate opening of the facial canal in the mastoid without fear of a possible lesion of the nerve itself, surgical time indispensable for preparation of the proximal extremity of the facial nerve for subsequent neurorrhaphy

Oncological cranio-maxillo-facial surgery

In 22 patients (13 male, 9 female), with carcinoma of the infra-meso-structure, piezoelectric surgery enabled superficial osteotomies to be carried out which were necessary to perform subtotal maxillectomy.

The advantage in this case was:

Fig. 4. Use of piezoelectric surgery to enable superficial osteotomies to be carried out which were necessary to perform subtotal maxillectomy. In this case, the advantage was precision in performing the osteotomies, also curvilinear, achieved with minimum bleeding of the soft tissues below.

– precision in performing the osteotomies in approach to frontal sinus, also curvilinear, achieved with minimum bleeding of the soft tissues below. It was thus possible to reduce loss of blood in this phase of approach (Fig. 4);
– minimum trauma to the bone which, if preserved (in the case of an osteotomy with a nasal maxillary cheek flap) results in a much faster repair process.

The main disadvantage encountered in this series was the difficulty or impossibility to perform the deeper osteotomies (maxillo-pterygoid disjunction, etc…), due to lack of inserts of the appropriate length.
No important complications occurred either post-operatively or at a distance.

Osteotomies in approach to frontal sinus

In 15 patients (9 male, 6 female), presenting frontal sinus diseases (8 mucoceles, 4 large osteomas occupying the frontal sinus *in toto*, 3 extracranial recurrence of meningioma), piezoelectric surgery was used to prepare the bone operculum access to the frontal sinus, following preparation of the bicoronal flap.
The cutting line was modelled on the template of the sinus (obtained by means of a cranio-sinusal X-ray with a frontonasal projection) (Fig. 5).
Also in this case, it is worthwhile stressing how very versatile the handle is in performing curvilinear osteotomies, drawing with great precision the shape of the sinus. Osteotomies were performed with an inclination inside/outside to allow later repositioning or the bone operculum (possible also on account of minimum bone loss).
In one patient presenting a voluminous extracranial recurrence of meningioma, use of the piezoelectric drill was shown to be particularly useful as the line of the osteotomy is continued beyond the anatomical limits of the frontal sinus with consequently exposure of the *dura mater*, which, however, was not damaged.

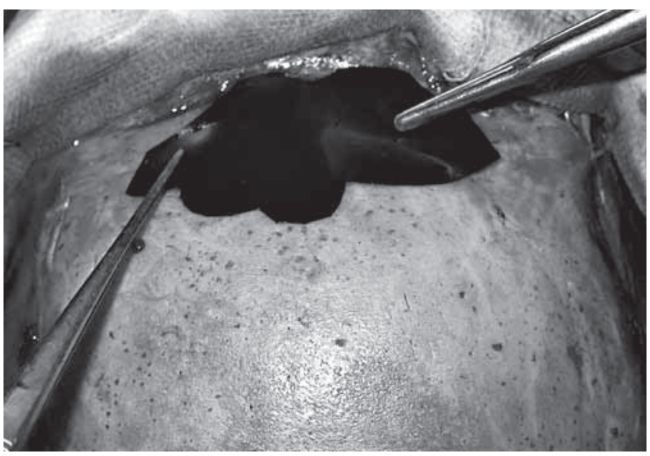

Fig. 5. The cutting line, performed using piezosurgery, was modelled on the template of the sinus (obtained by means of a cranio-sinusal X-ray with a frontonasal projection).

The length of the aggressive handle OT7A was found to be barely sufficient in performing caudal osteotomy towards the frontal bandeau, in the case of a grossly overweight male patient.
The psychological serenity resulting from the slight possibility of dural lesions (especially in the case of recurrence of intra/extracranial meningioma previously removed with a frontal craniotomic approach) and from the also minimum bleeding has compensated the relative slowness of the cutting procedure (~30% greater compared to the drill and oscillating saw). The potentiality of performing curvilinear osteotomies is considerably greater.
On the other hand, it was impossible to work inside the frontal sinus as the handpiece and inserts currently available are too short.

Cleaning surgery of osteonecrotic foci

Four female patients, surviving for a prolonged period of time, who showed signs of maxillo-mandibular osteonecrosis following therapy with bisphophonate, for bone metastases from breast carcinoma, were submitted to cleaning surgery of the osteonecrotic foci, employing the OP1 insert.
The aim was to clean the area, reducing to a minimum trauma of heat to the surrounding bone, already at great risk of necrosis.
The OP1 insert, with *bone 1* modality, was found to be very suitable in the cleaning procedure, as far as concerns both power and handling.
The impression emerging from these results, despite referring to only 4 patients, is positive even if it is impossible to draw conclusions with respect to the use of more traditional methods.
Certainly, we observed less damage to the mucosa and heavy bleeding of the apparently healthy bone.

Discussion

Piezoelectric surgery was proposed as a response to the need to overcome the limits of the traditional instruments available in bone surgery.
Briefly, osteotomy techniques consist in performing cutting actions (osteotomy) or remodelling (osteoplastic procedures) of the bone surface. All bone surgery interventions, in the different specialities, originate from a combination of these two techniques.
However, whilst it is true that there are only two bone surgery techniques, the surgical instruments available to perform these techniques are numerous.
In essence two types of instruments exist:
– manual instruments (scalpels, hammers, saws, etc…), characterized by considerable cutting efficacy, related to the mechanical force exerted in an instantaneous fashion, therefore, not easily controllable;

– motor-driven instruments, characterized by a cutting capacity produced by electric or pneumatic energy.

Generally, the micromotors used in bone surgery transform the electric energy into mechanical energy; the cutting is, therefore, the result of rotation produced by the movement of the drill or by the oscillating movement of the bone saw.

The drill produces a cutting action, combining the speed and the torque of the drill, with the pressure exerted on the handle and the cutting action of the burr. Nevertheless, it is this very pressure that makes the surgical manoeuvre more difficult to control and, therefore, less safe.

When it is necessary to perform an osteotomy starting from the cortex, clearly the strength necessary to make use of the "torque", in other words, the rotation, in the more mineralized bone structure, this suddenly becomes excessive when passing to the spongiosum or when the cortical bone is finished. This causes an immediate loss of control of the surgical instrument, a condition which may be very dangerous in close proximity to delicate anatomical structures, such as vessels and nerves.

Furthermore, the traditional motorized instruments, in producing the cutting action, generate macrovibrations, that, in turn, reduce the surgical safety.

The cutting action of the piezoelectric drill is, instead, the result of linear microvibrations of an ultrasound nature, with a range of only 20-60 ηm in a longitudinal direction, with, therefore, control of surgical procedures in all anatomical situations [9-14].

The uniqueness of this instrument consists in the possibility to adapt the frequency of the vibrations of the piezoelectric ceramics, producing an efficacious and efficient cutting action on the bone of different quality and, at the same time, without the presence of osseous fragments which, if they remain at the edge of the cut, have been demonstrated to be the main cause of the overheating produced by normal ultrasounds.

Research studies on animals, aimed at evaluating the characteristics of the healing process of the bone tissue following osteotomy, have demonstrated that this phenomenon occurs more rapidly and immediately following the use of the piezoelectric drill, compared to a drill or an oscillating saw, on account of the lack of phlogosis, responsible for a delay in bone regeneration.

Interesting, in this respect, is the recent article by Vercellotti et al., in which the Authors compared the efficacy of the piezoelectric drill with standard motorized instruments (diamond burrs and oscillating saw), in terms of different recovery of the bone tissue. Evaluations were performed on animals (rabbits), comparing the possible histological and histomorphometric modifications induced by the three different cutting instruments [15-19].

A considerable difference was observed already in the early phases of the healing process, with the appearance, only seven days after the operation using piezosurgery, of newly formed bone tissue (37% of the entire incised surfaces versus 20% in the bone sections obtained with the drill and 47% in those obtained with the oscillating saw). This phenomenon is related to the fact that the surfaces of the cut appear to be intact, regular, without any fragments or pigmentation, with vital osteocytes, with a consequent immediate relationship with the fibrin.

Moreover, piezosurgery was demonstrated to be a more precise cutting instrument. In all the animals examined, osteotomy in the entire thickness of the calvaria, performed with piezosurgery, was found to display an equal thickness in the internal and external parts.

In the cases in which the diamond burrs were used, the internal cut was always seen to be shorter than the external surface, with laceration of the *dura mater*.

On the other hand, in the cases, in which the oscillating saw was used, the result appeared clinically unacceptable as it was discontinuous.

Furthermore, the Authors evaluated the effects of the increase in temperature on the surfaces of the cut. In the bone sections examined, obtained with the piezoelectric drill, no phenomenon of necrosis was revealed, but on the contrary, nucleated osteocytes and a peak in growth factors was observed, in particular of the biomorphogenetic proteins, one hour after the operation, signs indicating early bone regeneration.

Instead, in those patients in whom the oscillating saw was employed, but, particularly, in those in whom the diamond burrs had been adopted, phenomena such as changes in the proteic structures and protoplasmatic lipids, modifications in enzymatic activity resulting in bone damage, were observed.

In particular, data emerging from these studies revealed that the bone drill represents a more aggressive cutting instrument, which intra-operatively is more difficult to control and is more damaging to the soft tissue, above all the nerve endings, consequently delaying the process of bone healing.

In our experience, piezoelectric surgery has enabled us to perform precise osteotomy lines, micrometric and curvilinear with absolute confidence, particularly in close proximity to the vessels and nerves and other important facial structures (*dura mater*).

In the group of patients in whom buccopharyngectomy was performed by the demolitive transmandibular approach, piezosurgery was found to be particularly useful in the fibula flap harvesting phase, allowing precise cuneiform osteotomies to be performed, with preservation of the periosteal circle.

No complications occurred during the post-operative period. The patients began walking already on the 4th day after surgery, initially with the help of crutches.

X-rays of the mandibula performed at 6, 12 and 18 months, post-operative follow-up confirmed perfect osteointegration of the flap, with no signs of extrusion of the osteosynthesis plates.

Also in the group of patients who underwent buccopharyngectomy or pelviglossectomy by the conservative transmandibular approach, in which the piezoelectric drill was used to perform osteotomy of the mandible, the cutting lines were found to be clean and precise.

No important complications occurred either in the post-operative period or at a distance thereafter.

Also in these patients, X-rays of the mandible performed at 6, 12 and 18 months, post-operative follow-up confirmed perfect osteointegration, with no signs of extrusion of the osteosynthesis plates.

In the group of patients presenting carcinoma of the infra-mesostructure, piezosurgery was found to be extremely useful, particularly in reducing to a minimum bleeding from the underlying soft tissues.

The inserts available enabled us to perform curvilinear osteotomies, with minimum bone trauma and with more rapid reparative processes.

No important complications occurred either in the post-operative period or at a distance thereafter.

Maxillo-facial control X-rays performed after 6, 12 and 18 months showed perfect osteorepair, with no signs of extrusion of the osteosynthesis plates.

In patients presenting frontal sinus pathologies, piezoelectric surgery is considered an ideal indication. In fact, with this technique, it is possible to perform linear and curvilinear osteotomies, with absolute psychological confidence, with minimal risk of lesions of the *dura mater*. None of these patients presented significant complications.

Finally, piezosurgery was found to be particularly useful in the cleaning surgery, in those patients presenting maxillo-mandibular osteonecrotic foci following chemotherapy with zotream, thus allowing the healthy endoral mucosa to be spared.

One of the main disadvantages reported, so far, in the literature, regarding the piezoelectric drill, concerns the increase in the operating time, compared with that with traditional cutting instruments.

In all our patients, the time taken to perform osteotomies was evaluated according to the type of insert employed. Data obtained were then compared with the time taken for analogous procedures, performed by the same surgical equipe, but using motorized cutting instruments. For each patient, observations of the surgeon operating, were recorded.

The inserts adopted in the present case series were fundamentally of three types:

1. OT6: bone saw, with a sharp surface and covered with titanium nitrite. Morphologically, this is a five-pointed saw, guaranteeing an osteotomy with maximum efficacy;
2. OT7-OT7A: bone saw, with 5 teeth, very thin (0.5 and 0.75 mm, respectively), with sharp surface and covered with titanium nitrite;
3. OP1: scalpel, the terminal part in the form of upturned trapezium, with sharp surface on three sides, covered with titanium nitrite. Allows cleaning and smoothing of bone surface.

The first three types of insert (OT6, OT7, OT7A) have been used to perform mandibular osteotomy in the group of patients undergoing buccopharyngectomy by conservative or demolitive transmandibular approach, and in the phases of harvesting and modelling of the fibula flap (Tables I, II).

Table I. Group of patients submitted to buccopharyngectomy by demolitive transmandibular approach and later reconstruction with fibula free-flap.

No.	Sex	Type of insert	Mandibular osteotomy Time employed (min)	Fibula osteotomy Time employed (min)
13	F	OT6	16.7 ±1.3	9.3 ± 1
2	M	OT6	21.5 ± 0.7	12 ± 0.5
8	M	OT7	17.7 ± 2	11.1 ± 2
10	M	OT7A	20.7 ± 1.3	11.8 ± 1

Table II. Group of patients submitted to buccocopharyngectomy/pelviglossectomy by mandibulotomy.

No.	Sex	Type of insert	Mandibular osteotomy Time employed (min)
10	F	OT6	10.8 ± 2
18	M	OT7	14 ± 1.7
16	M	OT7A	15.6 ± 0.7

The only difficulties encountered, occurred in patients in whom it was necessary to perform parasymphysaria osteotomy: the length of the inserts used, in fact, was found to be barely adequate.

The intra-operative time taken for the mandibular osteotomy phase, with the piezoelectric drill, was, nevertheless, greater than that when the oscillating saw was used, a rate calculated to be more than 30%, whereas time taken for preparation of the flap was comparable to that in the cases in which the oscillating saw was used. It is also necessary to bear in mind that the drill used was not adequately powerful.

In the group of patients presenting tumours of the infra-mesostructure, OT6, OT7, OT7A inserts were used to perform superficial osteotomies while the OP1 insert was employed for cleaning the antral surface of the maxillar sinus, ethmoid and *sphenoid sinus* (Table III).

Table III. Group of patients with carcinoma of infra-mesostructure.

No.	Sex	Type of insert	Osteotomy of superior maxilla Time employed (min)
9	F	OT6	19.4 ± 2
6	M	OT7	22.1 ± 1.7
7	M	OT7A	23 ± 1.5

The intra-operative time taken for the maxillary osteotomies was comparable to that in the cases in which traditional instruments were used.
The main obstacle that the surgeons encountered was the difficulty, or even the impossibility, to operate in the deeper spaces (maxillo-pterygoid disjunction), since, as already pointed out, the inserts were not of the appropriate length. The OP1 insert, on the other hand, was found to be perfect in the manoeuvre to free the surfaces of the paranasal sinuses from mucosa.
This same difficulty was encountered in the group of patients with frontal sinus diseases, in whom the OT6, OT7, OT7A inserts were found to be too short and with an angle that did not allow scrupulous cleansing of all the recesses, usually typical of the frontal sinus (Table IV).

Table IV. Group of patients presenting frontal sinus pathologies.

No.	Sex	Type of insert	Osteotomy of frontal sinus Time employed (min)
4	F	OT6	7.5 ±1.7
1	F	OT7	11
1	F	OT7A	10
1	M	OT6	9
5	M	OT7	9.4 ± 0.7
3	M	OT7A	11.3 ±0.9

The intra-operative time required for the osteotomies was longer (approximately 30%) compared to analogous cases in which instruments with a motorized cutting system were employed.
Finally, in the group of patients with maxillo-mandibular osteonecrosis, the OP1 insert was found to be very useful in the cleaning surgery of the foci, with minimum trauma on the endoral mucosa while the time required for this operation was extremely rapid (Table V).

Table V. Group of patients submitted to cleaning surgery of osteonecrotic foci.

No.	Sex	Type of insert	Cleaning surgery of maxillo-mandibular osteonecrotic foci Time employed (min)
4	F	OP1	31 ± 2

There is no doubt, in our opinion, that piezosurgery represents a new surgical option to perform osteotomy and osteoplasty in head and neck surgery, even if further improvements are necessary in order for the method to be adopted and appreciated on a larger scale.
Piezosurgery can, in fact, be defined as a saw, characterized by the versatility of a drill, in particular, when performing curvilinear osteotomies.
Certainly, for performing osteotomies rapidly and without difficulty (particularly mandibular osteotomy), the handles and inserts, currently available, are inadequate. In our opinion, it is necessary not only to increase the length of the inserts, but also the thickness, in order to avoid the surgeon, in attempting to improve the cutting power, increasing the pressure of the hand, thus preventing microvibration of the insert.
Another modification concerns the ergonomy of the handpieces, which, in our opinion, should have a longer stem and with a sufficient diameter, in order to be able to reach the bottom of the cavities, thus avoiding phenomena of "flatting", typical of other osteotomy instruments, for example, the drills and saws.
Another feature which should not be overlooked is that concerning the economic aspects: also the purchase price of the piezoelectric drill is worth bearing in mind as it is certainly competitive with the usual drills and saws. The handles and the inserts can, in fact, be repeatedly sterilized.

Conclusions

Piezoelectric surgery is a new instrument used for osteotomy and osteoplastic repair in major (including oncological) surgery of head and neck.
There can be no doubt, since this is a new cutting method, that piezosurgery involves a different learning curve compared to other techniques, requiring obstacles of a psychological nature to be overcome as well as that concerning surgical expertise.
Given the number of cases treated and the relative power of this instrument, analysis of complications, intra-operative time (which would appear, on average, to be 20% longer) and, therefore, morbidity, show the interesting potentiality of the technique.
In our opinion, this new ultrasound cutting method will, no doubt, in the future, be increasingly used in ENT surgery, particularly with improvements in power and geometry of the inserts, with possible applications also in neurosurgery, paediatric surgery and orthopedics, branches in which a selective action upon the mineralized tissues is of fundamental importance.

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