

Original Contributions

Minimally invasive vertical versus conventional tooth extraction

An interrupted time series study

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ABSTRACT

Background. Minimally invasive vertical tooth extraction techniques have evolved in light of the limitations of conventional tooth extraction techniques and flap surgery in preserving the alveolar bone. The authors conducted a study to obtain data on the performance of a vertical extraction system. This included comparing the need for flap surgery using the vertical extraction system versus conventional tooth extraction techniques for the extraction of anterior teeth and premolars not suitable for forceps extraction.

Methods. The authors conducted a prospective observational clinical study of the vertical extraction system versus conventional tooth extraction techniques using an interrupted time series in line with the Idea, Development, Exploration, Assessment, Long-term Follow-up collaboration framework for surgical innovation.

Results. Overall, 276 of 323 teeth (85.4%) in 240 patients were successfully extracted using the vertical extraction system. Of the 47 failures in the vertical tooth extraction cohort, 18 required flap surgery, resulting in an overall incidence of flap surgery of 5.6% (95% confidence interval [CI], 3.2% to 8.7%). During the routine care period, of the 94 anterior teeth and premolars in 78 patients, 21 teeth could not be extracted using conventional techniques and required flap surgery, leading to an incidence of flap surgery of 22% (95% CI, 14% to 32%).

Conclusions. The results suggest that the vertical extraction system may be used with a high success rate for extraction of severely destroyed teeth, and its use may lead to a marked reduction in the need for flap surgery. Randomized clinical trials are needed to confirm the findings.

Practical Implications. The use of a vertical extraction system may lower the incidence of flap surgery.

Key Words. Tooth extraction; oral surgical procedures; minimally invasive procedures.

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Tooth extraction is associated with loss of alveolar bone, which is thought to occur from both physiological¹⁻³ and iatrogenic mechanisms as no extraction technique is completely atraumatic.⁴⁻⁶ The postextraction loss of alveolar bone can compromise the functional and esthetic rehabilitation with removable or fixed prostheses, including dental implants.^{4,6,7}

Several possible determinants of the extent of alveolar bone loss have been proposed. These include systemic factors such as a patient's general health and behavior^{8,9}; local factors including the tooth type and location (mandible or maxilla); the preoperative condition of the socket; the number, proximity, and type of teeth extracted¹⁰; and postextraction treatment protocols.^{10,11} In addition, the mode of extraction has been reported to influence the extent of alveolar bone resorption.^{1,12,13} Conventional tooth extraction techniques involving the use of elevators, luxators, periostomes, and forceps operate on the principle of socket expansion and will, therefore, traumatize the alveolar bone to some extent.⁴⁻⁶ For teeth not manageable with these instruments, a standard approach would be reflection of a mucoperiosteal flap, often followed by bone removal to facilitate tooth extraction. Although the evidence for bone loss due to reflection of the flap alone may be inconclusive,^{14,15} bone removal during flap surgery represents additional alveolar bone loss even

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before any bone resorption in the context of socket remodeling commences. In addition, clinical research has implicated flap surgery with increased postoperative pain¹⁶⁻¹⁸ and may hamper soft-tissue esthetics at the rehabilitation stage.¹⁹ Therefore, a reduction in the need for flap surgery would be a desirable feature of any novel extraction technique.

In light of the limitations of conventional tooth extraction techniques and flap surgery in preserving alveolar bone and assuming that minimally invasive methods result in better ridge preservation, a number of novel vertical tooth extraction techniques have evolved.^{6,12,13,20} These techniques share the common principle of causing no direct trauma to the socket walls through severance of the periodontal ligament by pulling the tooth in an axial direction from its socket. Evidence regarding the effectiveness of vertical extraction systems is scarce. Timely evaluation of novel surgical techniques is important to prevent widespread adoption without sufficient evidence and, equally, to promote innovation supported by adequate evidence.^{21,22} However, evaluation of surgical innovation is challenging for various reasons, including but not limited to the fact that surgical technique and approach, as well as instrumentation, continue to evolve as novel techniques are used in practice. Hence, alternatives to randomized controlled trials play an important role, in particular in the earlier phases of the introduction of novel techniques into clinical practice. The IDEAL Collaboration has proposed a 5-stage framework of surgical innovation, which has been used in many surgical specialties.^{21,22-26}

We conducted a proof-of-principle clinical study from November 2010 through March 2011 that evaluated the technical applicability, success rates, learning curve, and limitations of a vertical extraction system (Benex, Helmut Zepf Medizintechnik and Hager & Meisinger).²⁷ The study suggested that the vertical extraction system was of limited use for the extraction of molars, but it achieved high success rates in anterior teeth and premolar extractions. Importantly, the study suggested that the use of the vertical extraction system may be associated with a marked reduction in the need for flap surgery for extractions of anterior teeth and premolars that were not suitable for standard forceps extraction.

Our aims for conducting this study were to extend our earlier cohort study to provide more robust data on the performance of the vertical extraction system in anterior teeth and premolar extractions and compare the need for flap surgery using the vertical extraction system with conventional tooth extraction techniques for the extraction of anterior teeth and premolars that are not suitable for forceps extraction. To this end, we conducted an interrupted time series study in line with the principles of the IDEAL framework stage 3.²¹

METHODS

Study design and participants

We conducted a prospective observational clinical study using the vertical extraction system (hereafter referred to as the vertical extraction cohort) and conventional tooth extractions (hereafter referred to as the conventional cohort) using an interrupted time series.²¹ As this study used only anonymized data collected as part of routine clinical care, formal review by a research ethics committee was not required. The study was approved by National Health Service Research and Development (no. BBC RMG 1440). All patients gave informed consent to treatment.

For the purpose of this analysis, we defined conventional tooth extraction techniques as the use of forceps, luxators, elevators, or periostomes for tooth extraction. Flap surgery was defined as reflection of a mucoperiosteal flap (with or without subsequent bone removal with a bur). In the vertical extraction cohort, success was defined as the complete removal of roots by means of the vertical extraction system. After failure using the vertical extraction system, teeth were extracted with conventional tooth extraction techniques or, if necessary, flap surgery.

From November 2010 through April 2014, patients in the vertical extraction cohort underwent extractions of anterior teeth and premolars by 1 of 7 clinicians with 3 or more years of experience in oral surgery, using the vertical extraction system. The vertical extraction system was introduced to the participating clinicians by 2 clinicians with prior experience with the system, using a slide presentation and 1-to-1 practical demonstration. Teeth had to be deemed not suitable for a conventional forceps extraction owing to the limited coronal tooth tissue remaining or to the crown fracturing during a forceps extraction attempt. We excluded primary teeth, molars, impacted teeth, and teeth with greater than first degree mobility. The study extended and included the data reported on in our 2013 report,²⁷ excluding mandibular molars.

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