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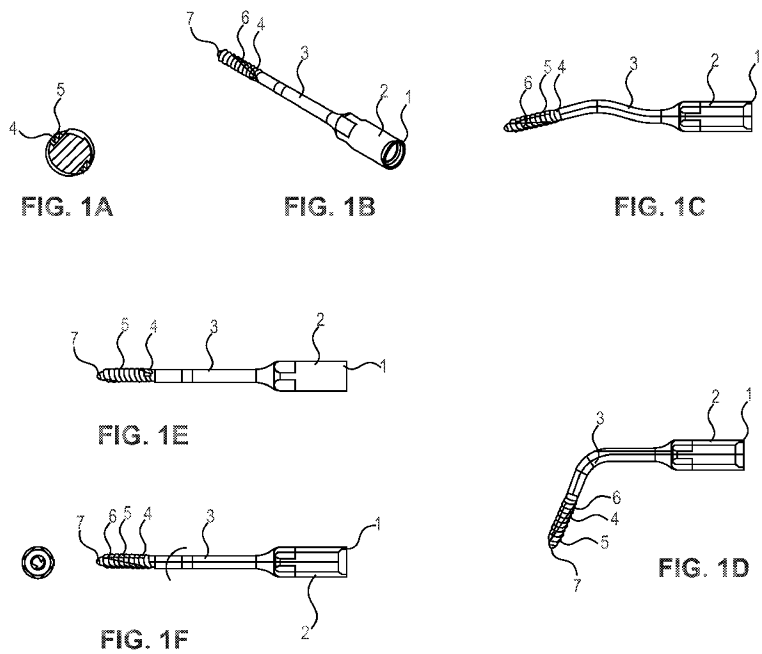

FIG. 1A FIG. 1B FIG. 1C FIG. 1E FIG. 1F FIG. 1D

(57) Abstract: A series of tips for use with an ultrasonic or piezoelectric dental surgical device dental are used in osteotomy, ostectomy and osteoplasty procedures or any procedure requiring removal or shaping of bone or other hard tissues. In some embodiments, fissures are provided in a cutting end of the tip to facilitate osteotomy. The tips are shaped so that they are comfortable for the surgeon to use in a proper position, so that when a handpiece to which the tips are releasably attached is held in the conventional manner, the geometry of the osteotomy will be precise and desirable. When energized, the tips readily cut through bone or facilitate shaping of skeletal structures at the surgical site. Methods for use of the tips and systems in which the tips provided the cutting function are also described.

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IMPROVED SURGICAL TIPS FOR PIEZOELECTRIC BONE SURGERY

Field of the Art

[0001] The present invention is in the field of surgical devices used for osteotomy, osteoplasty and ostectomy, specifically tips used with a piezoelectric surgical system used in dental surgery.

Background

[0002] Bone surgery operations that involve cutting as modeling of bone tissue (osteotomy), (ostectomy) and (osteoplasty) are notoriously difficult and require both precision and application of large mechanical forces to change the shape of mineralized bone or to remove bone tissue.

[0003] Traditionally, manual chisels and other hand instrumentation, as well as, rotary drills, oscillating and reciprocating saws are used to perform ostetomy, ostectomy and osteoplasty. Manual instruments have proven to produce unsatisfactory results often in part because bone has the tendency to shatter or split in unpredictable ways. The action of saws is limited to straight cuts with limited application. Saws also can produce excessive vibration and are difficult to handle and are non-selective in cutting into various hard and soft tissue structures. Drilling has two drawbacks, namely 1) the heat generated by drilling can inhibit bone growth and 2) the vibration of the drill can produce inaccurately shaped osteotomy and often damage the bone.

[0004] These difficulties led to the development of piezoelectric surgical devices. With these devices, high frequency vibrational energy produce a cavitation effect, which is preferentially exerted on hard tissues, minimizing trauma to surrounding soft tissue. The device typically has a handpiece with replaceable, selectable tips that are interchanged as a function of the procedure. The cutting action on the bone tissue is produced by variable modulation ultrasonic vibrations that are activated only on the cutting end of the tip. Ideally, the tip is the only tool that comes into contact with the mineralized bone tissue and the tip provides extremely rapid vibration and the necessary force and energy to cut bone.

[0005] Consequently, the energy applied to the bone tissue surface is highly directed and the affected area can be limited by the design of the tip. This feature allows the surgeon to perform an osteotomy or other procedure on the bone tissue with application of less mechanical force. This in turn lessens the trauma suffered by the bone tissue and the surrounding soft tissue to that caused by the friction of the cutting instrument and a small amount of heat that is absorbed into the bone. The vibrating tip is also less likely to damage the surrounding soft tissue because the energy caused by the vibrations of the tip is dissipated in the form of minor, localized heat and causes no irreparable damage.

[0006] While the development of the piezoelectric systems is an advantage over the older rotary technique, the highly focused application of vibrational energy emphasizes the value of improved tip designs. The tips should provide the ability to maximally focus the vibrational energy of the device while providing ease of use and comfort for the surgeon. Many existing tip designs do not always work well for their intended purpose. The current tips designed for osteotomy are designed with serrations at the tip, which leads to the production of an irregular osteotomy. The action of the surgeon to produce the cutting effect requires rotation of the handpiece, which requires wrist and larger muscle groups to control the osteotomy, leading to imprecise osteotomy design. Also, some osteotomy tips have abrasive walls that rely on diamond coatings to provide the abrasiveness, thereby creating excessive heat.

[0007] Accordingly, a need exists for piezoelectric surgical tips that are specially designed to produce precise cutting of hard tissues, that enhance the surgeon's ability to control the vibrational energy applied to the tip, and that enhance the surgeons control of the instrument. There is also a need for ultrasonic tips that reduce thermal injury to bone.

Summary of Invention

[0008] The present invention is surgical devices systems, and methods for bone surgery. Specifically, the devises are tips used in piezoelectric surgery wherein the tip designs are specially suited for dental osteotomies and bone shaping. These devices are suitable, for any surgical procedures requiring osteotomy, ostectomy, osteoplasty of hard tissues, where a great deal of precision is required, while avoiding excess thermal tissue injury. Such surgical procedures, may include harvesting of bone from donor sites, extraction of impacted or erupted teeth, preparation of osteotomy to place implants and other anchorage devices, corticotomy to facilitate orthodontic tooth movement, endodontic procedures, osteotomy to gain entrance into sinus lumen, osteotomy in orthognathic surgery, otorhinolaryngology surgery, orthopedic surgery to cut or shape various bones, and neurological surgery to operate on bone in close proximity to neurovascular structures.

[0009] Accordingly the tips of the present invention are designed and structured to provide a highly accurate, precise, and controlled applications of high frequency vibration energy when the system is energized and enable the surgeon to readily cut, shape and otherwise mold bone and other hard tissues.

[0010] The tips of the present invention are designed to be used with existing piezoelectric surgical apparatus such as Piezosurgery®, Piezotome®, PiezAart®, Variosurg®, Piezon®, SurgyStar®, Ultrasonic Bone Surgery® (UBS), Synthes®, and INTRAsurg®. These systems typically allow ready exchange of different tip designs depending on the procedures and the unique requirements of a patient's individual skeletal structure. In use, the tips are attached to a handheld instrument via a base at a proximal end such that the tip that is releasable from the instrument and terminating in a tip at the proximal end such that vibrational energy from the system, usually under manual control of the surgeon, is applied to the surgical site.

[0011] The design and structure of these enhanced tips provide enhanced and unique cutting and modeling capabilities such that the overall feel of the instrument is comfortable for the surgeon to use, and such that the tip can be readily be placed in the proper position to perform a procedure when the system is actuated and the energy of the system is activated to energize the handpiece and the tip. These tips are suitable for use with existing piezoelectric surgical systems and require no modification to the design or control elements of such systems.

Description of the Figures

[0012] Figures 1A – 1F are a fissured osteotomy tip having fissures or serrations along the length of the diotal end of the tip.

[0013] Figure 2 is an abrasive trumpet tip having an abrasive surface along the conical exterior at the tip.

[0014] Figure 3 is an indented periotome tip having concavities along the tip to reduce contact and facilitate passage of irrigation solution.

[0015] Figure 4 is an indented saw tip having concavities along the teeth of the saw tips.

[0016] Figure 5 is a fissured osteotome having features in common with the embodiment of Figure 1 but with specified indentations along the length of the distal end of the osteotome.

Detailed Description of Invention

[0017] The surgical system for bone surgery according to the invention provides a handpiece comprising a tip capable of operating on bone tissue. For this purpose, according to selected embodiment described below, various devices in addition to the tips can be mounted on a suitable handpiece. The handpiece has to provide for external and/or internal irrigation to the tip. Additionally, lighting may be provided for enhanced visualization.

[0018] The surgical system may also have a controller console with dedicated software to control the electrical acuity of the system and the selected application of vibrational energy. Optionally, the console controller has a touch pad or key pad or foot pedal for operator input and control.

[0019] The control electronics allow the operator to control the application at vibrational energy including the modulation between low frequency and high frequency bursts. In this manner the user controls the vibrational energy that is ultimately transmitted to the tip of the handpiece.

[0020] Various types of piezoelectric handpieces are utilized for dental surgical applications. A typical ultrasonic handpiece uses a standard tip with an inner aspiration fluid flow passage and has uniform inner and outer diameters along its length. Typically, such handpieces use some type of vibrating piezoelectric transducer, which converts electrical energy into mechanical energy. The mechanical energy is used to vibrate a tip, or needle, of the handpiece and the tip distal end emulsifies the tissue with which it comes into contact, a process referred to as cavitation. The tip is preferably configured to attach to the handpiece, such that a hollow interior of the tip mates to a fluid channel on the handpiece, to provide a passage of irrigation fluid from an external source, through the handpiece via the channel and to the distal end of the tip to reduce the temperature of the tip. Preferably a fluid-sealed fixture mounted on the distal end of the handpiee or the proximal end of the tip, or a mating fixture or both, seals the fluid path between the handpiece and the tip.

[0021] The handpiece may comprise a piezoelectric transducer that generates vibrational energy that is transmitted to the tip. The tip is made to vibrate at selected frequencies of between approximately 22 to 29KHz to make an extremely fine and precise cut in bone tissue.

[0022] As can be seen in the following description and figures, these tips have structural features that are configured to selectively supply or transmit vibrational energy to bone, variations in the orientation and shape of the tips allow the surgeon to select the specific tool necessary for the particular procedure dictated by the patient and the desired outcome. In each case, the overall efficiency of the handpiece is improved by the design and selective placement of structural features of the tip including specifically the orientation of serrations at the distal end of the tip along a region immediately distal to the point of the tip as described below.

[0023] The tips of the present invention are installed on an ultrasonic piezoelectric handpiece and energized with ultrasonic energy to vibrate and resonate such that the vibrating tip is brought into working contact with hard tissues such as bone or tooth structure. When contact is made and energy applied, the tip will abrade the hard tissues in contact with the working end of the tip such that the hard tissues can be removed in a controlled fashion. Even more specifically, tips are useful for preparation of jawbones to receive endosseous implants.

[0024] Figures 1A – 1F are a fissured osteotome or osteotomy tips having structures along the length of the tip to enhance the ability to cut or model bone. These tips also have unique geometries that aid the visibility and hand control by the surgeon during a bone removal or modeling procedure.

[0025] A surgical device for bone surgery according to the invention is described with the aid of the accompanying figures. As shown in Figures 1A-1F, the surgical device is comprised of a tip having a base 1 and a body 2. The base 1 is adapted to releasably engage a handpiece (not shown) that is operably connected to a piezoelectric surgical device operated by a surgeon by means of a controller. Typically, the controller allows the surgeon to selectively apply vibrational energy, through the handpiece, to the box 1 of the device, through the body 2 of the device. The most proximal portion of the body 2 forms the base 1 and closely conforms and preferably releasably attaches to the handpiece so that a piezoelectric or ultrasonic transducer associated with the device transmits vibrational energy through the body without unacceptable loss to the shaft 3 for transmission to the distal end. The shape and design of the base 1 and the body 2 are only constrained by their ability to reliably transmit vibrational energy to the operative portion of the tip. Typically, the body 2 tapers into an elongated shaft 3 that terminates in the “cutting end” of the device.

[0026] The shaft 3 may take a variety of angles or conformations to allow the advantageous orientation of the distal end of the tip relatively to the handheld piece. The overall design, curvature, and length of the elongated shaft 3 may vary according to the position in which a cutting is desired in the procedure. The size and diameter of shaft 3 is also variable according to the practical constraints described herein. The most common diameters range from 0.5 millimeters to 5.0 millimeters, the most common lengths range from 2 millimeters to 15 millimeters in the overall tip. Thus, the portion of the device devoted to each of the base, body, base 1, body 2, an elongated shaft 3 are only constrained by the operative ability to transmit vibrational energy to the distal end and the need to have the distal most end designed as described herein.

[0027] The most distal end of the tip has a shaft with a length thread that is generally described as a cutting end and may be disposed at variable angles relative to and along the elongated shaft, but typically deflects at an angle ranging between 0 and 90 degrees. Within the cutting end, the structures that directly contact the bone to transmit energy are the cutting surface. Various structural means for transmitting the energy are formed to create the cutting surface. The formation of a working cutting surface along the length of the distal end of the shaft 3 to form an operative cutting end is an important feature of the invention and difference from other known tip designs. Known tips tend to have the cutting surface located only at the most distal end of the tip such that the surgeon must continuously rotate or re-position the tool to perform an osteotomy having more than a minimally defined linear length. Moreover, the present design allows the surgeon to position the distal end of the tip between two structures such that the vibrational energy is transmitted along the entire length of the cutting portion of the tip.

[0028] In the embodiment of Figures 1A-1F, the overall cutting end is generally comprised of the shaft length and a number of fissures 4 that can take a variety of different geometries to form the cutting surface. The fissures 4 have characteristic sharpness provided by an edge 5 that is sharpened along one or more of the edges 5 that pass around the circumference of the shaft 3 to provide a series of circumferential edges 5 that may be located along a continuous fissure 4 or may be located at an edge 5 at each individual fissure 4. The fissures 4 with edges 5 are preferably circumferentially arranged around the entire external surface of the distal end of the shaft 3 to form the cutting tip, but may be limited to only the most distal portion depending on the design of the individual tip.

[0029] The geometry of the fissure 4, the edge 5 and the overall cutting surface may include cylindrical, common-tapered cylindrical, flame-shaped, oblong, ovoid, or spherical. The orientation of the fissures 4 are generally in a cylindrical or spiral shape around the cutting end and may terminate at a distal point 7 that is smaller in diameter than each individual fissure 4. The distal point 2 and a length of the distal end comprising the cutting end may also have formed therein an indented channel 6 that may be linear or may form a partial or complete spiral along with the orientation of the fissures 4 to allow irrigation or other passage of fluid and materials along the cutting end.

[0030] The indented channel 6 may be replaced or supplemented by an internal channel (not shown) that runs the length of the distal end of the cutting end, preferably from an opening proximate to the distal point 7 to a fixture in the base 1 (traversing the elongated shaft 3) such that irrigation fluids or aspirated materials may travel in either direction along the path of the shaft 3. As will be apparent, the internal irrigation/aspiration channel or indented channel 6 may be formed independently in any tip disclosed herein. Referring specifically to Figure 1A, a head on view of the tip of the invention shows the orientation of the edge 5 relative to the distal point 7 of the tip. Advantageously, this configuration minimizes the surface area at the point of contact between the cutting surface of the tip and surrounding bone tissue, when the length of the cutting surface of the tip engages skeletal bone structure during the application of high frequency vibrational energy. The number of individual turns in the fissures 4 and their pitch can vary but the number of turns comprising a cutting end it is generally between 2 and 20. Modulating the pitch and the the dimensions of the fissures will allow the tips to have varying degrees of coarseness suited for varying bone densities. Referring specifically to Figures 1E and 1F, the dimensions of the cutting end at the tip are in overall size and orientation not significantly different from existing tips. Typically, the small length of the device is less than 50 mm. and may be approximately 36.7 mm. The diameter of the base 1 is approximately 3.7 mm and has an overall length, when taken together with the body 2 is

10.3 mm. The body 2 taper (3.0 mm) to the elongated shaft 3 having an overall length of approximately 23.4 mm. The cutting surface is typically found at the distal-most end (approximately 15 mm) and wherever the fissures 4 and edges 5 may be formed in the most distal 10 mm or less. In the spiral design, the pitch; i.e. the distance between 2 adjacent edges 5 at an identic points A-A along the length of the cutting surface may be 1.0 mm.

[0031] Referring to Figure 2, an embodiment of the invention is termed an abrasive trumpet and has a tip comprised of cutting surface formed by an abrasive coating formed in a trumpet or flare-shaped distal end of the tip. Referring to Figure 2, the tip has a base and a body 10 that serve the purpose of releasable attachment to a handheld device and transmitting vibrational energy as described above. An elongated shaft 11 may be of any length and orientation to position the distal end of the tip in operative configuration for a surgical procedure. The elongated shaft 11 may have a preformed curve 12 that performs the same function. As with the embodiments described in Figures 1A-1F above, the overall measured angle along the base, through the elongated shaft and the preformed curve 12 generally create an angle between 0 and 180 degrees and most preferably between 0 and 90 degrees.

[0032] In the embodiment of Figure 2, an abrasive coating 14 at the distal most portion of the tip provides a cutting surface that can comprise all or a substantial portion of the most distal end. The distal point (reference 7 in Figures 1B, 1E, 1D and 1F) is formed into an annular and most distal end of the tip. As in the embodiment of Figures 1A-1F, fissures, channels, or additional edges may be incorporated into the distal most tip by conventional manufacturing methods. The abrasive coating 14 of the distal end may be found by forming an additional lay of an abrasive coating material at a selected portion of the tip to yield the cutting end. The preferred method to create the abrasive surface is diamond coating, see USP 5,299,937 and Sein et al., Diamond and Related Materials, Vol. 11:3-6, pp. 231-35 (2002). Each of chemical etching, laser etching, EDM manufacturing and coating of a distal end with a diamond slurry are all conventional methods for forming an abrasive coating 14 at a selected region of the tip to form the cutting surface. The abrasive coating 14 may cover an entire portion of the distal end or maybe selectively be formed in any shape or format as desired. For certain surgical procedures, the distal end is ideally formed into a trumpet of flare shape 13 with the smallest circumference 15 adjoining the elongated shaft 11 and having a circumference substantially identical thereto. The elongated shaft 11 can have variable diameters and lengths, however the most common diameter will range from 2 millimeters to 5.0 millimeters at the distal most tip and common lengths of the entire cutting tip range from 2 millimeters to 8.0 millimeters.

[0033] Although a flare or trumpet shape is shown in Figure 2, essentially any tip can be provided with a selectively placed abrasive coating 14 to enhance the bone cutting or bone modeling function as illustrated by this embodiment. In use, the embodiment of Figure 2 is primarily used for reshaping bone along a perimeter of a lateral window made during maxillary sinus surgery. The circular end portion 16 of the trumpet shaped tip 13 may be solid and smooth, solid and covered with abrasive material and maybe concave, flat, or convex but is preferably substantially flat along the end surface.

[0034] The bone modeling function is best provided by a distal end that is substantially flat and smooth so that the distal end can be placed against bone that is not desired to be cut or modeled or against soft tissue such that the cutting function provided by the translation of vibrational energy does not extend through the distal most portion of the tip. For cetain applications, the terminal end may consist of a flat surface. In other designs, the terminal end may be hollow. The hollow end may be contiguous with the irrigation channel to allow irrigating fluid to exit from the end, producing hydrolic pressure, which may be advantageous to simultaneously dissect soft tissues away from the tip.

[0035] As with the embodiments described above, channels or grooves may be formed in any exterior or interior surface of the tip, including traversing the elongated shaft 11 to provide for irrigation or aspiration of materials.

[0036] Referring now to Figure 3, an indented periotome tip is shown wherein indentations 25 formed along the distal most portion of the tip substantially reduce the contact area between the cutting end of the tip at the distal-most end and the surrounding soft tissue. This configuration allows irrigating solution to freely enter the indentations 25 spaces between indentations 25 and along the distal end of the tip and the soft tissue. The reduction in the surface area and friction along the length 23 of the cutting surface also reduces generated heat and promotes dispersion of heat between the periotome and the bone. As in the above described embodiments, the device has a base 20 designed to releasably engage a handheld device as part of the piezoelectric surgical system and has a body

21 that tapers into an elongated shaft 22 that may be configured in any angle (as described above) to facilitate performing the surgical procedure.

[0037] The indented periotome may terminate in a distal point 26 that is smaller in diameter than the length 23 of the cutting surface of the tip containing the indentations 25 along the length thereof. The portion of the distal end of the tip containing the indentations typically has spaced apart flat surfaces 24 that are substantially equivalent diameter of the tip and has concavities 25 formed or cut along the length.

[0038] As shown in Figure 3, an alternating spacing between the concavities 25 and the flat outer surfaces 24 facilitate the free passage of fluid along the length of the tip. The distal end of the indented periotome tip may be cylindrical or may be oval in cross section to eliminate the overall cross section of the device, for example to allow insertion of the periotome inside the periodontal ligament space, between a tooth and the surrounding bone structure.

[0039] Referring to Figure 4, an indented saw tip is provided for linear cutting of bone tissue along the length of a saw-tipped edge 36. In this embodiment, each indented saw tooth 34 has a series of indentations or concavities 37 along the edges of each individual tooth 34. The concavities 37 preferably span each edge of each tooth 34 extending away from the point 33 along the lateral edge 32 of each tooth 34. The concavities 37 preferably also extend away on the lateral edge 32 adjacent to the last tooth at either end. The concavities 37 in the lateral edge 32 and the individual tooth 34 provide the free passage of solution around the teeth 34 and reduce the contact area between the saw teeth 34 and the surrounding bone and soft tissue.

[0040] As with other embodiments described herein, the reduction in the surface area contacted between the tip and the bone and surrounding tissue reduces friction and provides for more rapid dissipation of heat during bone cutting. As with the above described embodiments, the indented saw tip preferably has a base 30 and a body 31 designed for releasable attachment to a handheld device for transmitting vibrational energy to the distal most portion of the saw tip. The indentations or concavities 37 are preferably arranged in alternating positions on either side of the blade and can be semicircular, ovoid, or any shape that reduces the overall surface area at the point of contact between the tip and the surrounding tissue.

[0041] As described above, the concavities may be formed by known manufacturing methods including EDM, laser etching, chemical etching, mechanical etching or formation of grooves by any known technique. The size of the individual concavities may be adjusted to minimize the surface area between the contact of the tissue and the saw tip, while maintaining the structural integrity of the entire cutting end of the saw tip as a function of the desired size of the saw teeth 34 and the materials used to form the tip.

[0042] Referring to Figure 5, a fissured osteotomy tip has a base 40 and a body 41 for releasable attachment to a handheld device as described above. An elongate shaft 42 is curved to bring the distal end of the tip into a desired configuration for applying vibrational energy to a surgical sight. As in the embodiment of Figures 1A-1F, a distal most end contains a fissured tip having fissures 44 and edges 46 that facilitate an osteotomy by cutting through bone upon the application of vibrational energy. The osteotomy tip has a groove or channel 46 that may traverse the cutting surface and be disposed in any portion of the length of the cutting end of the device to permit passage of irrigation or aspiration materials along the length of the tip. In this embodiment, the most distal point 47 is not tapered down to a point but remains essentially the same diameter as the length of the cutting end of the tip.

[0043] The method of the present invention is placing an osteotomy tip at a surgical site, activating a piezoelectric source to deliver high frequency energy to the site, removing one at the site along a length of the osteotomy tip at a cutting and wherein the cutting end is defined by an osteotomy tip having an indented or abrasive surface at the distal end thereof. The removal of bone may be a straight, linear excision or a shaping of bone structure at the points of contact with the osteotomy tip. The indented surface preferably provides a series of concavities along a length of the osteotomy tip to increase the active length of the cutting surface while decreasing the surface area of the immediate contact between the bone and the tip.

[0044] While the present invention has been particularly shown and described with respect to certain preferred and illustrative embodiments, it will be understood by those skilled in the art that variations and modifications may be made therein without departing from the spirit and scope of the present invention.

I CLAIM:

1. A piezoelectric surgical apparatus comprising:

a handpiece comprising a tip having a base that releasably engages the handpiece, and wherein the tip has a cutting surface formed between a distal point of the tip and proximally along a length of the shaft to form a cutting surface along a length thereof; and

a source of vibrational energy for transmitting piezoelectric energy to the cutting surface of the tip.

2. The apparatus of claim 1, wherein the tip has a fixture at the proximal end of the base for sealing the base to the handpiece.

3. The apparatus of claim 1, wherein the tip is further comprises an internal fluid communication pathway.

4. The apparatus of claim 3, wherein the base of the tip and the handpiece have a mating fixture for sealing the fluid communication pathway.

5. The apparatus of claim 1 further comprising:

a controller having software to selectively apply vibrational energy through the handpiece to the tip.

6. The apparatus of claim 1, wherein the shaft has an indentation running distally from an area proximate to the distal point of the tip along the cutting surface of the shaft.

7. The apparatus of claim 1, wherein the shaft has a plurality of fissures formed in the cutting surface of the shaft.

8. The apparatus of claim 1, wherein the tip is comprised of a series of circumferential edges along the cutting surface.

9. The apparatus of claim 1, further comprising a lighting source to direct light at the distal end of the tip.

10. The apparatus of claim 1, wherein the source of piezoelectric energy is a transducer.

11. The apparatus of claim 1 wherein the vibrational energy is between 22 and 29 KHz.

12. A piezoelectric tip for bone surgery comprising:

a base having a fixture for releasable attachment to a handpiece,

a body comprising a fluid communication pathway,

an elongated shaft comprising a cutting surface extending proximally from a distal point along a length of the shaft, and wherein the cutting surface comprises means for applying piezoelectric energy along the length of the cutting surface.

13. The piezoelectric tip of claim 12, wherein the means for applying piezoelectric energy comprises a plurality of fissures formed in the shaft.

14. The piezoelectric tip of claim 13, wherein the fissures are comprised of edges circumferentially surrounding the shaft.

15. The piezoelectric tip of claim 12, further comprising a channel running substantially the length of the cutting surface.

16. The piezoelectric tip of claim 12 wherein the cutting surface comprises an abrasive coating formed on a flared trumpet shape and the distal point is a distal and annular shaped leading edge of the tip.

17. The piezoelectric tip of claims 12 – 16 wherein the fluid communication pathway is internal to the base and the body of the tip and provides fluid communication traversing the cutting surface and from the base to an opening proximate to the distal point.

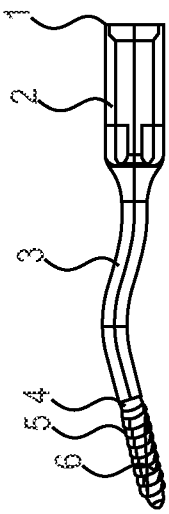

FIG. 1C

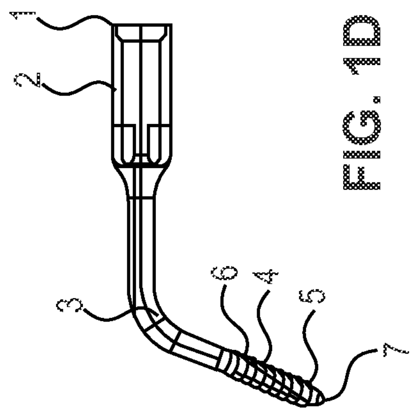

FIG. 1D

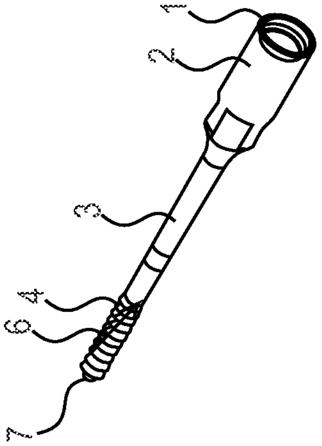

FIG. 1B

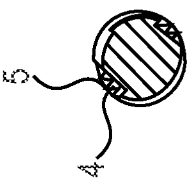

FIG. 1A

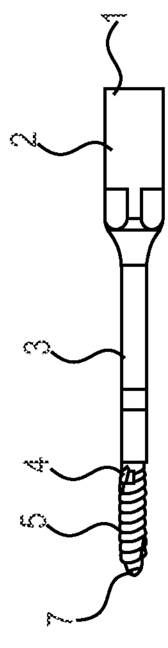

FIG. 1E

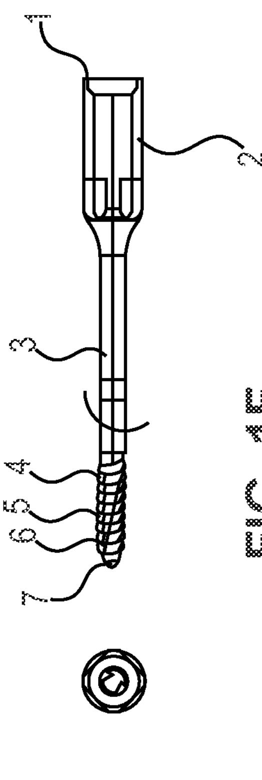

FIG. 1F

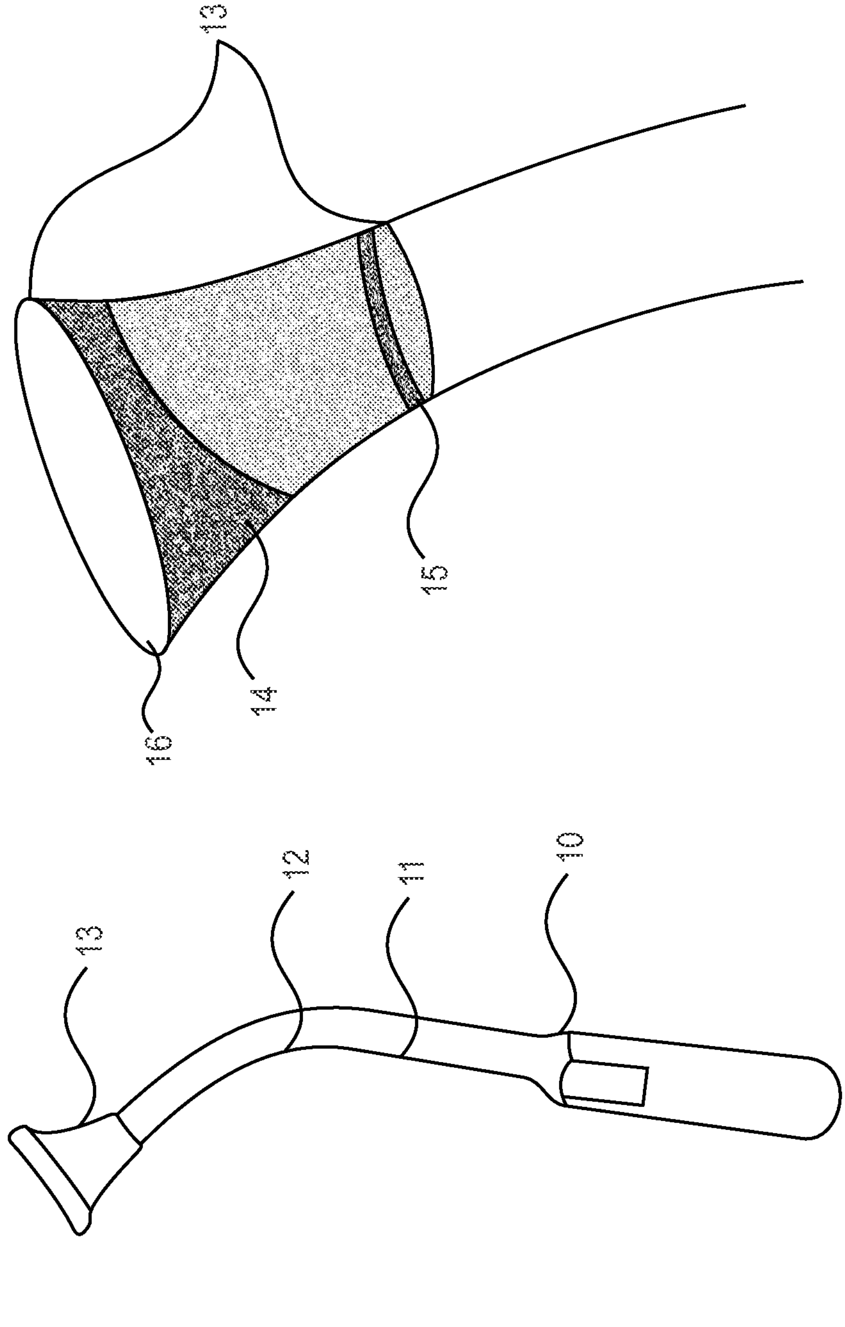

FIG. 2

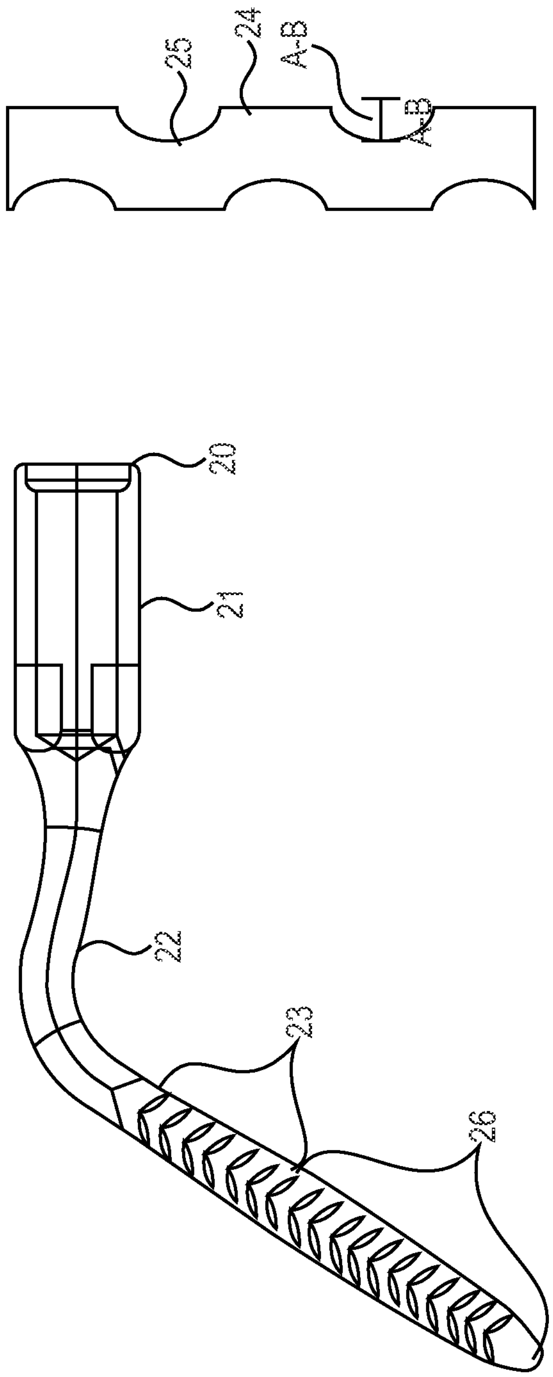

FIG. 3

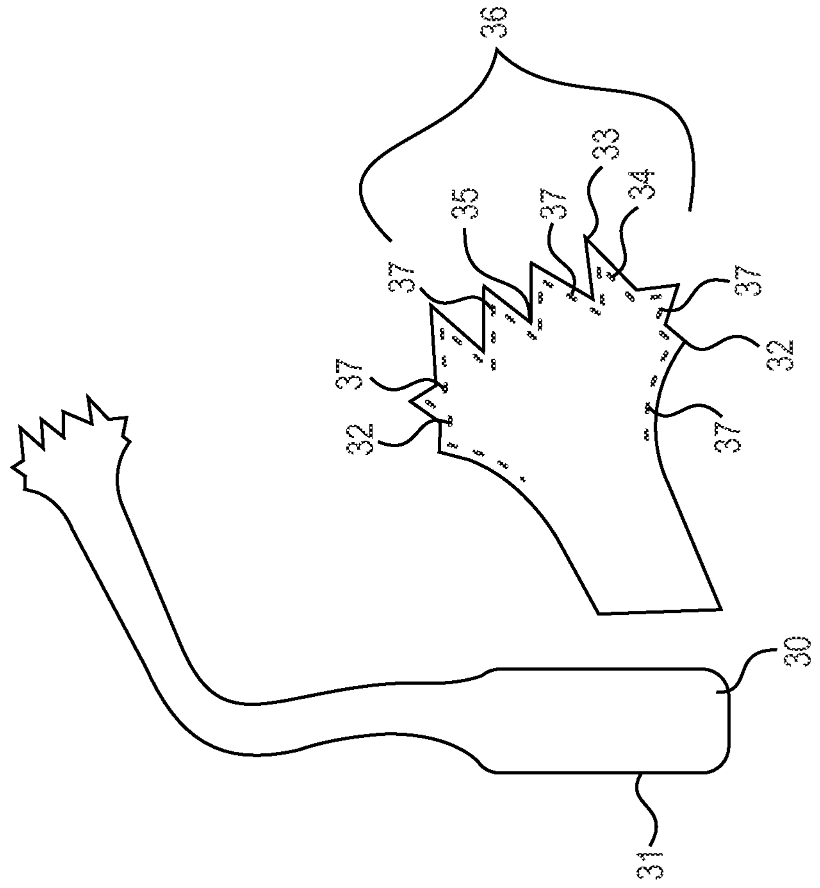

FIG. 4

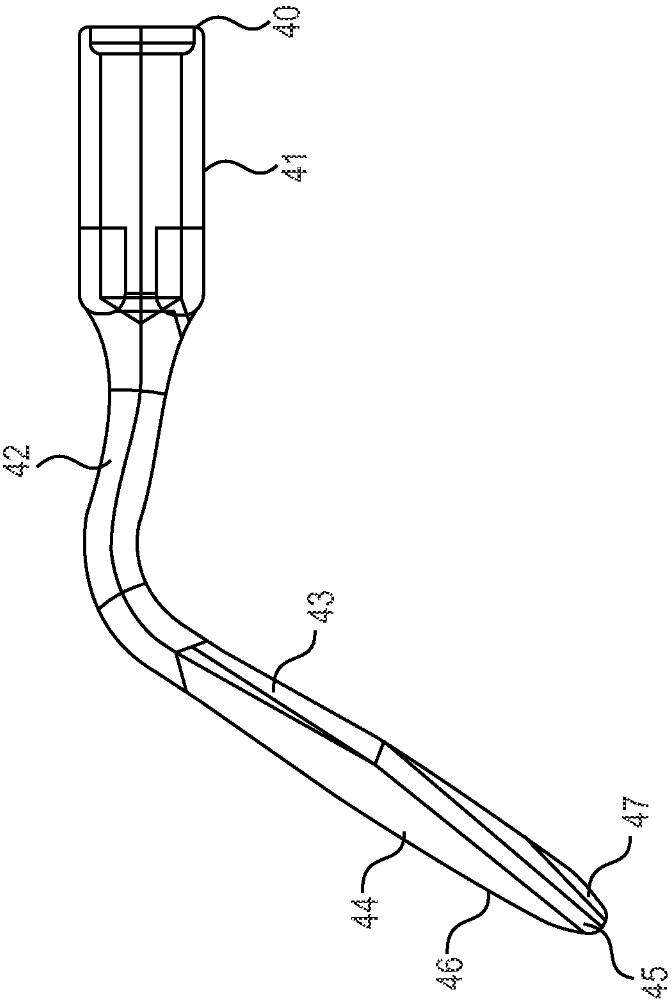

FIG. 5

INTERNATIONAL SEARCH REPORT	International application No. PCT/US 2012/064530

A. CLASSIFICATION OF SUBJECT MATTER

***A61B 17/32** (2006.01)*
***A61C 1/07** (2006.01)*
***A61C 3/03** (2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B 17/32, A61C 1/07, A61C 3/03

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PATSEARCH, ESP@CENET, RUPAT, DEPATISNET, USPTO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/0015102 A1 (TOMASO VERCELLOTTI) 18.01.2007, claims, para. [0029]-[0033], fig. 1-5	1-3, 5-7, 10-14, 17
Y		4, 9, 16
A		8, 15
Y	EP 2327369 A2 (NAKANISHI INC.) 01.06.2011, claims, abstract, para. [0019]-[0020], fig. 1	4
Y	US 2010/0248178 A1 (SIALO-LITE LTD.) 30.09.2010, abstract, fig. 1	9
Y	US 6722882 B2 (EARTH CITY TECHNOLOGIES, INC.) 20.04.2004, abstract, fig. 1	16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 January 2013 (15.01.2013)	21 February 2013 (21.02.2013)
Name and mailing address of the ISA/ FIPS Russia, 123995, Moscow, G-59, GSP-5, Berezhkovskaya nab., 30-1 Facsimile No. +7 (499) 243-33-37	Authorized officer L. Gubchenko Telephone No. (495) 531-64-81

专利名称(译)	改进压电骨手术的手术技巧		
公开(公告)号	EP2775944A4	公开(公告)日	2015-12-09
申请号	EP2012848053	申请日	2012-11-09
[标]申请(专利权)人(译)	扎德HOMAYOUN ^ h		
申请(专利权)人(译)	扎德，HOMAYOUN H.		
当前申请(专利权)人(译)	扎德，HOMAYOUN H.		
[标]发明人	ZADEH HOMAYOUN H		
发明人	ZADEH, HOMAYOUN H.		
IPC分类号	A61B17/32 A61C1/07 A61C3/03		
CPC分类号	A61B17/16 A61B2017/0046 A61B2017/32007		
代理机构(译)	POTTER CLARKSON LLP		
优先权	61/558404 2011-11-10 US		
其他公开文献	EP2775944A1		
外部链接	Espacenet		

摘要(译)

用于牙科超声波或压电牙科手术装置的一系列尖端用于截骨术，骨切除术和骨成形术手术或需要移除或成形骨或其他硬组织的任何手术。在一些实施例中，在尖端的切割端中提供裂缝以促进截骨术。尖端被成形为使得它们对于外科医生在适当位置使用是舒适的，使得当以常规方式保持尖端可释放地附接到其上的手持件时，截骨术的几何形状将是精确和期望的。当通电时，尖端容易穿过骨头或便于在手术部位塑造骨骼结构。还描述了使用尖端和系统的方法，其中尖端提供切割功能。