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Review

Piezoelectric compared with conventional rotary osteotomy for the prevention of postoperative sequelae and complications after surgical extraction of mandibular third molars: a systematic review and meta-analysis

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Abstract

The purpose of this review was to determine if postoperative sequelae (facial swelling, trismus, pain) and neurological complications are reduced when mandibular third molars are surgically extracted using a piezoelectric device for osteotomy compared with conventional rotary burs, and to determine if there is a difference in operating time between the two techniques. Clinical trials were identified through a search (April 2015) on the PubMed, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL) and Google Scholar databases. Studies were assessed by study type, characteristics of participants, sample size, surgical technique, cointerventions, outcomes, risk of bias, and findings. We calculated a Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) rating of confidence in the effect estimates. We identified 2515 citations and found 15 eligible clinical trials. Patients who had osteotomies with the piezoelectric device had less facial swelling (standard mean difference -1.15; 95% CI -2.02 to -0.27; $p < 0.0001$), trismus (greater maximum mouth opening, standard mean difference 0.78; 95% CI 0.56 to 1.00; $p = 0.33$) and pain (standard mean difference -0.84; 95% CI -1.55 to -0.13; $p < 0.0001$) at day 1, less facial swelling at day 7 (standard mean difference -0.98; 95% CI -1.52 to -0.44; $p = 0.05$), and a reduced risk of neurological complications (odds ratio (OR) 0.28; 95% CI 0.09 to 0.89; $p = 0.79$). Trismus at day 7 and pain at day 5 did not differ significantly between the two methods. Operating time was longer with the piezoelectric device (standard mean difference 0.83; 95% CI 0.57 to 1.09; $p = 0.001$). The confidence in the effect estimates was low or very low across all outcomes. The findings raise the possibility of an improved clinical healing response to osteotomy with the piezoelectric device compared with one performed with conventional rotary burs for surgical extractions of mandibular third molars.

Keywords: mandibular; extraction; piezoelectric; piezosurgery; osteotomy; oral surgery; meta-analysis

Introduction

Piezoelectric bone surgery (piezosurgery) is a technique in which an ultrasonic device is used for cutting bone, and it is used in a number of surgical fields for osteotomies, osteoplasties, and harvesting of bone for grafting. It has been used in oral and maxillofacial surgery for nearly three decades, particularly for sinus augmentation.[1] More recently it has been used for surgical extraction of teeth, with the first trial published in 2008. The current analysis pertains to its use for this purpose.[2]

The use of an ultrasound instrument for bone surgery was first reported by Horton et al in 1975 who used the

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instrument in dogs and found improved bone regeneration and healing when it was compared with rotary burs.[3] The instrument uses a micrometric cut, which involves a minimum surface area of bone, and reduces the risk of marginal thermonecrosis compared with conventional rotary burs, which can produce high temperatures when cutting bone.[1,4] The micromovements improve precision in cutting and tactile control, and eliminate macrovibrations that occur with rotary instruments.[1] At its oscillation frequency of 24-32 kHz, and provided that excessive mechanical force is not applied, it is tissue-selective and cuts mineralised structures but not soft tissue.[1,5,6] It might therefore reduce the risk of iatrogenic trauma to surrounding soft tissues, including vessels, nerves, and mucosa.[1] There may also be advantages of an oscillating tip such as improved intraoperative visibility as a result of the cavitation phenomenon (when implosion of gas in blood vessels has a haemostatic effect), and evacuation of debris from microstreaming generated by the continuous whirling movement of fluid.[1]

There have, however, been concerns that the ultrasonic instrument might increase operating time, and other concerns surrounding the risk of overheating of the device if excess pressure is applied, the possibility of injury to the inner ear, and the risk of breakage of the ultrasonic tips.[7,8] The most important outcomes are of course clinical, and they must be rigorously tested with appropriately designed and executed clinical trials. Advantages and disadvantages must then be weighed against the cost of instruments and the particular clinical needs.

A number of trials since 2008 have compared surgical tooth extractions performed with the piezoelectric device and those performed with conventional rotary burs. Most of the data currently available refer to mandibular third molars, with fewer available for maxillary third molars or other teeth. The purpose of this study was to review systematically all available trials that have examined outcomes for mandibular third molars and to conduct pooled analyses where possible. Our aim was to conduct a thorough examination, with particular attention to the risk of bias in the studies included.

Methods

Search

The search was designed by library staff at our university and conducted by the first author. It used the PubMed (from 1951 -April 2015), EMBASE (from 1966 - April 2015), the Cochrane Central Register of Controlled Trials (CENTRAL) (from 1996 - April 2015) and Google Scholar (searched May 2015) databases. A combination of medical subject headings and keywords was used (Appendix, supplemental data online only). The lists of reference studies that met our inclusion criteria were hand-searched for any additional potentially relevant studies.

Eligibility/inclusion of studies

Eligible trials compared conventional rotary bur osteotomy with piezoelectric osteotomy for the surgical removal of mandibular third molars, and reported numerical results for any of our primary or secondary outcomes. If the trial included teeth other than the mandibular third molar, but results for mandibular third molar teeth were reported separately for any of our outcomes, then the study was included. There were no restrictions imposed on participants (for example, regarding general health or age) or for duration of follow-up. There were no language restrictions and papers in languages other than English were translated.

Outcomes

Pain, facial swelling, and trismus were designated as primary outcomes, and operating time and neurological complications as secondary outcomes.

Extraction of data

The titles and abstracts were assessed independently in an un-blinded manner by the first author. The full texts of those studies deemed potentially relevant were then reviewed to determine if the study met the inclusion criteria. Full text was available for all studies identified.

For each study that met our inclusion criteria, data were extracted by the first author using the following predefined data fields: type/design of study, characteristics of participants, sample size, surgical technique, co-interventions, outcomes, and findings. Investigators were contacted if there were missing data, if information needed clarification, or for numerical values if data were reported using only graphs. If the latter were not provided, then the values were derived from the original graphs.

Assessment of quality

Two reviewers independently assessed the risk of bias for each study included using the criteria laid down in the Cochrane Handbook for Systematic Reviews of Interventions.[9] Disagreements were resolved by discussion. The Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) rating system was used to evaluate the quality of the body of evidence for each outcome (confidence in the effect estimates).[10] It specifies four categories of evidence - high, moderate, low, and very low. Studies were given an initial level according to their design (random control trials (RCT) were high level) and were downgraded if there was evidence of serious risk of bias, imprecision, inconsistency, indirectness, or if they contained publication bias.[11]

Statistical analysis

Statistical analyses were performed using Stata (version 13.1, StataCorp, College Station, Texas, USA). For continuous

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