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Piezoelectric bone surgery compared with conventional rotary instruments in oral surgery and implantology: Summary and consensus statements of the International Piezoelectric Surgery Academy Consensus Conference 2019

KEY WORDS

impacted mandibular third molar extraction, implant site preparation, piezoelectric surgery, sinus augmentation, systematic review

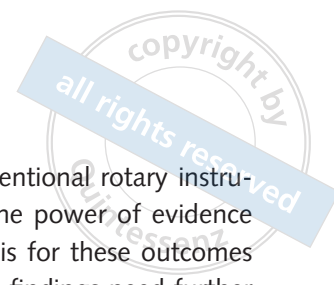
ABSTRACT

Purpose: Piezoelectric bone surgery was introduced into clinical practice almost 20 years ago as an alternative method for cutting bone in dental surgical procedures, in an attempt to reduce the disadvantages of using conventional rotary instruments. The aim of this Consensus Conference was to evaluate the current evidence concerning the use of piezoelectric surgery in oral surgery and implantology.

Materials and methods: Three working groups conducted three meta-analyses with trial sequential analysis, focusing on the use of piezoelectric surgery in impacted mandibular third molar extraction, lateral sinus floor elevation and implant site preparation. The method of preparation of the systematic reviews, based on comprehensive search strategies and following preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines, was discussed and standardised.

Results: Moderate/low evidence suggests that piezoelectric surgery is significantly associated with a more favourable postoperative course (less pain, less trismus) after impacted mandibular third molar extraction than conventional rotary instruments. Moderate evidence suggests that implants inserted with piezoelectric surgery showed improved secondary stability during the early phases of healing compared with those inserted using a drilling technique. Strong/moderate evidence suggests that piezoelectric surgery prolongs the duration of surgery in impacted mandibular third molar extraction, sinus floor elevation and implant site preparation, but it is unclear whether the slight differences in duration of surgery, even if statistically significant, represent a real clinical advantage for either operator or patient. Weak evidence or insufficient data are present to draw definitive conclusions on the other investigated outcomes.

Conclusions: Further well-designed trials are needed to fully evaluate the effects of piezoelectric surgery, especially in implant site preparation and sinus floor elevation.



Piezoelectric bone surgery for impacted mandibular third molar extraction compared with conventional rotary instruments: a systematic review, meta-analysis and trial sequential analysis

Main findings of the review

The meta-analysis and trial sequential analysis (TSA) of piezoelectric bone surgery (PBS) for impacted mandibular third molar extraction compared with conventional rotary instruments included 9 randomised clinical trials¹. Five studies were published in journals with an impact factor (mean impact factor 1.75) and four studies in journals with no impact factor. Eight RCTs out of nine were judged to be at high risk of bias and one RCT was judged to be at unclear risk of bias.

- Moderate/low evidence suggests that PBS significantly reduces postoperative morbidity in terms of postoperative pain and trismus compared with conventional rotary instruments. Quantitative analysis for the parameter 'swelling' was not performed due to significant differences in swelling evaluation methods across studies.
- Strong evidence suggests that PBS prolongs the duration of surgery compared with rotary instruments. In five studies, odontectomy was performed with rotary instruments in both groups, one study used a mixed technique (PBS/rotary) in the test group, two studies did not report how odontectomy was performed, and in one study odontectomy was not performed before extraction.

There are insufficient data available to ascertain whether PBS reduces the risk of neurological complications when compared with conventional rotary instruments.

Consensus statements

PBS for impacted mandibular third molar extraction seems significantly associated with a more favourable postoperative course (less pain, less trismus)

when compared with conventional rotary instruments. TSA showed that the power of evidence of the present meta-analysis for these outcomes is moderate/low, and these findings need further confirmation. Duration of surgery, however, is significantly longer when using PBS. Moreover, current evidence is based on many studies at high risk of bias often published in medium- or low-quality journals.

No definitive conclusions can be drawn regarding the protective effect of PBS on the risk of neurological complications, as the power of evidence of the present meta-analysis is weak for this specific outcome due to the limited number of events recorded in the included studies.

Clinical recommendations

In cases of impacted mandibular third molar extraction, PBS for osteotomy and bone guttering around the impacted tooth may reduce postoperative morbidity compared with conventional rotary instruments and should be considered a viable treatment option. The use of rotary instruments for initial tooth sectioning in areas far from delicate structures appears reasonable to shorten the duration of surgery and avoid unnecessary wear of ultrasonic tips.

Recommendations for future research

High-quality, adequately powered randomised controlled trials comparing PBS and rotary instruments for impacted mandibular third molar extraction are needed. Special attention should be paid to study design in order to reduce the risk of bias. In particular, the incidence of neurological complications in the two treatment groups should be investigated. Standardised and widely accepted methods to assess postoperative swelling should be adopted to obtain comparable results.



Piezoelectric bone surgery for lateral sinus floor elevation compared with conventional rotary instruments: a systematic review, meta-analysis and trial sequential analysis

Main findings of the review

The meta-analysis and TSA of PBS for lateral sinus floor elevation compared with conventional rotary instruments included four RCTs². All studies were published in journals with an impact factor (mean impact factor 2.89). Three of the four included studies were judged to be at high risk of bias. The fourth study was judged to be at low risk of bias.

- Weak evidence suggests that there is no difference between PBS and rotary instruments in reducing the risk of sinus membrane perforation during sinus floor elevation. TSA showed that a much more powered information size (2034 interventions compared to 143 interventions included in the present meta-analysis) is necessary to make conclusions about the magnitude of the treatment effect for this specific outcome.
- There is moderate evidence that PBS prolongs the duration of surgery in comparison with rotary instruments. The mean difference between test and control groups was 3.43 minutes. For this specific item, the power of the present meta-analysis was close to the required information size threshold determined by TSA (119 interventions included vs. 136 interventions necessary for 80% power).
- There are insufficient data to assess whether PBS improves the survival rate of implants inserted in combination with sinus augmentation procedures. The implant survival rate at 1-year follow-up was reported in only one study.

Consensus statements

PBS for lateral sinus floor elevation seems to be associated with a similar risk of sinus membrane perforation to that of conventional rotary instruments. In addition, the duration of surgery

is slightly longer when using PBS. The power of evidence of the present meta-analysis is weak for membrane perforation risk and moderate for duration of surgery. It should be considered that the surgical technique adopted in the four included studies (window reflection into the sinus cavity) was previously described as the least predictable approach for piezoelectric antrostomy, with a perforation risk comparable to that of rotary instruments³. In addition, none of the included RCTs specified the surgical phase during which perforations occurred. If the membrane was damaged during elevation with manual curettes or the grafting procedure, it would have been completely independent from the use of PBS or rotary burs. The slight difference in mean duration of surgery between the two techniques, even if statistically significant, does not seem to represent a real clinical advantage for either operator or patient.

Clinical recommendations

Bone window reflection into the sinus cavity seems to result in a similar membrane perforation risk when using either PBS or rotary instrument techniques. Two safer surgical techniques are available, however, when using PBS in lateral sinus floor elevation: window outlining and removal, and thinning the lateral wall until the membrane is visible under a thin layer of bone before outlining the window. Previous reviews and RCTs have shown that thinning the lateral wall before window outlining presents a lower risk of membrane perforation than the other approaches³⁻⁵.

Recommendations for future research

Adequately powered randomised controlled trials comparing PBS and rotary instruments for lateral sinus floor elevation are needed. PBS, with the safer approach in terms of membrane perforation risk (erosion of the lateral wall), should be used as a comparator. Moreover, future trials should report the exact moment at which perforation occurs (during antrostomy, window detachment, membrane elevation, the grafting procedure) in order to better understand the real cause of the complication.



Piezoelectric bone surgery for implant site preparation compared with conventional drilling techniques: a systematic review, meta-analysis and trial sequential analysis

Main findings of the review

The meta-analysis and TSA of PBS for implant site preparation compared with conventional drilling techniques included nine studies (eight RCTs and one CCT)⁶. Eight studies were published in journals with an impact factor (mean impact factor 2.12) and one RCT in a journal with no impact factor. Four RCTs were judged to be at high risk of bias, one at unclear risk of bias and three at low risk of bias. The only CCT was evaluated as a low-quality study.

- TSA showed moderate evidence suggesting that ultrasonic implant site preparation significantly prolongs surgery duration when compared with conventional drilling techniques. The mean difference between the two groups was 3.21 minutes.
- Current evidence suggests that PBS significantly improves the secondary stability of implants 4, 8 and 12 weeks after insertion compared with conventional drilling techniques. TSA highlighted a weak power of evidence at the 4- and 8-week follow-ups and a moderate power at 12 weeks.
- Even if marginal bone loss was slightly lower in the PBS group than in the drilling group, the difference was not significant at the 6-, 12- and 15-month follow-ups. TSA was not performed for this outcome due to the limited number of studies reporting marginal bone loss.
- No significant differences in implant failure rate were demonstrated between PBS and conventional drilling techniques at follow-ups varying from 3 to 24 months. However, meta-analysis of this specific outcome had an extremely weak power of evidence. TSA showed that a sample of 4440 implants is necessary for a power of 80%, compared to the 451 implants evaluated in the included studies.

Consensus statements

PBS requires a longer duration of surgery for implant site preparation compared with conventional drilling techniques. It remains unclear whether the slight difference in mean duration of surgery between the two techniques, even if statistically significant, represents a real clinical advantage for either operator or patient. Implants inserted with PBS showed improved secondary stability during the early stages of healing (first three months after surgery) compared with implants inserted using drilling techniques.

There is insufficient data available on marginal bone loss and implant failure rate to draw conclusions on eventual differences between PBS and conventional drills for implant site preparation.

Clinical recommendations

Ultrasonic implant site preparation seems to improve bone healing in the early stages after implant placement, resulting in higher secondary stability up to 3 months compared with conventional drill osteotomy. PBS could be a helpful tool in challenging clinical situations (immediate/early loading, low bone quality, low-responding patients). A mixed site preparation (starting implant osteotomy using conventional drills and finalising it using ultrasonic tips) could be an alternative strategy to overcome the drawback of the slightly prolonged duration of surgery when using only PBS.

Recommendations for future research

Adequately powered RCTs comparing PBS with conventional drills for implant site preparation are needed. Efforts should be made to design studies with accurate standardisation of surgical and prosthetic protocols and careful control of patient-related confounding factors influencing implant stability, marginal bone loss and implant osseointegration. Standardised and widely accepted methods to assess implant stability and marginal bone loss should be adopted to obtain comparable results. Finally, investigations



analysing the incidence of accidental injuries to nerves and vessels during implant site preparation using the two techniques should also be performed.

References

1. Cicciù M, Stacchi C, Fiorillo L, et al. Piezoelectric bone surgery for impacted lower third molar extraction compared with conventional rotary instruments: A systematic review, meta-analysis and trial sequential analysis [pub ahead of print 10 April 2020]. *Int J Oral Maxillofac Surg* doi: 10.1016/j.ijom.2020.03.008.
2. Stacchi C, Troiano G, Berton F, et al. Piezoelectric bone surgery for lateral sinus floor elevation compared with conventional rotary instruments: A systematic review, meta-analysis and trial sequential analysis. *Int J Oral Implantol* 2020;13:109–121.
3. Stacchi C, Andolsek F, Berton F, Perinetti G, Navarra CO, Di Lenarda R. Intraoperative complications during sinus floor elevation with lateral approach: A systematic review. *Int J Oral Maxillofac Implants* 2017;32:e107–e118.
4. Stacchi C, Vercellotti T, Toschetti A, Speroni S, Salgarello S, Di Lenarda R. Intraoperative complications during sinus floor elevation using two different ultrasonic approaches: A two-center, randomized, controlled clinical trial. *Clin Implant Dent Relat Res* 2015;17(Suppl 1):e117–e125.
5. Stacchi C, Lombardi T, Cusimano P, et al. Bone scrapers versus piezoelectric surgery in the lateral antrotomy for sinus floor elevation. *J Craniofac Surg* 2017;28:1191–1196.
6. Stacchi C, Bassi F, Troiano G, et al. Piezoelectric bone surgery for implant site preparation compared with conventional drilling technique: A systematic review, meta-analysis and trial sequential analysis. *Int J Oral Implantol* 2020;13:141–158.



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