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Comparison of the piezoelectric cutter with a conventional cutting technique in orthognathic surgery

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Abstract

The use of a piezoelectric cutter has been reported to improve outcomes in orthognathic surgery, particularly with regards to neurosensory disturbance of the inferior alveolar nerve. The aims of this retrospective longitudinal cohort study were to compare outcomes regarding neurosensory disturbance, and operating time. During two 15-month periods a single surgeon treated 24 consecutive patients with a conventional cutting technique and a further 24 consecutive patients with a piezoelectric cutter. In both groups the duration of operation was noted, and neurosensory disturbance graded at 12-month follow up. Neurosensory recovery was better in the piezoelectric group than in the conventional group ($p = 0.01$), and the duration of operation nearly identical. We conclude that the piezoelectric cutter offers advantages with regards to neurosensory deficit over a more conventional technique without the previously-reported disadvantage of a longer operating time.

Keywords: Orthognathic surgery; Piezoelectric Cutter; Neurosensory Disturbance

Introduction

The surgical correction of dentofacial deformities has become a mainstay of oral and maxillofacial surgeons. Techniques have continually evolved since the first reported correction of mandibular prognathism by Angle, Blair, and Whipple in 1898,[1] and through the work of Obwegeser, Dal Pont, Hunsuck, and Epker,[2] the primary purpose being an attempt to improve surgical outcomes and patients' satisfaction.

The use of saws in orthognathic surgery was popularised by Spiessl in 1976,[3] and has been the mainstay of treatment to the present day. In 2004 Vercellotti et al introduced the use of piezoelectric surgery as a safe technique for sinus lifts,[4] and it was subsequently used for other purposes including mandibular and maxillary osteotomies.

Postoperative sensory disturbances in the lower lip and chin, which have been reported to occur in 9%–85% of operated sides after sagittal split ramus osteotomy, are a disquieting drawback of the procedure.[5,6] Piezoelectric surgery uses low-frequency ultrasonic vibrations (25–29 kHz) to cut mineralised tissues.[7] Ultrasonic devices are thought to offer considerable advantages over conventional techniques as they cut bone selectively and give a degree of protection to soft tissues such as nerves and vascular structures. These perceived benefits increased the use of piezoelectric cutters among orthognathic surgeons, and several studies have compared their use with conventional techniques. Most of the studies showed that the cutter was superior,[8–10] but only a small number reported long-term rates of paraesthesia.

A disadvantage of the piezoelectric cutter is the supposed duration of operation when compared with traditional techniques. Eggers et al observed a 30% increase.[11]

The purpose of this cohort study was two-fold: to compare the degree of enduring paraesthesia between the piezoelectric cutter group and the conventional techniques group after bilateral sagittal split osteotomy (BSSO), and to compare overall operating times.

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Material and methods

Selection of patients

Conventional group

A total of 26 consecutive patients who had had either BSSO or bimaxillary osteotomy using conventional techniques were identified from April 2014 to the end of June 2015. All were treated by a single surgeon at a single operating centre. Patients who required segmental surgery or simultaneous genioplasty, those with obstructive sleep apnoea, and those who had been followed up for less than 12 months, were excluded. Two patients who had orthognathic surgery for obstructive sleep apnoea were excluded.

Piezoelectric group

A total of 27 consecutive patients who had had either BSSO or bimaxillary osteotomy with a piezoelectric cutter were identified from April 2016 to the end of September 2017. The inclusion and exclusion criteria were the same in both groups. Three patients (two who had simultaneous genioplasty and one who had segmental surgery) were excluded.

Surgical technique

The same surgeon did, or supervised, all the operations.

Patients in the conventional group were treated using the short sagittal split osteotomy technique that was popularised by Epker for BSSO.[2] The cuts were made with a fissure burr, Lindemann burr, and acrylic burr. The mandible was split with a Peterson's osteotome to ensure that there were no bridges of cortical bone between the cuts, and with tufnol-handled osteotomes, and a Smith's spreader.

The same techniques were used in the piezoelectric group. The piezoelectric cutter (Piezoelectric System, DePuy Synthes) was used to make all the cuts except the lingual cut. To aid visualisation and access, an acrylic burr was used where the cortical bone was grooved above and just beyond the lingula, and the cut completed with the piezoelectric cutter. The Piezo round saw tip (38.9 × 5.0 mm diameter × 0.6 mm) was used for all the osteotomies (Fig. 1). Down-fracturing, mobilisation, bone trimming, and fixation, were the same in both groups.

The Le Fort I osteotomy technique popularised by Obwegeser[12] was used in both groups. All cuts were made with either a reciprocating saw or the piezoelectric cutter.

All patients were given the standard postoperative regimen of antibiotics, analgesics, and dexamethasone.

Outcome measures

The assessment of cutaneous sensitivity of the lower lip and chin can be objective or subjective, and Westermark reported a positive correlation between the two after BSSO.[13] It has been argued, however, that patients' satisfaction after orthognathic surgery does not depend on objective test results but on their perception of altered sensation.[14] It is generally accepted that the peripheral nerves take between three and six months to recover, so by 12 months after operation it is likely that this will be the final clinical state.

Fig. 1. Piezo tip.

For these reasons, cutaneous sensitivity of the lower lip and chin was measured subjectively on a verbal analogue scale (0–10). At the 12-month postoperative review, patients were asked to rate the degree of altered sensation (0 being no perception of sensation in a particular area of the lip and chin and 10 being normal sensation). The operating surgeon assessed all the patients in both groups.

The significance of any difference in altered sensation between the two groups, which included all the patients, was assessed with a Student's two-tailed *t* test. The size of the effect was calculated using Cohen's *d* test.

The operating time (total minutes of purely surgical time) was obtained from the theatre management system (TheatreMan, Trisoft Healthcare), which is administered by the theatre sister.

Results

Patients' details and additional data are summarised in Tables 1 and 2.

Cutaneous sensitivity

In the piezoelectric group (mean (range) age 23 (18–34) years), eight patients had a degree of altered sensation in the lower lip and chin 12 months postoperatively (mean (range) score 8.5 (7–9); 95% CI 8.06 to 8.93).

In the conventional group (mean (range) age 27 (18–57) years), 11 patients had a degree of altered sensation in the lower lip and chin 12 months postoperatively (mean (range) score 7.2 (4–9); 95% CI 6.5 to 7.8).

In comparison with the conventional group, the *t* value in the piezoelectric group was $t(46) = 2.55$, which showed a significant difference ($p = 0.014$). The effect size showed a value of 0.53, with an 80% overlap, and 63% superiority.

Table 1
Demographic data – conventional group.

Case No.	Procedure	Operating time (minutes)	Neurosensory disturbance – mandible (verbal analogue scale)		Registrar present	Simultaneous 3rd molar extraction	Age (years)	Sex
			Right	Left				
1	BSSO	80	10	8	Yes	No	33	F
2	BSSO	84	10	10	No	No	40	F
3	BSSO	84	10	10	Yes	No	19	M
4	BSSO	98	10	6	No	No	28	F
5	BSSO	100	10	10	No	No	40	M
6	BSSO	107	8	8	No	No	19	F
7	BSSO	108	10	10	No	No	23	F
8	BSSO	109	6	10	Yes	Yes	57	F
9	BSSO	121	10	10	Yes	No	27	F
10	BSSO	148	9	9	Yes	Yes	28	M
11	Bimax	195	10	10	Yes	No	21	F
12	Bimax	209	10	10	Yes	No	18	F
13	Bimax	218	10	10	No	No	30	M
14	Bimax	227	10	10	Yes	No	29	F
15	Bimax	240	10	8	No	No	19	F
16	Bimax	246	10	10	Yes	No	20	F
17	Bimax	247	10	10	No	No	19	F
18	Bimax	250	7	7	Yes	No	21	F
19	Bimax	253	10	10	No	Yes	21	F
20	Bimax	260	10	7	No	Yes	18	F
21	Bimax	264	8	4	No	No	29	F
22	Bimax	268	8	10	No	Yes	36	F
23	Bimax	268	10	10	Yes	No	18	F
24	Bimax	274	7	5	No	Yes	39	M

BSSO: bilateral sagittal split osteotomy; Bimax: bimaxillary procedure.

Table 2
Demographic data – piezoelectric cutter group.

Case No.	Procedure	Operating time (minutes)	Neurosensory disturbance mandible (verbal analogue scale)		Registrar present	Simultaneous 3rd molar extraction	Age (years)	Sex
			Right	Left				
1	BSSO	83	9	9	Yes	No	21	F
2	BSSO	105	10	9	Yes	No	19	F
3	BSSO	109	10	10	Yes	No	34	F
4	BSSO	111	10	8	Yes	No	21	M
5	BSSO	112	10	10	No	No	26	F
6	BSSO	115	10	10	Yes	No	20	M
7	BSSO	115	10	10	Yes	No	19	M
8	BSSO	119	10	10	Yes	No	21	F
9	BSSO	120	9	9	Yes	No	23	M
10	BSSO	127	10	10	No	No	20	F
11	Bimax	197	10	10	Yes	Yes	25	F
12	Bimax	214	10	10	No	No	19	F
13	Bimax	216	10	10	No	No	19	F
14	Bimax	220	10	10	No	No	21	F
15	Bimax	221	10	10	Yes	No	21	M
16	Bimax	229	9	10	No	No	27	F
17	Bimax	231	10	8	Yes	No	28	M
18	Bimax	234	10	10	Yes	No	27	M
19	Bimax	234	10	10	Yes	No	19	F
20	Bimax	240	8	10	Yes	No	21	F
21	Bimax	240	10	10	Yes	No	21	M
22	Bimax	265	10	10	Yes	No	18	F
23	Bimax	270	7	10	No	No	21	F
24	Bimax	296	10	10	Yes	No	38	M

BSSO: bilateral sagittal split osteotomy; Bimax: bimaxillary procedure.

Operating time

In the piezoelectric group 10 patients had BSSO alone and the remaining patients a bimaxillary procedure. The mean (range) operating times were 112 (83–127) minutes for BSSO and 236 (197–296) minutes for the bimaxillary procedures. In the conventional group 10 patients had BSSO and 14 a bimaxillary procedure. The mean (range) operating times were 104 (80–148) minutes for BSSO and 244 (19–274) for the bimaxillary procedures.

Discussion

The piezoelectric cutter has a number of potential advantages over conventional techniques, though debate continues as to whether these are real and actually improve surgical outcomes. The advantage that has been most widely reported is its low risk to adjacent soft tissues, in particular the inferior alveolar nerve.[9] It has also been reported to enable cuts to be more precise, to reduce soft tissue swelling and blood loss, and to be preferable to conventional techniques.[10]

Our subjective assessment is that the cutter allows for the accurate, precise, and atraumatic cutting of bone, and the contra-angle cutting attachment enables all cuts to be straightforward, including those at the lower border of the mandible in a BSSO and the posterior tuberosity in a Le Fort I osteotomy. It is also the ideal instrument to help release the inferior alveolar neurovascular bundle from a cortical buccal canal in a BSSO, or to remove bone from around the greater palatine bundles in a Le Fort I osteotomy.

The most common argument against claims that the cutter improves surgical outcome regarding neurosensory disturbance of the inferior alveolar nerve, is that it is the splitting technique that has the biggest impact on the nerve.[15] A number of different techniques have been reported with regards to splitting the mandible, and these include the use of osteotomes, chisels, and spreaders. We propose that the piezoelectric cutter gives the operator greater confidence to complete the cuts in cortical bone, particularly at the lower border of the mandible, and therefore improves the ability to split the mandible more precisely.

Neurosensory recovery was better in the piezoelectric group at 12 months postoperatively than it was in the conventional group. This was both in terms of the total number of patients affected and the degree of reported disturbance. These results are consistent with those of Pagotto et al in a systematic review and meta-analysis of five studies,[16] which showed a significant difference between the two groups at three and six-month follow up.

Most studies have shown that operations with the piezoelectric cutter take longer than those that use a more conventional technique, and some studies have reported increases of 30%–50%.[11] This was not the case in our study, as the mean operating times were nearly identical for both procedures. These results are also consistent with those reported by Pagotto et al.[16]

Within the limitations of this retrospective study, we conclude that the piezoelectric cutter reduced both the degree of neurosensory disturbance of the inferior alveolar nerve and the number of patients affected. The operating time was similar to that of the conventional technique.

Further research with larger numbers of patients and a more objective measure of outcome is required to prove the hypothesis conclusively.

Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patients' permission

Not applicable.

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