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Practitioner experience with sonic osteotomy compared to bur and ultrasonic saw: a pilot *in vitro* study

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A. Rashad, P. Sadr-Eshkevari, M. Heiland, R. Smeets, N. Prochnow, E. Hoffmann, P. Maurer: Practitioner experience with sonic osteotomy compared to bur and ultrasonic saw: a pilot in vitro study. Int. J. Oral Maxillofac. Surg. 2015; 44: 203–208.

Abstract. The aim of the present study was to compare subjective experiences using bur, ultrasonic, and sonic osteotomy systems. Ten novice (N) and 10 expert (E) practitioners performed osteotomies on bovine ribs with each system. They scored ease of handling and sense of accuracy on visual analogue scales. The duration of the osteotomy procedure and the amount of noise were recorded objectively. Learning experience was evaluated in a second run. The Mann–Whitney *U*-test, Wilcoxon signed rank tests, and Spearman's rank correlation coefficient were used for the statistical analyses. The sonic system was significantly slower, with the worst noise impact (92.9 dB; standard deviation (SD) 7.1). However, both user groups improved significantly in the second run (N 7.9, E 7.6). There were no significant differences in handling. The sense of accuracy was evaluated to be significantly best for the sonic system (N 8.4, E 8.4), compared to the ultrasonic system (N 7.1, E 7.1; both $P = 0.043$) and bur system (N 5.5, $P = 0.002$; E 6.0, $P = 0.006$). The practitioners had a promising experience with the application of the ultrasonic system and particularly with the sonic system.

Key words: sonic surgery; ultrasonic surgery; bur osteotomy; comparative investigation; osteotomy impression..

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Based on the discoveries of palaeontologists, the first evidence of drilled teeth dates back to around 9000 years ago when flint tips were used as drills.[1] Rotary cutting systems have contributed enormously to all fields of medicine, including dentistry, orthopaedics, and oral and maxillofacial surgery. Although conventionally driven systems have enjoyed supremacy for many years, an increasing number of alternative cutting techniques have been developed and used.[2] Among the alternatives, high-frequency mechanical vibrations have long been used to cut hard substances. The dental profession applied this technology to cut dento-osseous structures as early as the middle of the 20th century.[3,4]

Despite the introduction of the first oscillation osteotomies around 60 years ago,[5] the first modernized applications of this technology in oral and maxillofacial surgery date back to the early 21st century. Vercellotti et al.[6] attempted to partially replace bur osteotomy instruments with ultrasonic osteotomy instruments. These instruments were originally designed to overcome the inherent disadvantages of the rotary systems, namely the frictional heat and vibration induced pain, trauma, and patient apprehension.[7] The recent re-introduction of the technology, however, was rather a reflection of the generally accepted trend towards superior soft tissue safety, accuracy of the cut, and less invasion of the surgical area.[8]

Various sonic osteotomy devices have been developed very recently.[9–11] Their development has been in line with the ever-growing advancements in osteotomy techniques and the armamentarium that provides the dental profession with superior clinical and patient experiences. Despite the thorough studies performed on the conventional rotary osteotomy systems and the relatively large and growing body of literature on ultrasonic osteotomy,[8,11,12] very little is known about the sonic osteotomy systems. The aim of the present study was to introduce a new sonic osteotomy system and describe practitioner satisfaction with its application in terms of ease of handling and sense of accuracy.

Materials and methods

Osteotomy systems

Three osteotomy systems were used; the inserts are shown in Fig. 1. (1) The bur system comprised a KaVo INTRAsurg 1000 (Fig. 2) (KaVo Dental GmbH, Biberach/Riß, Germany) with a Lindemann bur H254E (Komet/Gebr. Brasseler GmbH & Co. KG, Lemgo, Germany). (2) The ultrasonic system comprised a Piezosurgery device (Fig. 3) with an ultrasonic tip OT7S-4 (Mectron Medical Technology, Carasco, Italy). (3) The sonic system comprised a KaVo INTRAsurg 1000 Air (Fig. 2) (KaVo Dental GmbH) with a

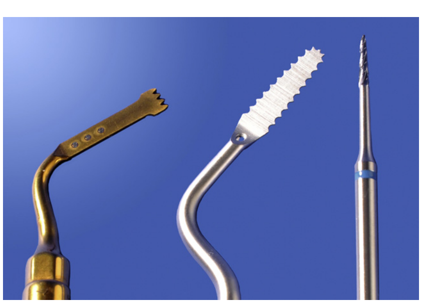

Fig. 1. From left to right: ultrasonic tip OT7S-4, sonic tip SFS 101, Lindemann bur H254E.

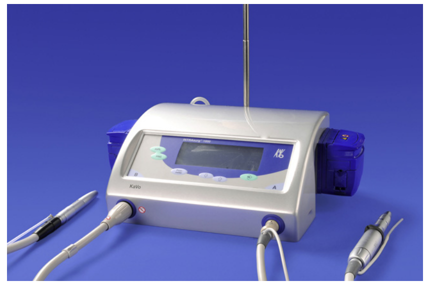

Fig. 2. Sonic driven KaVo INTRAsurg 1000 Air (left) and conventionally driven KaVo INTRAsurg 1000 (right).

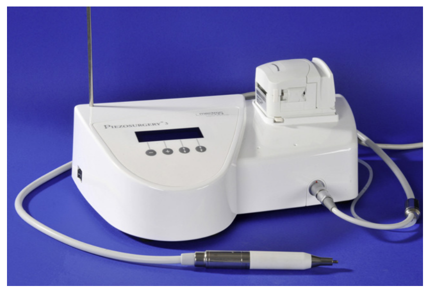

Fig. 3. Ultrasonic driven Piezosurgery.

SF1LM hand-piece and a sonic tip SFS 101 (Komet/Gebr. Brasseler GmbH & Co. KG).

Bone

Osteotomies were performed on fresh bovine ribs (cortical layer 8 mm in thickness) that were tempered at $20 \pm 0.5\,^{\circ}C$ by water quenching. Bovine ribs represent a well established bone model for the human mandible due to similarities in bone density and the ratio between cortical and cancellous bone.[13,14]

Methods and variables

Ten novice (N; residents) and 10 expert (E; faculty) surgical practitioners performed osteotomies on a 30-mm straight marked line to 8 mm in depth with each of the three devices; they subsequently expressed their subjective impressions of ease of handling and sense of accuracy using visual analogue scales (VAS) ranging from 0 to 10 (0 = worst possible result, 10 = best possible result). Each individual used a new osteotomy tip for each osteotomy. The study protocol was peer-reviewed and due to the *in vitro* study design was granted an exemption by the local institutional review board.

The ease of handling was defined as the practitioner's overall impression of the osteotomy device following a single osteotomy experience, in terms of convenience. Sense of accuracy was defined as the ability of the practitioner to follow a marked straight line as closely as subjectively possible during the osteotomy.

The time taken for osteotomy of the 30-mm straight marked line was recorded in seconds. Acoustic levels (dB) were recorded for 10 consecutive osteotomies for all three testing devices. Measurements were conducted using a digital gauge with an accuracy of ± 2 dB (1 kHz) and a range of 30–130 dB (Voltcraft SL-100, Conrad Electronic GmbH, Hirschau, Germany).

All the above-mentioned parameters were recorded once more in a second run, under the same conditions, with the addition of a VAS evaluation of the learning curve for each osteotomy system. Learning experience was defined as the practitioner's impression of how much they had improved in the second application of the osteotomy device in terms of convenience of application.

Statistical analysis

Non-parametric statistical analyses were performed according to the sample size. To compare the distribution of unpaired and paired groups, the Mann–Whitney *U*-test and the Wilcoxon signed rank tests were applied, respectively. To quantify the relationship between two metric variables, the Spearman's rank correlation coefficient was calculated. All tests were two-sided. Differences were considered significant at $P < 0.05$. PASW Statistics version 18.0 (SPSS Inc., Chicago, IL, USA) was used for the statistical analyses.

Results

Time needed for osteotomy

Sonic preparation was significantly the most time-consuming osteotomy technique ($P = 0.036$ compared to ultrasonic osteotomy; $P < 0.001$ compared to bur osteotomy), followed by ultrasonic preparation, which was still significantly slower than bur osteotomy ($P = 0.023$). Table 1 summarizes the mean times taken for osteotomy according to the three tested systems and the user groups.

For all three tested devices and on both runs, the surgically expert practitioners needed less time to complete the osteotomy in comparison to the novice practitioners. However, differences were not significant for sonic preparations in the first run and all three osteotomy methods in the second run ($P > 0.05$).