J Oral Maxillofac Surg
66:183-188, 2008

Ultrasonic Bone Cut Part 2: State-of-the-Art Specific Clinical Applications

Philippe Leclercq, DDS, Charlotte Zenati, DDS†*
and David M. Dohan, DDS, MS, PhD‡

The ultrasonic lancet makes it possible to realize, with extreme precision and safety, a great number of oral and maxillofacial surgeries. It is during 4 particular interventions, however, that this tool may have many advantages over conventional instrumentation, ie, nontraumatic removal of osseointegrated implants, chin and retromolar bone harvesting, and inferior alveolar nerve lateralization. This study presents these applications in detail and discusses their advantages and disadvantages compared with former techniques. The use of the piezoelectric lancet considerably simplifies these surgical protocols as it has a nontraumatic cut and a solid interface cleavage, under the effects of ultrasounds that facilitates the breaking of bone fragments.

The development of an appropriate instrumentation to any surgical situation is a determining element in the rationalization of the most complex interventions. This clinical and technologic research is able to transform some delicate surgeries into codified and reproducible acts.

In the field of bone graft, most available tools are more or less a lucky adaptation of the instrumentation used in dental or maxillofacial surgery. They are often little efficient, miniaturized applications of general-purpose instrumentation: oscillating saw, bone scissors and hammer, electrical motorized hand-piece, or bone drill. Maxillomandibular bone grafts, however, cannot be assimilated to a true orthopedic surgery; bone grafts correspond more to the first stage of facial reshaping and reconstruction. Therefore, they require instruments of appropriate precision.

Easy-to-use, precise, secure, and efficient for bone cut, the ultrasonic lancet is an effective tool for the surgeon in many clinical situations.[1-6] However, in our opinion, for an experienced practitioner, the use of piezosurgery is truly required in only 4 particular interventions: the removal of osseointegrated implants, chin and retromolar bone harvesting, and inferior alveolar nerve lateralization. It is, indeed, during these 4 delicate operations that the properties of the ultrasonic lancet become a major advantage for successful treatment.

Ultrasonic Lancet and Removal of Osseointegrated Implants

An osseointegrated implant can resist in torsion to forces of greater than 90 N. Generally, above this threshold, the metal of the implant begins to lose its shape. The removal of such an ankylosed structure is therefore particularly delicate, and within a high risk of taking a part of the peri-implant bone with the implant. Fortunately, such operations are mostly realized on failed implants, ie, nonosseointegrated or with peri-implantitis. The removal, therefore, is easy because the implant is set in fibrous tissue.

It is sometimes necessary to eliminate some implants despite their perfect osseointegration. This is particularly the case with ectopic implants because they are judged as prosthetically unusable or because the position of the implant implies major esthetic damage. The removal of these implants has to be the least traumatic, to limit the decay of the implant site. An osseointegrated implant is deeply connected to the bone that supports it, which implies great difficulties in breaking the bone/implant interface and high risk of fracture of the peri-implant osseous walls during the operation.

The ultrasonic lancet allows effective management of this type of situation because of solid interface cleavage under the effects of ultrasound vibrations and the realization, by microabrasion, of thin osseous trenches. In other words, it is sufficient to make 2

*Private Practice, Paris, France.

†Student, Biophysics Laboratory, Faculty of Dental Surgery, Paris V University, Odontology Service, AP-HP Hospital Albert Chenevier, Créteil, France.

‡Assistant Professor, Department of Oral Surgery, AP-HP Hospital Albert Chenevier, Biophysics Laboratory, Faculty of Dental Surgery, Paris V University, Montrouge, France.

Address correspondence and reprint requests to Dr Dohan: Biophysics Laboratory, Faculty of Dental Surgery, 1 Rue Maurice Arnoux, 92120 Montrouge, France; e-mail: drdohand@hotmail.com

0278-2391/08/6601-0032$34.00/0
doi:10.1016/j.joms.2005.12.050

thin vestibular or lingual trenches, on each side of the implant, to give flexibility to the osseous wall, whereas the ultrasonic vibrations will favor the cleavage of the solid bone/implant interface. The removal of the implant is then easy, with the knowledge of these procedures (Figs 1, 2). However, the risk of fracture of the peri-implant osseous walls remains important, particularly during the extraction phase itself, because this phase requires applying consequent twisting forces on the implant and on the alveolar bone.

Ultrasonic Lancet and Chin Bone Harvesting

Chin bone harvesting may provide 1 or 2 big plates from a dense cortical bone with limited risk for the donor site. In many clinical situations, these 2 fragments are enough to realize moderate extent grafts, concerning either maxillary sinus lifts or apposition grafts to increase alveolar thickness or height.[7] This intraoral donor site is often recommended, as it allows avoiding extraoral osseous harvesting (from the parietal bone, iliac bone, etc), and general anesthesia. Light sedation and a local anesthetic are enough to perform a chin bone graft. For a conscious patient, there is a particularly unpleasant moment when the practitioner, after having cut the graft's limits, uses the bone chisel to remove the bone fragment from the mandibular body. Every hammer blow echoes violently into the patient's head, and after the intervention, this traumatic recollection can darken all the practitioner's efforts in decreasing the intraoperative sufferings.

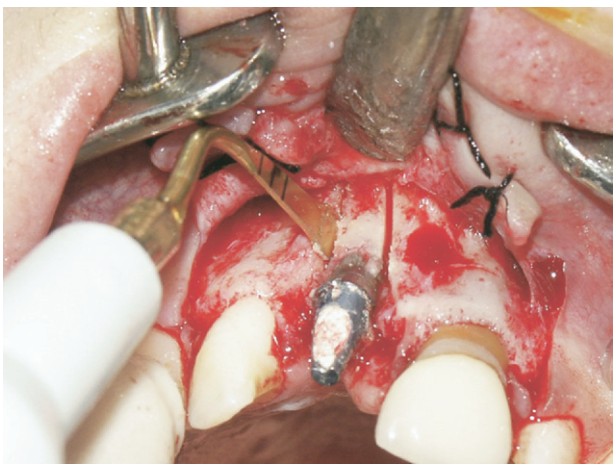

FIGURE 1. For nontraumatic removal of an osseointegrated implant positioned in an ectopic place, make 2 thin trenches on each side of the implant to give a certain flexibility to the osseous wall while imposing ultrasonic vibrations to the bone/implant interface.

Leclercq, Zenati, and Dohan. Ultrasonic Bone Cut. J Oral Maxillofac Surg 2008.

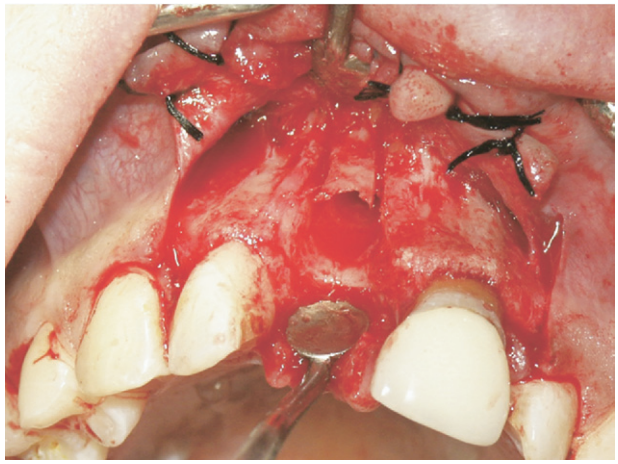

FIGURE 2. Interface cleavage and the implant removal done with a minimum decay of the bone volume.

Leclercq, Zenati, and Dohan. Ultrasonic Bone Cut. J Oral Maxillofac Surg 2008.

The ultrasonic lancet offers an alternative to the bone chisel and hammer. Making the graft demarcation trench with the ultrasonic lancet creates a thinner section than the one obtained with the bone drill.[8,9] This trench is also deeper than the one obtained with a cutting disc (eg, inserts allow work up to 10 or 12 mm of depth). Furthermore, the ultrasound vibration transmission through the graft induces, little by little, a fracture of the solid interface between the cortical plate and the underlying medullar tissues. This cleavage of both structures of different densities will allow easy collection of the osseous fragment, and sometimes it is not necessary to use a chisel and hammer. Even if the bone chisel is needed on occasion to finish the separation of the graft, the impacts that are made are very moderate (Fig 3).

The use of the ultrasound lancet provides security to the practitioner in regard to patient comfort and the prognosis of his intervention.[10-12] By decreasing the number and the intensity of the chisel strokes needed for the cleavage of the cortical plate, the risk for fracture is reduced. To make grafts of quality, however, it is important to collect bone fragments of a determined dimension and shape to make a precise and meticulous reconstruction[13]; this is one of the keys to the functional and esthetic success for these grafts. The graft integrity is a crucial element.

Ultrasonic Lancet and Retromolar Bone Harvesting

Situated on the mandibular body in the mandibular branch continuation, the retromolar bone of-

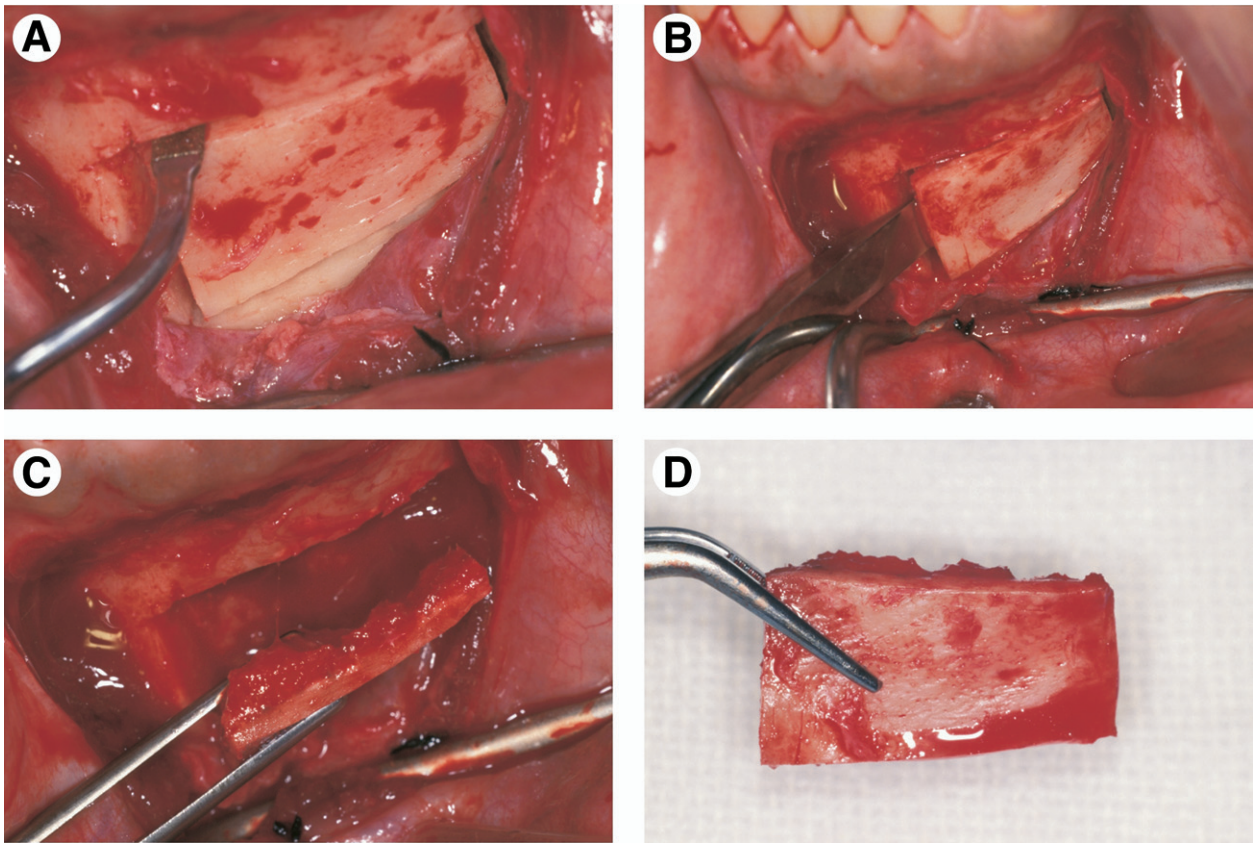

FIGURE 3. Chin bone harvesting with an ultrasonic lancet. The graft outlines are made with a thin and diamond-coated insert (*A*) that allows the cleavage between the cortical plate and the mandibular mass with little use of chisel and hammer (*B, C*). The bone fragment has better chances to remain intact, and it is easier to control its thickness (*D*).

Leclercq, Zenati, and Dohan. Ultrasonic Bone Cut. J Oral Maxillofac Surg 2008.

fers an alternative to chin bone harvesting. Although this zone is more difficult to access than the chin, it has the advantage of allowing the collection of longer and thicker fragments than in the chin zone. Furthermore, situated on the force convergence area of the mandible, the donor site will easily reconstitute itself under the influence of mechanical stimuli that are applied.

The problem of retromolar harvesting is similar to chin harvesting: one must make the thinnest trenches and mobilize the graft least violently to avoid traumatic shocks and graft breaking with a chisel and hammer.

It is important to make a sketch of the graft dimensions (for the receiving zone). The graft thickness is determined by a low, horizontal section. It can be made with a disc (mounted on an electrical motorized hand-piece) or with a specific insert of the ultrasonic lancet to trace the inferior limit of the osseous fragment. The use of the ultrasonic lancet is particularly reassuring, even more than for the chin zone, as it offers the certainty of avoiding damage to nearby tissues.[14,15] With difficult surgical access and visual control of the retromolar angle, this security is of great value and contributes to the surgical ease of the practitioner (Fig 4).

Ultrasonic Lancet and Inferior Alveolar Nerve Lateralization

The lateralization of the inferior alveolar nerve is a very delicate operation that is reserved for extreme clinical situations.[16] Its main difficulty remains in the initial release of the nerve: it is necessary to decorticate it, without any damage, up to the mental foramen. This bone foramen must be eliminated to avoid risk of constriction of the nervous pedicle during the lateralization of the nerve.[17,18]

The use of the ultrasonic lancet is very interesting in this situation because it allows a secure bone cut and an easy access to and release of the nerve.[19] The ultrasonic vibrations make the cortical plate cleavage easier from the soft structures that are underneath. This is the only true difficulty of the inferior alveolar nerve lateralization gesture, and it is raised as a matter of course with the ultrasonic lancet.

The release of the inferior alveolar nerve implies to meticulously introduce instruments through an osse-

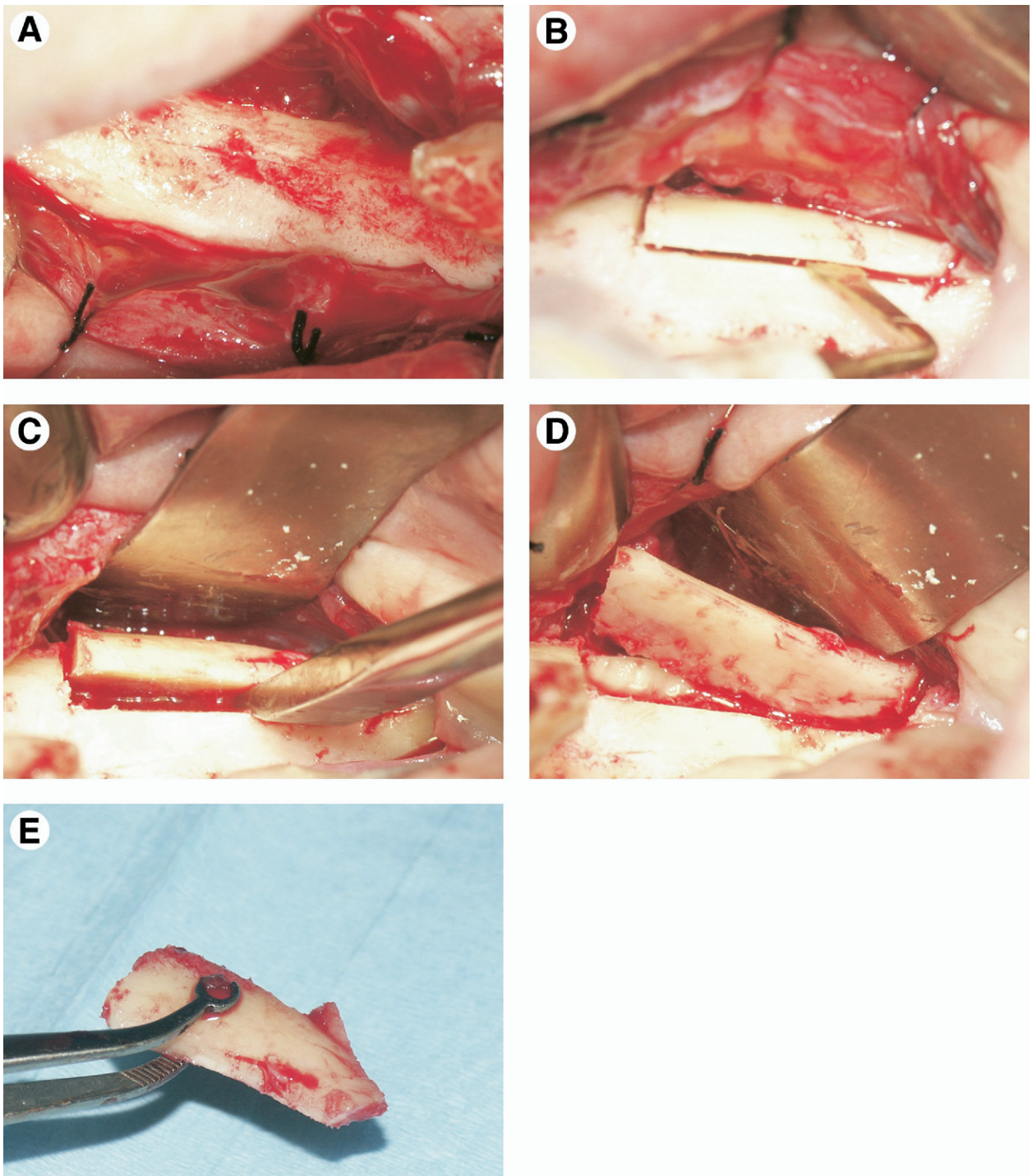

FIGURE 4. Retromolar harvesting using the ultrasonic lancet. On a bare mandibular body (*A*), the graft outlines are made using a thin insert, like a bone saw (*B*). The ultrasound vibrations facilitate the cleavage of the graft, which then only require a restricted use of the struck chisel (*C*). To control the thickness of the harvesting, it is important not to forget to draw the limits of the bone fragment on the lateral part of the mandibular body: an osseous fragment with perfectly calculated dimensions is obtained (*D, E*).

Leclercq, Zenati, and Dohan. Ultrasonic Bone Cut. J Oral Maxillofac Surg 2008.

ous wall of difficult access. The ultrasonic lancet has a cutting power only at the end of its insert; it can be used in inaccessible sectors without damaging the neighboring tissues (cheeks, tongue).

The risk for accidental damage of the nerve during the osseous section is reduced by the weak cutting power of the ultrasound lancet inserts. The micro-abrasive oscillations of these inserts will provide more

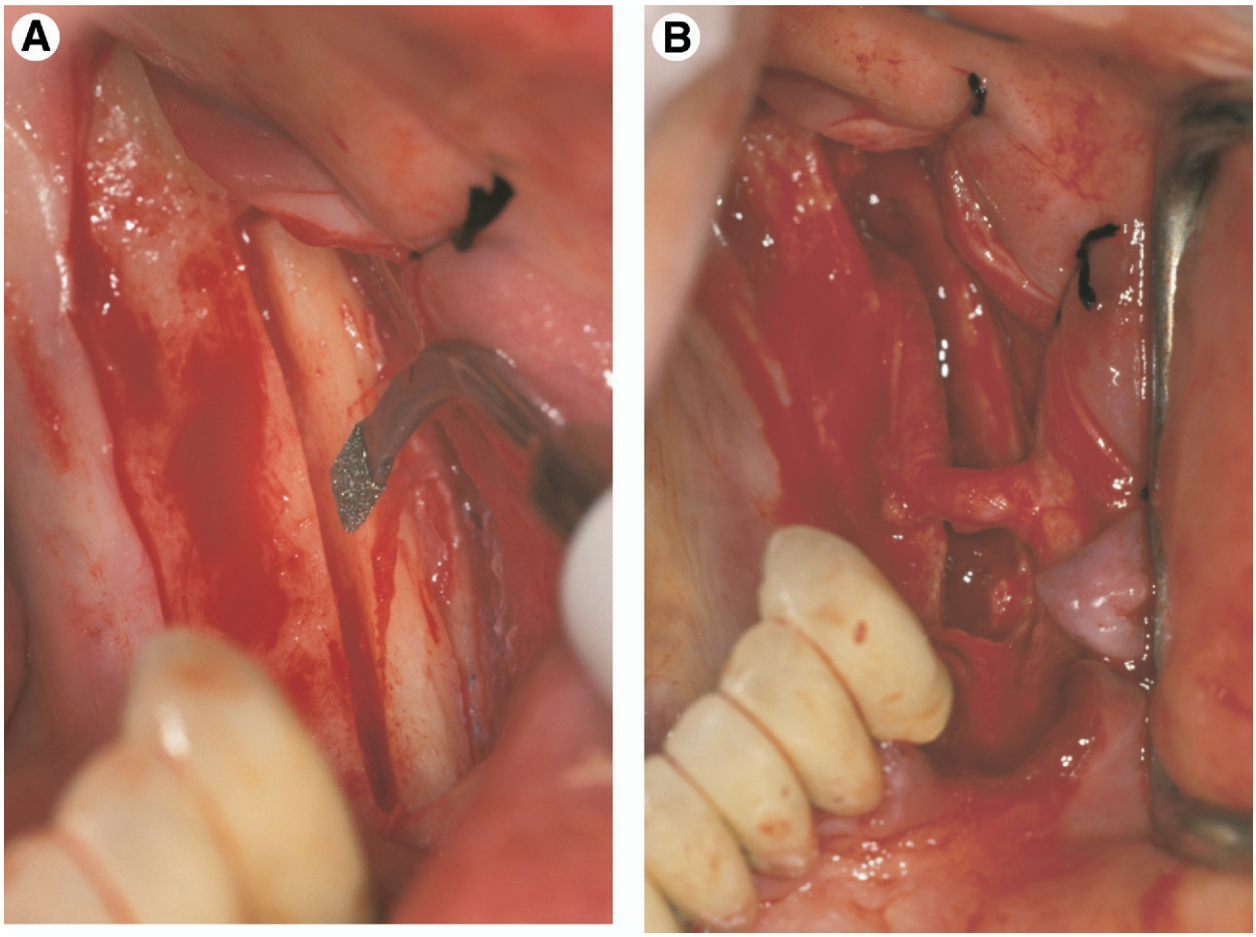

FIGURE 5. Release and lateralization before implantation of an inferior alveolar nerve with the use of the ultrasonic lancet. The osseous plate access is made with a diamond-coated insert (*A*). The bone hole of the mental foramen is eliminated and the nerve is released on all its length; it is a preliminary condition for the success of such an intervention without after effects (*B*).

Leclercq, Zenati, and Dohan. Ultrasonic Bone Cut. J Oral Maxillofac Surg 2008.

precise information to the surgeon about the hardness of the encountered tissues than a turbine or a hand-piece, and will reduce errors of the estimated cutting depth.[12]

The use of the ultrasonic lancet contributes to demystifying surgery of the inferior alveolar nerve. This procedure still remains delicate, but it is greatly secured and facilitated with this instrumentation (Fig 5).

Discussion

The main disadvantage for using the ultrasonic lancet in bone harvesting surgery is its inefficacy and fragility when facing very dense bone tissues.[12,15] However, the major part of our harvesting comes from very cortical sectors, ie chin bone, retromolar bone, or parietal bone. Thus, in theory, the main indication of the ultrasonic lancet is more or less its main contraindication.

Clinically, however, it is easy to adapt to this lack of efficacy in front of hard bone tissues; by progressing more slowly and without force, the most cortical bones always weaken. Note the accelerated wear of the inserts and a higher rate of parts fracture than with bones that are not as hard. These fractures do not have any consequences on the quality of cutting,[11,13] but they require a careful inventory control of spare inserts.

Despite this inadequacy, the ultrasonic lancet remains the best instrument available to realize bone harvesting, even for very dense cortical bones.[10,13,20] The ultrasound vibrations favor the cleavage of the solid interfaces and facilitates the separation of the graft from the donor site. The harvesting of the bone plate will be even, often made without the help of a bone chisel and hammer, as the violent impacts would risk breaking the grafts in fragments that are difficult to use afterward. In deeply buried sites, the use of the ultrasonic lancet is extremely reassuring because it gives the certainty of not hurting soft or hard tissues.[5,19] The cost of some broken inserts is widely rewarded by an ease and a surgical security

both for the practitioner and for the patient. This is a strong argument for an experienced practitioner; the bone chisel and hammer knocks are always the main postoperative painful recollections. For this reason only, the use of an ultrasonic lancet in the protocol of bone harvesting should be systematic.

In conclusion, the ultrasonic lancet belongs to the category of tools that transform delicate operations into easy and perfectly mastered procedures. However, it is important to define the advantages, the inconveniences, and the reasonable application field to take advantage of its benefits without exceeding the limits.

References

1. Vercellotti T: Piezoelectric surgery in implantology: A case report—a new piezoelectric ridge expansion technique. Int J Periodontics Restorative Dent 20:358, 2000
2. Vercellotti T, De Paoli S, Nevins M: The piezoelectric bony window osteotomy and sinus membrane elevation: Introduction of a new technique for simplification of the sinus augmentation procedure. Int J Periodontics Restorative Dent 21:561, 2001
3. Torrella F, Pitarch J, Cabanes G, et al: Ultrasonic ostectomy for the surgical approach of the maxillary sinus: A technical note. Int J Oral Maxillofac Implants 13:697, 1998
4. Gruber RM, Kramer FJ, Merten HA, et al: Ultrasonic surgery—an alternative way in orthognathic surgery of the mandible. A pilot study. Int J Oral Maxillofac Surg 34:590, 2005
5. Robiony M, Polini F, Costa F, et al: Piezoelectric bone cutting in multipiece maxillary osteotomies. J Oral Maxillofac Surg 62: 759, 2004
6. Shelley ED, Shelley WB: Piezo surgery: A conservative approach to encapsulated skin lesions. Cutis 38:123, 1986
7. Tulasne JF: [Commentary on maxillary pre-implant rehabilitation. A study of 55 cases using autologous bone graft augmentation]. Rev Stomatol Chir Maxillofac 100:265, 1999
8. Horton JE, Tarpley TM Jr, Wood LD: The healing of surgical defects in alveolar bone produced with ultrasonic instrumentation, chisel, and rotary bur. Oral Surg Oral Med Oral Pathol 39:536, 1975
9. Horton JE, Tarpley TM Jr, Jacoway JR: Clinical applications of ultrasonic instrumentation in the surgical removal of bone. Oral Surg Oral Med Oral Pathol 51:236, 1981
10. Aro H, Kallioniemi H, Aho AJ, et al: Ultrasonic device in bone cutting. A histological and scanning electron microscopical study. Acta Orthop Scand 52:5, 1981
11. Vercellotti T, Crovace A, Palermo A, et al: The Piezoelectric osteotomy in orthopedics: Clinical and histological evaluations (pilot study in animals). Medit J Surg Med 9:89, 2001
12. Vercellotti T: Technological characteristics and clinical indications of piezoelectric bone surgery. Minerva Stomatol 53:207, 2004
13. Chiriac G, Herten M, Schwarz F, et al: Autogenous bone chips: Influence of a new piezoelectric device (Piezosurgery) on chip morphology, cell viability and differentiation. J Clin Periodontol 32:994, 2005
14. Stubinger S, Kuttenberger J, Filippi A, et al: Intraoral piezosurgery: Preliminary results of a new technique. J Oral Maxillofac Surg 63:1283, 2005
15. Eggers G, Klein J, Blank J, et al: Piezosurgery: An ultrasound device for cutting bone and its use and limitations in maxillofacial surgery. Br J Oral Maxillofac Surg 42:451, 2004
16. Hirsch JM, Branemark PI: Fixture stability and nerve function after transposition and lateralization of the inferior alveolar nerve and fixture installation. Br J Oral Maxillofac Surg 33:276, 1995
17. Garg AK, Morales MJ: Lateralization of the inferior alveolar nerve with simultaneous implant placement: Surgical techniques. Pract Periodontics Aesthet Dent 10:1197, 1998
18. Peleg M, Mazor Z, Chaushu G, et al: Lateralization of the inferior alveolar nerve with simultaneous implant placement: A modified technique. Int J Oral Maxillofac Implants 17:101, 2002
19. Bovi M: Mobilization of the inferior alveolar nerve with simultaneous implant insertion: A new technique. Case report. Int J Periodontics Restorative Dent 25:375, 2005
20. Brisman DL: The effect of speed, pressure, and time on bone temperature during the drilling of implant sites. Int J Oral Maxillofac Implants 11:35, 1996