Journal of Cranio-Maxillo-Facial Surgery xxx (2014) 1–10

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Comparison of piezosurgery and traditional saw in bimaxillary orthognathic surgery

Giuseppe Spinelli [a], Davide Lazzeri [b], Marco Conti [a], Tommaso Agostini [a], Giuditta Mannelli [c,*]

[a] Traumatology and Maxillo-Facial Surgery Unit (Head in Chief Dr. Giuseppe Spinelli), Orthopedic Traumatological Center, Azienda Ospedaliera Universitaria Careggi, Florence, Italy
[b] Plastic and Reconstructive Surgery Unit, Hospital of Pisa, Italy
[c] First Clinic of Otolaryngology, Department of Surgery and Translational Medicine, University of Florence, Via Largo Brambilla 3, 50134 Florence, Italy

A R T I C L E I N F O

Article history:
Paper received 30 July 2013
Accepted 18 February 2014

Keywords:
Piezoosteotomy
Orthognathic surgery
Jaw and maxillary osteotomies
Blood loss
Nerve impairment

A B S T R A C T

Purpose: Investigators have hypothesised that piezoelectric surgical device could permanently replace traditional saws in conventional orthognathic surgery.
Methods: Twelve consecutive patients who underwent bimaxillary procedures were involved in the study. In six patients the right maxillary and mandible osteotomies were performed using traditional saw, whilst the left osteotomies by piezoosteotomy; in the remaining six patients, the surgical procedures were reversed. Intraoperative blood loss, procedure duration time, incision precision, postoperative swelling and haematoma, and nerve impairment were evaluated to compare the outcomes and costs of these two procedures.
Results: Compare to traditional mechanical surgery, piezoosteotomy showed a significant intraoperative blood loss reduction of 25% ($p = 0.0367$), but the mean surgical procedure duration was longer by 35% ($p = 0.0018$). Moreover, the use of piezoosteotomy for mandible procedure required more time than for the maxillary surgery ($p = 0.0003$). There was a lower incidence of postoperative haematoma and swelling following piezoosteotomy, and a statistically significant reduction in postoperative nerve impairment ($p = 0.003$).
Conclusions: We believe that piezoelectric device allows surgeons to achieve better results compared to a traditional surgical saw, especially in terms of intraoperative blood loss, postoperative swelling and nerve impairment. This device represents a less aggressive and safer method to perform invasive surgical procedures such as a Le Fort I osteotomy. However, we recommend the use of traditional saw in mandible surgery because it provides more foreseeable outcomes and well-controlled osteotomy. Further studies are needed to analyse whether piezoosteotomy could prevent relapse and promote bony union in larger advancements.

1. Introduction

Traditional ultrasonic surgery has been used in dental practice since the 1940s (Lynn et al., 1942). In the following decades, it has been applied to the following more challenging oral surgical procedures: alveolar ridge expansion (Blus and Szmukler-Moncler, 2006; Schlee et al., 2006) exposure of impacted canines (Grenga and Bovi, 2004), lateralisation of the inferior alveolar nerve (Bovi, 2005), sinus lifts for the placement of implants (Eggers et al., 2004; Stübinger et al., 2005; Barone et al., 2008), endodontic and periodontal surgery (Vercellotti and Pollack, 2006; Peñarrocha et al., 2007), and to harvest autologous bone grafts (Sohn et al., 2007). The end of the second millennium saw the growing clinical introduction of the ultrasonic scalpel (Shelley and Shelley, 1986; Lee and Park, 1999; Gonzalez-Garcia et al., 2009), and it has become competitive with conventional instruments in maxillo-facial surgery for orthognathic operations in certain frameworks (Stübinger et al., 2005; Kotrikova et al., 2006; Landes et al.,

* Corresponding author. Tel.: +39 0557947988; fax: +39 055435649.
E-mail address: mannelli.giuditta@gmail.com (G. Mannelli).

http://dx.doi.org/10.1016/j.jcms.2014.02.011

2008a, 2008b; Beziat et al., 2009; Gilles et al., 2013; Hoffmann et al., 2013).

Piezoelectric device involves the use of 60–200 μm/s ultrasonic microvibrations at 24–29 kHz to cut mineralised tissue, allowing soft tissue to remain unharmed at this frequency. This instrument seems to offer several main advantages in oral and maxillo-facial surgery (Stübinger et al., 2005; Kotrikova et al., 2006; Beziat et al., 2007; Landes et al., 2008a, 2008b; Maurer et al., 2008; Beziat et al., 2009; Gonzalez-Garcia et al., 2009; Gilles et al., 2013) such as: (1) minimal risk for soft tissue, which vibrates without fracture when in contact with the osteotome tip; (2) excellent visibility within the surgical field due to minimal bleeding and the cavitation effect removing osteotomic detritus; (3) precision and geometric cutting, due to the limited vibration amplitude and specific design of the osteotome; and (4) low acoustic and vibration impact. However, three main disadvantages have been reported: (1) dense bone cutting could take up to 4 times longer than a traditional rotary saw; (2) it is necessary to maintain a stock of tips; and (3) higher cost than mechanical osteotomes.

All of these characteristics have translated by authors into clinical and surgical results such as a reduction of intraoperative blood loss, more cutting precision, a longer operation duration mean time, a less incidence of postoperative swelling and haematoma, a lower incidence of nerve damage and a faster nerve recovery when impaired (Eggers et al., 2004; Beziat et al., 2007; Landes et al., 2008a, 2008b; Gonzalez-Garcia et al., 2009; Pineiro-Aguillar et al., 2011; Gilles et al., 2013).

In accordance with these findings, here we proposed a prospective clinical study between piezoelectric surgical device and traditional saw use in orthognathic surgery in order to assess whether piezoelectric device could permanently replace the traditional technique in this type of surgical procedure. We performed a comparative analysis between intraoperative and postoperative outcomes of both devices in twelve consecutive patients who underwent bimaxillary procedures for maxillo-facial disorders.

2. Material and methods

2.1. Patients

Twelve patients who were scheduled to undergo orthognathic surgery, were prospectively enrolled in this study between December 2011 and December 2012 with the assent of the Florence University Hospital IRB. All the participants signed an informed consent agreement. The indications for surgery included the presence of facial skeletal dysmorphia in all 12 patients and sleep apnea symptoms claimed by a single patient. A history of previous orthognathic surgery, maxillo-facial trauma or reconstructive facial surgery, were considered exclusion criteria.

2.2. Surgical method

The senior surgeon (G.S.) performed 12 bimaxillary procedures while patients were under general anaesthesia with nasal intubation. The surgical technique was chosen on the basis of the personal experience of the surgeon, by comparing surgical techniques reported in literature (Kahnberg, 1997; Landes et al., 2008a, 2008b; Nada et al., 2010; Gilles et al., 2013). The surgeon prepared and dissected the subperiosteum as usual before performing the bilateral sagittal split osteotomy (BSSO), and the mandibular osteotomy was initiated at 45° on the lingual ramus side. He penetrated into the cortical bone by going with the tip of the surgical instrument towards the inferior alveolar nerve channel without harming it. The split manoeuvre was performed with a manual rotation after have completed the inferior vertical osteotomy. The preparation of the periosteum for the Le Fort I osteotomy was carried on in the usual fashion through sulcular incisions; both, piezosurgery tip and traditional saw's blade, were pulled around the maxillary tuberosity under video-endoscopic-assisted control and inserted deeper paying attention to not produce haemorrhage. The surgeon then, brought the tip of both instruments towards the anterior sinus wall and then we penetrated the lateral nasal wall over the entire length of the nasal septum, to obtain the final maxillary down-fracture. In this setting, to compare piezoosteotomy characteristics with a traditional mechanical device, the surgeon performed a total of 48 single osteotomies, 24 maxillary and 24 mandible osteotomies, for a total of 4 osteotomies per patient. In six patients out of the twelve the right maxillary and mandible osteotomies were performed using the piezoelectric device, whilst the left osteotomies where performed using a traditional saw. In the remaining six patients the surgical procedures were reversed, and the patients underwent right maxillary and mandible osteotomies using a traditional saw, whilst the left osteotomies were performed using piezoelectric device. The scalpel's ultrasonic osteotome operated at a nominal, non-modulated frequency of 22.5 kHz, and the amplitude of the vibrations ranged from 35 to 300 mm.

2.3. Parameters assessment

To compare each device's characteristics, we analysed several surgical and clinical parameters on the basis of literature reports (Eggers et al., 2004; Beziat et al., 2007; Landes et al., 2008a, 2008b; Gilles et al., 2013). We analysed the following intraoperative and postoperative parameters:

(1) intraoperative blood loss was evaluated in mL collected by the same type of calibrated suction instrument during each surgical procedure. A standard amount of 0.9% saline solution was used to cool the bone and clean the surgical site, and it was counted and subtracted by the total amount of surgical fluids suctioned. This procedure was performed per each side and per each surgical device respectively.

(2) the operative time of the whole surgical procedure was evaluated objectively using OPERA software, an application for computer which helped us in recording the operative time of all of the surgical steps per each side and device, counting positioning, osteotomy and osteosynthesis time, objectively;

(3) incision surgical precision was evaluated subjectively by surgeon's comfort in splitting bone, in terms of force to apply during the osteotomy, attention to pay in order to obtain as much linear resected margins as possible with minimal bone consumption, by comparing the handiness of each device for both maxillary and mandible osteotomy;

(4) postoperative swelling was evaluated using a quantitative method. We took several photos to each patient's frontal, lateral and third-fourth side, in order to document the improvement and evolution of their facial appearance during the postoperative period. By looking at their frontal side picture, we presumed to draw an imaginary line dividing their face vertically along its middle point and horizontally at the level of the chin (Fig. 1). At this point, we measured the difference in millimetres of the extension of the swelling along the horizontal imaginary line using a meter, verifying the presence or absence of haematoma; we performed this analysis at one day, one week, one month, three months and six months after surgery, to compare our results;

(5) nerve impairment was calculated based on a total of 24 mandibular osteotomies using a clinical neurosensory test