Title: **BIDIRECTIONAL ALVEOLAR RIDGE DISTRACT**

**FIG. 1A**

Abstract: An osteogenic distractor for increasing a height and a width of an alveolar ridge comprising an elevation stage for distracting a movable ridge segment of said alveolar ridge relative to a stationary ridge segment of said alveolar ridge, an expansion stage for distracting a buccal section and/or a lingual section of the movable ridge segment, and an element for causing the elevation stage to move relative to the stationary ridge element.
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BIDIRECTIONAL ALVEOLAR RIDGE DISTRACTOR

RELATED APPLICATION/S

This application is related to U. S. Provisional Application No. 61/118,539 titled "Bidirectional Distraction Osteogenesis - Provisional" filed on 28-Nov-2008, and on which this application claims priority.

The contents of all of the above documents are incorporated by reference as if fully set forth herein.

FIELD AND BACKGROUND OF THE INVENTION

The present invention, in some embodiments thereof, relates to methods and apparatus for performing distraction osteogenesis and, more particularly, but not exclusively, to a method and apparatus for performing alveolar ridge distraction.

The alveolar ridge is a bony ridge located on the top part of the mouth (maxillae - upper jaw), and on the bottom part of the mouth (mandible - lower jaw), and include the alveoli which are sockets housing the teeth (the bottom portion of the teeth are inserted in these sockets). A common problem encountered when performing teeth implantation is alveolar ridge deficiency which typically results in the height of the bone in the alveoli ridge being reduced. Frequently, the width of the bone is also reduced (thinning). In an attempt to overcome the problem of alveolar ridge deficiency, a relatively long crown is generally used to reach the bone. Although this solves the problem, the solution is relatively short term as the crown frequently exhibits a relatively short lifespan due to excessive mechanical forces acting on the long crown (bending moments).

In recent years, a technique referred to as alveolar distraction has become increasingly popular, frequently used in teeth implantation procedures involving an alveolar ridge of a reduced height. Using distraction, the height of the alveolar ridge may be increased (the height of the bone is increased) which allows for a shorter crown to be used. Furthermore, the width of the bone may also be increased providing for a
greater support area for the crown. As a result, the lifespan of the crown may be greatly extended.

U.S. Patent No. 6,537,070 "Combination Distraction Dental Implant and Method of Use" relates to "a method of installing a dental prosthesis in the jaw of a patient comprising the steps of inserting in the jaw of a patient a dental implant comprising an incremental distraction mechanism and a prosthesis support means for securing said dental prosthesis and inducing distraction osteogenesis by surgically sectioning the jaw to form a sectioned jaw portion capable of moving away and separating from the remainder of said jaw, wherein said incremental distraction mechanism and said prosthesis support means are integrated into a single system."

U.S. Patent No. 6,280,191 "Distractor Suitable for Permanent Implantation into Bone" relates to "an osteogenic distractor suitable for indexed osteotomy following permanent implantation into bone. The osteogenic distractor may be a means for anchoring two or more sections of bone and a means for facilitating movement of one section of anchored bone relative to another section of anchored bone. Furthermore, the continuous tension on the bone produced by the distractor may facilitate stimulation of osteogenesis around the implant."

U.S. Patent No. 6,126,662 "Bone Implant" relates to "a kit of assemblable components for implantation into the bone of a mammal for use in distraction osteogenesis. The kit comprises a fixture, a footing and a distracter, the fixture including a longitudinally extending body portion with a proximal end and a distal end, the body portion having an exterior surface adapted for contact and integration with bone tissue, the body portion having a generally longitudinally extending bore extending from a proximal opening adjacent the proximal end to a distal opening adjacent the distal end. The footing includes a proximal surface and a distal surface. The distracter comprises a generally rod-shaped body including a distal end and a proximal end, and the proximal end of the distracter is adapted to bear against the footing. There are first and second engaging means on the fixture and the distracter respectively for adjustably locating the fixture relative to the distracter."

U.S. Patent No. 6,309,220 "Bone Distention and Condensation Dental Implant Distraction Apparatus and Method" relates to "a dental bone distraction apparatus for widening a bore hole in bone for the installation of a dental implant post comprising
adental implant distractor including at least two vertically separated sectors, having in combination a coronal tapered depression and an apical tapered depression; a draw screw having a threaded shaft and a head including a tapered surface underlying a driven end sliding within the coronal tapered depression of the at least two vertically separated sectors; an apical tapered nut engaging with said threaded shaft and said tapered nut sliding within said apical tapered depression of said at least two vertically separated sectors; said draw screw, when tightened into said apical tapered nut, forcing said at least two vertically separated sectors away from each other to effect a wider spacing of said at least two vertically separated sectors for the condensation and distraction of surrounding dental bone."

U.S. Patent No. 6,758,673 "Periosteal Distraction" relates to "devices and methods for gradual displacing of the periosteal tissue covering bones. The gap developing between the bone and the displaced periosteal tissue will be filled with bone callus as it is in distraction osteogenesis. The devices and methods allow formation of bone in distraction osteogenesis without cutting a segment of the bone."

U.S. Patent No. 7,025,592 "Bone-Dislocating Device" relates to "a bone-dislocating device suitable for being inserted in a bone to be dislocated (16), in particular a maxillary or jaw bone, comprises a wedged body (12), subdivided into two parts (12a and 12b) substantially having a triangular section, said wedged body (12) being equipped with driving elements (17) close to an upper end, for spacing the two parts (12a and 12b) of the wedged body (12)."

U.S. Patent No. 6,491,696 "Device for Distracting Bone Segments, Especially in the Area of a Jaw" relates to "a device for distracting bone segments, comprising at least two components (12, 13) which can be displaced in relation to each other by means of an adjustment device (14) such that a distance between them is increased. According to the invention the first component (12) is configured as an outer sleeve, a second component (13) is configured as an at least partly inner sleeve which is at least partly positioned within the outer sleeve (12), the outer and inner sleeves (12, 13) can be at least partly inserted into a hole in the bone segments (19, 21) and the inner sleeve (13) engages one bone segment (19) and the outer sleeve (12) another bone segment (21)."
SUMMARY OF THE INVENTION

According to an aspect of some embodiments of the present invention there is provided an osteogenic distractor for increasing a height and a width of an alveolar ridge comprising an elevation stage for distracting a movable ridge segment of the alveolar ridge relative to a stationary ridge segment of the alveolar ridge, an expansion stage for distracting a buccal section and/or a lingual section of the movable ridge segment, and an element for causing the elevation stage to move relative to the stationary ridge element. Optionally, the elevation stage is attached to the lingual section of the movable ridge section by means of a fastening plate.

According to some embodiments of the present invention, the elevation stage comprises means for supporting an underside of the movable ridge segment. Optionally, the means for supporting an underside of the movable ridge segment comprises an anchoring latch. Optionally, the elevation stage comprises a threaded bore adapted to receive the moving element.

According to some embodiments of the present invention, the expansion stage is attached to a buccal section of the movable ridge by means of a fastening plate. Optionally, the expansion stage is wedge-shaped for widening an expansion free volume.

According to some embodiments of the present invention, the distracter comprises an expansion screw for causing the expansion stage to move relative to the elevation stage. Optionally, the distracter comprises at least one horizontal linear guide for causing the elevation stage to be aligned with the expansion stage.

According to some embodiments of the present invention, the distracter comprises a chassis for supporting the elevation stage. Optionally, the chassis comprises a threaded distal end for insertion into the stationary ridge segment. Optionally, a distal end of the chassis is attached to a mounting plate for affixing to the stationary ridge element.

According to some embodiments of the present invention, the distracter comprises a post for insertion in the stationary ridge segment. Optionally, the post is adapted to receive the moving element. Optionally, the moving element is a threaded element.
According to an aspect of some embodiments of the present invention there is provided an osteogenic distractor for increasing a height and a width of an alveolar ridge and configured to be endosseously mounted inside a gum, comprising an elevation stage for distracting a movable ridge segment of the alveolar ridge relative to a stationary ridge segment of the alveolar ridge, and an expansion stage for distracting a buccal section and/or a lingual section of the movable ridge segment.

According to an aspect of some embodiments of the present invention there is provided an osteogenic distractor for increasing a height and a width of an alveolar ridge comprising a flexure chassis comprising an upper flexure for expansion (widening) distraction of a movable ridge segment of the alveolar ridge relative to a stationary ridge segment of the alveolar ridge, and an inferior flexure for anchoring the flexure chassis to the moveable ridge segment, a jack screw for insertion through the flexure chassis; and a post for mating with a distal end of the jack-screw. Optionally the jack screw comprises a conical head for causing the upper flexure to push on the buccal section and the lingual section of the movable ridge segment. Optionally, the inferior flexure comprises anchoring latches to support the movable ridge from an underside.

According to an aspect of some embodiments of the present invention there is provided an osteogenic distractor for increasing a height and a vector orientation of an alveolar ridge comprising an elevation stage for distracting a movable ridge segment of the alveolar ridge relative to a stationary ridge segment of the alveolar ridge, and a vector adjustment mechanism for adjusting a vector orientation of the distractor. Optionally, the vector orientation of the distractor may range from 0° - 60°. Optionally, the vector orientation of the distractor may range from 0° - 30°. Optionally, the vector orientation is in a buccal direction. Optionally, the vector orientation is in a lingual direction.

According to an aspect of some embodiments of the present invention there is provided an automatic osteogenic distractor for increasing a height and a width of an alveolar ridge comprising a distractor comprising an elevation stage for distracting a movable ridge segment of the alveolar ridge relative to a stationary ridge segment of the alveolar ridge, an expansion stage for distracting a buccal section of the movable ridge segment relative to a lingual section of the movable ridge segment, and a
moving element for causing the elevation stage to move relative to the stationary ridge element, and a mechanism for actuating the moving element.

According to an aspect of some embodiments of the present invention there is provided a method for increasing a height and a width of an alveolar ridge by osteogenic distraction comprising attaching a chassis of a distractor to a stationary ridge segment of the alveolar ridge, attaching an elevation stage in the distractor to a first section of a movable ridge segment of the alveolar ridge, attaching an expansion stage in the distractor to a second section of the movable ridge segment opposite the first section, distracting the movable ridge segment relative to the stationary ridge segment and distracting a buccal section of the movable ridge segment relative to a lingual section of the movable ridge segment. Optionally, attaching the chassis comprises screwing the chassis into a hole in the stationary ridge segment. Optionally, attaching the chassis comprises affixing the chassis onto a mounting plate on the stationary ridge segment. Optionally, the method comprises inserting a post into a hole in the stationary ridge segment.

According to some embodiments of the present invention, attaching an elevation stage in the distractor to a first section of a movable ridge segment comprises supporting an underside of the movable ridge segment. Optionally, the elevation stage is attached to the first section of the movable ridge section by means of a fastening plate. Optionally, the method comprises supporting an underside of the movable ridge segment. Optionally, the method comprises attaching the expansion stage to a buccal section of the movable ridge by means of a fastening plate. Optionally, the expansion stage is wedge-shaped for widening an expansion free volume. Optionally, the method comprises an expansion screw for causing the expansion stage to move relative to the elevation stage. Optionally, the method comprises at least one horizontal linear guide for causing the elevation stage to be aligned with the expansion stage.

According to some embodiments, the method comprises supporting the elevation stage with a chassis. Optionally, the chassis comprises a threaded distal end for insertion into the stationary ridge segment. Optionally, a distal end of the chassis is attached to a mounting plate for affixing to the stationary ridge element. Optionally, the method comprises inserting a post in the stationary ridge segment. Optionally,
the post is adapted to receive the threaded element. Optionally, the threaded element is a jack screw.

According to an aspect of some embodiments of the present invention there is provided a method for automatically increasing a height and a width of an alveolar ridge comprising distracting a movable ridge segment of the alveolar ridge relative to a stationary ridge segment of the alveolar ridge using an elevation stage, distracting a buccal section of the movable ridge segment relative to a lingual section of the movable ridge segment using an expansion stage, causing the elevation stage to move relative to the stationary ridge element using a moving element, and actuating the moving element.

Unless otherwise defined, all technical and/or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention pertains. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of embodiments of the invention, exemplary methods and/or materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and are not intended to be necessarily limiting.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the invention. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the invention may be practiced.

In the drawings:

FIGs. 1A - 1C schematically illustrate a perspective view, a side view, and a front view, respectively, of an exemplary distractor for performing alveolar ridge elevation and expansion, in accordance with an embodiment of the present invention;
FIGs. 1D and 1E schematically illustrate an exploded view and a perspective view, respectively, of the distractor of FIGs. 1A - 1C attached to an exemplary segment of an alveolar ridge including a stationary ridge segment, a movable ridge segment including a buccal section and a lingual section, in accordance with an embodiment of the present invention;

FIGs. 2A and 2B schematically illustrate an exploded view and a perspective view, respectively, of an exemplary distractor for performing alveolar ridge elevation and expansion, attached to an exemplary segment of an alveolar ridge in a gum and including a stationary ridge segment, a buccal section and a lingual section in a movable ridge segment, in accordance with some embodiments of the present invention;

FIGs. 3A and 3B schematically illustrate an exploded view and a perspective view, respectively, of an exemplary distractor for performing alveolar ridge elevation and expansion, attached to an exemplary segment of an alveolar ridge in a gum and including a stationary ridge segment, a buccal section and a lingual section in a movable ridge segment, in accordance with some embodiments of the present invention;

FIGs. 4A and 4B schematically illustrate an exploded view and a perspective view, respectively, of an exemplary distractor for performing alveolar ridge elevation and expansion, attached to an exemplary segment of an alveolar ridge in a gum and including a stationary ridge segment, and a buccal section and a lingual section in a movable ridge segment, in accordance with some embodiments of the present invention;

FIGs. 5A and 5B schematically illustrate an exploded view and a sectional view, respectively, of an exemplary distractor for performing alveolar ridge elevation and expansion, attached to an exemplary segment of an alveolar ridge including a stationary ridge segment, and a buccal and a lingual section in a movable ridge segment, in accordance with some embodiments of the present invention;

FIG. 6A schematically illustrates a perspective view of an exemplary distractor for performing alveolar ridge elevation, expansion, and vector control/adjustment, in accordance with some embodiments of the invention;

FIG. 6B schematically illustrates a perspective view of the distractor of Fig.6B attached to an exemplary segment of an alveolar ridge in a gum and including a stationary ridge segment, and a buccal section and a lingual section in a movable ridge segment, all in accordance with some embodiments of the present invention;
FIG. 7A schematically illustrates an exploded view of an exemplary distractor for performing alveolar ridge elevation, expansion, and vector control/adjustment, in accordance with some embodiments of the invention;

FIG. 7B schematically illustrates a perspective view of the distractor of FIG. 7A attached to an exemplary segment of an alveolar ridge in a gum and including a stationary ridge segment, and a buccal section and a lingual section in a movable ridge segment, in accordance with some embodiments of the present invention;

FIG. 8 schematically illustrates an exemplary automatic distractor for automatically adjusting alveolar ridge elevation distraction gaps and/or ridge expansion distraction gaps in a patient, in accordance with some embodiments of the invention; and

FIG. 9 illustrates a flow chart for an exemplary optional alveolar bidirectional operational process using the distractor of FIGs. 7A—IIE, in accordance with an embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The present invention, in some embodiments thereof, relates to methods and apparatus for performing distraction osteogenesis and, more particularly, but not exclusively, to a method and apparatus for performing alveolar ridge distraction.

An aspect of some embodiments of the present invention relates to a method for performing alveolar bidirectional distraction osteogenesis including elevation distraction (increasing a height of the ridge) and expansion distraction (increasing a width of the ridge) in the alveolar ridge. The method may comprise the use of an apparatus (distractor) configured to be mounted endosseously (inside the bone). Optionally, the distractor may be mounted extraosseously (outside the bone). Optionally, the distractor may be mounted partially endosseously and partially extraosseously, wherein at least the main chassis and the elevation stage are located endosseously, and the expansion (widening) stage is located extraosseously. Optionally, the expansion stage may also be located endosseously. The distractor, in some embodiments, may simultaneously distract in both directions (ridge elevation and ridge expansion). Optionally, the apparatus may be adapted to distract first in one direction, and then in the other direction. Optionally,
the apparatus may be used only for ridge elevation. Additionally or alternatively, the apparatus may be used only for ridge expansion.

In some embodiments, the ridge elevation magnitude may range from 5 mm - 15 mm at a distraction rate of 0.3 - 1 mm per day. For example, 10 mm at a 0.5 mm rate per day (two turns per day - 0.25 mm/turn) requires 20 days; 10 mm at a 0.75 mm rate per day requires 13.3 days. Optionally, the ridge expansion magnitude could exceed up to 8 mm at a similar rate. For example, 6 mm expansion at 0.5 mm rate per/day (two turns - 0.25 mm/turn) requires 12 days.

The distraction procedure is performed gradually in a few distractions sessions per day. Optionally, the distractor may include all, or part, of its components made from a biocompatible material such as a Ti alloy, or Stainless steel 316LVM, or any other biocompatible material, or any combination thereof. Optionally, all or part of the components may be from a material which prevents bone attachment. Optionally, the parts may include a coating which prevents bone attachment.

In some embodiments of the present invention, the method may comprise elevation distraction by affixing an elevation mechanism to a lingual section of a movable ridge segment, for example, by attaching a fastening plate to the section, and elevating the segment a predetermined distance from a stationary ridge segment. Optionally, the elevation mechanism may be attached to a buccal section. Optionally, the method may include latching the elevation mechanism onto an underside of the movable ridge segment, for example, by means of a flexure including anchoring latches, and elevating the segment the predetermined distance from the stationary ridge segment. Optionally, the method may include supporting an underside of the segment with the elevation mechanism, and elevating the segment the predetermined distance from the stationary ridge segment. Optionally, supporting the underside includes clamping means so as to prevent possible twisting of the movable ridge segment. Additionally or alternatively, a contact area between the elevation mechanism and the underside of the movable segment is substantially small allowing for an increased free volume between the stationary ridge segment and the movable ridge segment leaving sufficient room for Callus formation (intermediate bone formation).

In some embodiments of the present invention, the method may comprise expansion distraction by affixing an expansion mechanism to the buccal section of the
movable ridge segment, for example, by attaching a fastening plate to the side and
pulling in a direction away from the lingual section. Optionally, the pulling may be done
from the lingual section of the movable ridge segment. Optionally, expansion distraction
may be performed simultaneously while elevation distraction is being performed. In
some embodiments, "simultaneously while elevation distraction is being performed"
may refer to at some point of time during the period of time when elevation distraction is
being performed. Optionally, may refer to a point of time following the period of time
when elevation distraction was performed. For example, in some embodiments, the
distractor may include a wedge-shaped element, or similar, which is introduced into the
movable ridge segment as the segment is elevated, forcibly widening an expansion
distraction gap between the buccal section and the lingual section.

In some embodiments of the present invention, the method may comprise
affixing the distractor to the stationary ridge segment by drilling a hole in the segment
and inserting a portion of the distractor in the hole. Optionally, the hole is adapted to
support the distractor when subject to mechanical forces and hangover moments
typically associated with the use of a crown and with teeth implants. Optionally,
insertion of the portion of the distractor into the hole may include attaching the distractor
by screwing or by any other suitable means of attachment. Optionally, suitable means of
attachment may include mating components in the distractor (for example, a threaded
female post inserted in the stationary segment to which a threaded male portion of the
distractor is inserted. Optionally, the method may comprise affixing the distractor to the
stationary ridge segment by means of a fastening plate, thereby eliminating a need for
the hole. By not requiring the hole to be made in stationary ridge segment, problems
associated with nerve channels being located in the vicinity of where the hole was
supposedly to be located are substantially resolved.

In some embodiments of the present invention, the method may be used in an
anterior area of the mandible or the maxilla. Optionally, the method may be used in a
posterior area of the mandible or the maxilla. Optionally, the method may be used for a
single tooth, or for a segment (plurality of teeth).

In some embodiments of the present invention, the method may include
control/adjustment of an angular direction of bone growth in the alveolar ridge. The
phrase "direction of bone growth" may hereinafter also be referred to as "vector". 
Vector adjustment may be in the buccal direction (oriented towards an inside of a cheek). Optionally, vector adjustment may be in the lingual direction (oriented towards the tongue). Optionally, vector adjustment may range from 0° - 60°, for example, 0° - 20°, 20° - 40°, 40° - 60°, in either direction. Optionally, vector adjustment may be in both directions, that is, adjusting in a buccal direction at times, and at other times in the lingual direction. Additionally or alternatively, vector adjustment may be performed one time, or optionally numerous times, during the distraction procedure. Optionally, vector adjustment may be used with the bidirectional distractor. Optionally, vector adjustment may be used with distractors configured only for elevation distraction.

In some embodiments of the present invention, the method may include a use of automatic distraction for adjusting the ridge elevation and/or expansion, substantially limiting, optionally eliminating, a use of manual adjustment. An automatic distractor may be include a manual distractor configured with a motor and respective electronics for adjusting a ridge elevation and/or a ridge expansion according to predetermined criteria, such as for example, pre-programmed timing and/or sequences. Optionally, a mechanical controller may be used. Optionally, hydraulic means may be used to activate the ridge elevation and/or ridge expansion mechanisms in the distractor. Optionally, vector control/adjustment may also be performed. Additionally or alternatively, adjustments are continuously made, or optionally, in steps. Optionally, the adjustments may be made by remote control by a patient or a doctor using wireless communications technology. Optionally, wired communications technology may be used for connecting to the remote control. Additionally or alternatively, a combination of wired and wireless communication technology may be used.

Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not necessarily limited in its application to the details of construction and the arrangement of the components and/or methods set forth in the following description and/or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various ways.

Referring now to the drawings, Figs. 1A – 1C schematically illustrate a perspective view, a side view, and a front view, respectively, of an exemplary distractor 100 for performing alveolar ridge elevation and expansion, in accordance with an embodiment of the present invention. Reference is also made to Figs. 1D and 1E which
schematically illustrate an exploded view and a perspective view, respectively, of distractor 100 attached to an exemplary segment of an alveolar ridge including a stationary ridge segment 120, a movable ridge segment including a buccal section 121 and a lingual section 122, in accordance with an embodiment of the present invention. Distactor 100, as shown, is configured to be used endosseously (inside the bone), although in some embodiments, the distractor may be configured to be used extraosseously (outside the bone). Optionally, distractor 100 may be configured to be used both endosseously and extraosseously. Endosseous, or partially endosseous, application of distractor 100 substantially restricts device interference with eating and reduces risk of infection. Distactor 100 is attached to a hole drilled in the stationary ridge segment and includes an elevation stage for increasing a height of the ridge bone and an expansion stage for increasing the width of the ridge bone. Optionally, distractor 100 may be affixed to a mounting plate attached to a buccal portion of the stationary ridge segment, so that drilling of a hole is not required. The elevation stage is configured to pull on the movable ridge segment increasing a free volume between the segment and the stationary ridge segment for elevation distraction. The expansion stage is configured to pull on a buccal section of the movable ridge segment relative to a lingual section, increasing a free volume between the two sections for expansion distraction.

Distactor 100 includes a main chassis 104 with a circular threaded distal end 112 for screwing into a threaded hole 130 in stationary ridge segment 120. Main chassis 104 may be cylindrical in shape as shown, or may include other polygonal cross-sectional shapes such as for example rectangular, hexagonal, octagonal. Optionally, the cross-sectional shape may be elliptical or other curved shape. Threaded hole 130 may be a pre-drilled hole suitable for receiving distal end 112, and adapted to support distractor 100 when subject to mechanical forces and hangover moments typically associated with the use of a crown and with teeth implants. Optionally, threaded hole 130 may include a mating connector (post) inserted inside the hole and suitable for receiving distal end 112. Optionally, hole 130 is a self-tapping hole formed by screwing main chassis 104 into stationary ridge segment 120.

In some embodiments, main chassis 104 may be affixed to stationary ridge segment 120 by means of a mounting (fastening) plate and attachment means such as
screws, so that hole 130 is not required. In such a case distal end 112 is not required to be threaded and may include a flat end (not tapered like a screw) which may be connected to the mounting plate, for example, by welding or other connection means suitable for attaching chassis 104 onto the mounting plate such that distractor 100 may withstand mechanical forces typically acting on crowns used in teeth implants.

In some embodiments, the elevation mechanism for performing the elevation distraction in distractor 100 includes an elevation stage 118 and a jack screw 102. Elevation stage 118 (together with an expansion stage 110 which is mechanically attached to the elevation stage) moves in a direction away from stationary ridge segment 120 when the jack screw 102 is rotated. Optionally, depending on a direction of rotation of jack screw 102, elevation stage 118 (together with the expansion stage) may move in a direction towards stationary ridge segment 120. Elevation stage 118 includes a threaded bore 119 which extends along a longitudinal axis of main chassis 104 and through which jack screw 102 passes. A chassis cap 104A seals a proximal end of main chassis 104 and includes a bore through which jack screw 102 passes and is aligned with threaded bore 119. Turning of a jack screw knob 102A, which in some embodiments may be a hexagonal socket head or external hexagon head, causes jack screw 102 to rotate and elevation stage 118 to move relative to the stationary ridge segment as threaded bore 119 is displaced along a threaded portion 102B of the jack screw. Optionally, other means may be used for elevating elevation stage 118, such as, for example, hydraulic means. Optionally, an axially distending mechanism may be used.

Elevation stage 118 is attached to lingual section 122 of the movable ridge section by means of a lingual fastening plate 114, where the elevated buccal section 122 is attached by means of buccal fastening plate 108 to the expansion mechanism 110 which is coupled to the elevation stage 118, so that the movable ridge segments move together with the elevation stage.

In some embodiments, the expansion mechanism for performing the widening distraction in distractor 100 includes an expansion stage 110 and an expansion screw 106. Expansion stage 110 is attached to buccal section 121 by a buccal fastening plate 108 such that, when the expansion screw is rotated, the expansion stage moves relatively to the opposing elevation stage 118 (and lingual section 122). Expansion stage 110 pulls on buccal section and causes a widening of an expansion distraction gap (not shown) in
the movable ridge segment. Optionally, depending on a direction of rotation of expansion screw 102, expansion stage 110 may move in a direction towards elevation stage 118 reducing the width of the expansion gap, which may be useful for a more precise adjustment of the distraction distance. Optionally, the expansion mechanism includes horizontal linear guides 116 to maintain expansion stage 110 continuously aligned with elevation stage 118, the guides perpendicularly oriented with respect to the longitudinal axis of main chassis 104. Optionally, the expansion mechanism includes one horizontal linear guide 116 on one side of main chassis 104, expansion screw 106 optionally acting as a horizontal linear guide on the opposing side of the main chassis.

In some embodiments, affixing of lingual fastening plate 114 and buccal fastening plate 108 to lingual section 122 and buccal section 121, respectively, may be by means of screws (not shown) inserted through screw holes 115 and 109 on the fastening plates. Optionally, fastening may be done by other means as applicable for securing lingual fastening plates 114 and 108 to the movable ridge segment. Optionally, elevation stage 118 and expansion stage 110 may not be fixedly attached to lingual section 122 and buccal section 121, as previously disclosed and to be further disclosed below for some embodiments of the present invention.

A typical use of distractor 100 may include first adjusting elevation distraction by rotating jack screw 102, followed by adjusting of expansion distraction by rotating expansion screw 106. Optionally, expansion distraction may be adjusted prior to elevation distraction. Optionally, distractor 100 may be configured for simultaneous adjustment of both elevation distraction and expansion distraction, for example, by having expansion stage 110 engage an inclined interface which causes it to slide as the expansion stage is elevated by elevation stage 118. Additionally or alternatively, distractor 100 may be used only for elevation distraction or for expansion distraction.

Reference is made to Figs. 2A and 2B which schematically illustrate an exploded view and a perspective view, respectively, of an exemplary distractor 200 for performing alveolar ridge elevation and expansion, attached to an exemplary segment of an alveolar ridge in gum 224 and including a stationary ridge segment 220, a buccal section 221 and a lingual section 222 in a movable ridge segment, in accordance with some embodiments of the present invention. Optionally, distractor 200 may simultaneously perform alveolar ridge elevation and ridge expansion. Stationary ridge segment 220, buccal section 221
and lingual section 222 may be similar to that shown in Figs. ID and IE at 120, 121 and 122 respectively. Optionally, distractor 200 may include similar functional characteristics as those of distractor 100 shown in Figs. IA - IE. Distractor 200 is attached to a hole drilled in the stationary ridge and includes an elevation stage for increasing a height of the ridge bone and an expansion stage for increasing the width of the ridge bone. The elevation stage is attached to a buccal section of the movable ridge segment and is configured to pull on the movable ridge segment increasing a free volume between the segment and the stationary ridge segment for elevation distraction.

The expansion stage includes a wedge-shaped element configured to forcibly thrust into a split made in the movable ridge segment as the movable ridge segment is elevated by the elevation stage, widening a free volume between the buccal and the lingual sections of the movable ridge segment for expansion distraction. In some embodiments, an increase in the elevation results in an increase in the expansion.

Distractor 200 includes a core screw 204 with a circular threaded distal end 212 for screwing into a threaded hole 230 in stationary ridge segment 220. Threaded hole 230 may be similar to that shown in Figs. ID and IE at 130.

Distractor 200 additionally includes a threaded jack screw 206 rotably mounted over core screw 204 and passing through a threaded bore 219 in an elevation stage 218. A retaining ring 204A is placed over core screw 204 (which may optionally have a hexagonal socket head) to substantially prevent jack screw 206 from slipping from over the core screw. Elevation stage 218 is positioned between buccal section 221 and lingual section 222 and is configured to move along a portion of a length of jack screw 206 when the jack screw rotates about core screw 204. Sections 221 and 222 may be attached to elevation stage 218 by a suturing element 216 (which may optionally include a metallic wire) such that, when jack screw 206 is rotated, the sections (the movable ridge segment) move together with the elevation stage.

Distractor 200 additionally includes a wedge-shaped expansion stage 210 which may be mounted at a predetermined position on jack screw 206. Expansion stage 210 is configured to fit inside elevation stage 218 as the elevation stage moves along a portion of the length of jack screw 206 when the screw is rotated, so that the wedge-shaped portion of the expansion stage forcibly drives into a expansion distraction gap between
the buccal section 221 and lingual section 222 further widening the expansion distraction gap.

In a typical elevation distraction and expansion distraction operation, rotating jack screw head 206A will cause rotation of jack screw 206 around core screw 204. When rotated in a pre-determined direction jack screw 206 also rotates inside threaded bore 219 of elevation stage 218 causing the elevation stage to advance with the attached movable ridge segment in a direction away from stationary ridge segment 220 (in a direction towards jack screw head 206A). As elevation stage 218 advances along a portion of the length of jack screw 206, expansion stage 210 which is in a fixed position on the jack screw, forcibly drives its wedge-shaped elements into the distraction gap between buccal section 221 and lingual section 222, expanding the width of the gap. In this manner, distractor 200 has increased an elevation distraction gap and an expansion distraction gap. Optionally, when jack screw 206 is rotated in an opposite direction, elevation stage 218 may move in a direction towards stationary ridge segment, reducing the elevation distractor gap and the expansion distraction gap.

Reference is made to Figs. 3A and 3B which schematically illustrate an exploded view and a perspective view, respectively, of an exemplary distractor 300 for performing alveolar ridge elevation and expansion, attached to an exemplary segment of an alveolar ridge in gum 324 and including a stationary ridge segment 320, a buccal section 321 and a lingual section 322 in a movable ridge segment, in accordance with some embodiments of the present invention. Stationary ridge segment 320, movable buccal section 321 and lingual section 322 may be similar to that shown in Figs. 1D and 1E at 120, 121 and 122 respectively. Distractor 300 is attached to a mounting plate on a buccal side of the stationary ridge segment and includes an elevation stage for increasing a height of the ridge bone and an expansion stage for increasing the width of the ridge bone. The elevation stage is attached to a buccal section of the movable ridge segment and is configured to support the movable ridge segment from an underside of the segment and to push on the segment increasing a free volume between the segment and the stationary ridge segment for elevation distraction. The expansion stage includes a wedge-shaped element configured to forcibly thrust into a split made in the movable ridge segment as the movable ridge segment is elevated by the elevation stage, widening a free volume between the buccal and the lingua sections of the movable ridge segment.
for expansion distraction. In some embodiments, an increase in the elevation results in an increase in the expansion.

Distractor 300 may be similar to that shown in Figs. 2A and 2B with a difference that, in some embodiments, a core screw 304 may be affixed to stationary ridge segment 320 by means of a mounting (fastening) plate 308 and attachment means such as screws 316, so that a hole similar to 230 in Figs. 2A and 2B is not required. In such a case distal end 212 is not required to be threaded and may include a flat end (not tapered like a screw) which may be connected to mounting plate 308, for example, by screwing or other connection means suitable for attaching core screw 304 onto the mounting plate such that distractor 300 may withstand mechanical forces typically acting on crowns used in teeth implants. An additional difference is that elevation stage 318 is configured with prongs for supporting an underside of the movable ridge segment including the buccal section 321 and lingual section 322, for elevating the ridge segment, compared with use of suturing element 216 in Figs. 2A and 2B to attach the movable ridge segment to elevation stage 218 for elevating the segment. Other components of distractor 300 such as jack screw 306 including jack screw head 306A, retainer ring 304A, expansion stage 310, and elevation stage threaded bore 319 may be similar to that shown in Figs. 2A and 2B at 206 including 206A, 204A, 206, 210 and 219.

Reference is made to Figs. 4A and 4B which schematically illustrate an exploded view and a perspective view, respectively, of an exemplary distractor 400 for performing alveolar ridge elevation and expansion, attached to an exemplary segment of an alveolar ridge in gum 424 and including a stationary ridge segment 420, and a buccal section 421 and a lingual section 422 in a movable ridge segment, in accordance with some embodiments of the present invention. Stationary ridge segment 420, movable buccal ridge segment 421 and movable lingual ridge segment 422 may be similar to that shown in Figs. 1D and 1E at 120, 121 and 122 respectively. Distractor 400 is attached to a hole drilled in the stationary ridge segment and includes an elevation stage for increasing a height of the ridge bone and an expansion stage for increasing the width of the ridge bone. The elevation stage is attached to a buccal section of the movable ridge segment and is configured to support the movable ridge segment from an underside of the segment and to push on the segment increasing a free volume between the segment and the stationary ridge segment for elevation distraction. The expansion stage includes a
wedge-shaped element configured to forcibly thrust into a split made in the movable ridge segment as the movable ridge segment is elevated by the elevation stage, widening a free volume between the buccal and the lingua sections of the movable ridge segment for expansion distraction. In some embodiments, an increase in the elevation results in an increase in the expansion.

Distractor 400 may be similar to distractor 300 in Figs. 3A and 3B with a difference that, in some embodiments, distractor 400 includes a core screw 404 with a circular threaded distal end 412 for screwing into a threaded hole 430 in stationary ridge segment 420. Core screw 404 including distal end 412 and retainer ring 404A, and threaded hole 430 may be similar to that shown in Figs. 2A and 2B at 204 including 212 and 204A, and 230. Jack screw 406 including jack screw head 406A, expansion stage 410, and elevation stage threaded bore 419, may be the same as that shown in Figs. 3A and 3B at 206 including 206A, 210, and 219.

Reference is made to Figs. 5A and 5B which schematically illustrate an exploded view and a sectional view, respectively, of an exemplary distractor 500 for performing alveolar ridge elevation and expansion, attached to an exemplary segment of an alveolar ridge including a stationary ridge segment 520, and a buccal 521 and a lingual section 522 in a movable ridge segment, in accordance with some embodiments of the present invention. Optionally, distractor 500 may simultaneously perform alveolar ridge elevation and ridge expansion. Stationary ridge segment 520, buccal section 521 and lingual section 522 may be similar to that shown in Figs. 1D and 1E at 120, 121 and 122 respectively. Distractor 500 may optionally include similar functional characteristics as distractors 100 - 400 previously described. Distractor 500 is configured to simultaneously perform elevation distraction and expansion distraction by using flexing properties of a metal flexure chassis. Elevation distraction is performed by latching onto an underside of the movable ridge segment and pulling on the segment as a jack screw is rotated. Expansion distraction is performed by the chassis pushing sideways on a split in the movable ridge segment, the direction of pushing both in the lingual and buccal directions.

Distractor 500 includes a threaded jack screw 502 with a threaded distal end 502B and a conical head 502A, for screwing (mating) into a threaded post 512.
configured to be inserted into a threaded hole 530 in stationary ridge segment 520. Mating between jack screw 502 and post 512 is non-locking so that rotational motion of the jack screw, when inside the post, is not restricted (the jack screw may be free to rotate). Optionally, jack 502 screw is secured vertically to the threaded post 512 by means of a tooth or index mechanism which allows rotational motion only. Threaded hole 530 may be similar to that shown in Figs. ID and IE at 130.

Distractor 500 further includes a flexure chassis 504 comprising an upper flexure 504A for expansion distraction, an inferior flexure 504B with anchoring latches 505 /which anchors the whole flexure to the moving elevated ridge section, and a threaded bore 504C through which jack screw 502 passes. Threaded post 512 is screwed into stationary ridge section 520 optionally following prior drilling of hole 530. Inserting and rotating of jack screw 502 via threaded bore 504C, through inferior flexure 504B, forces anchoring latches 505 outwards so that they latch to an underside of movable ridge segment on buccal section 521 and lingual section 522. While continuing to rotate jack screw 502, a tip at distal end 502B collides with a internal cavity bottom of post 512, causing flexure chassis 504 to move along a portion of the length of the jack screw.

In a typical alveolar bidirectional distraction procedure, rotation of jack screw 502 in an elevation direction will cause flexure chassis 504 to move along a portion of length of the jack screw in a direction away from stationary ridge segment 522, widening an elevation distraction gap 507. Optionally, rotation of jack screw 502 in an opposite direction will move flexure chassis 504 in a direction towards stationary ridge segment 522, narrowing distraction gap 507. Movement of flexure chassis 504 causes the movable ridge segment to move together with the flexure chassis, the segment supported by anchoring latches 505. As flexure chassis 504 moves in a direction away from stationary ridge segment 522, the flexure chassis advances further into conical head 502A which engages with upper flexure 504A, pushing sideways on buccal section 521 and lingual section 522 (which move together with the flexure chassis) and increasing an expansion distraction gap. The further flexure chassis 504 advances into conical head 502A, the greater the sideways pushing on buccal section 521 and lingual section 522 and the wider the expansion distraction gap.
Reference is made to Fig. 6A which schematically illustrates a perspective view of an exemplary distractor 600 for performing alveolar ridge elevation, expansion, and vector control/adjustment, and to Fig. 6B which schematically illustrates a perspective view of the distractor attached to an exemplary segment of an alveolar ridge in a gum 624 and including a stationary ridge segment 620, and a buccal section 621 and a lingual section 622 in a movable ridge segment, all in accordance with some embodiments of the present invention. Optionally, distractor 600 may simultaneously perform alveolar ridge elevation and ridge expansion. Stationary ridge segment 620, buccal section 621, and lingual section 622 may be similar to that shown in Figs. 1D and IE at 120, 121 and 122 respectively. Optionally, distractor 600 may include similar functional characteristics as those of distractors 100 - 500 previously described.

Distractor 600 is configured to be attached to a buccal side of the stationary ridge segment, and in addition to allowing for elevation and expansion distraction, the distractor is additionally configured to allow vector adjustment of the ridge bone.

Distractor 600 may be affixed to stationary ridge segment 622 from the buccal section by means of fixation plates 614 and 608, thereby eliminating a need to drill a hole in the stationary ridge segment (and resolving problems with nerve channels in the segment). The elevation and the expansion mechanism and fixation plates 614 and 608 are connected to the main chassis 604 by interconnection threaded rods 606. Elevation distraction is performed by rotating a screw 602 inside a main chassis 604, causing elevation stage 610 to move away from stationary ridge segment 620. Expansion distraction is performed by a wedge-shaped expansion stage 605 as the movable ridge segment is moved further away from stationary ridge segment 620 and forcibly driven further into the expansion stage. A distance between expansion stage 605 and stationary ridge segment 605A may be adjusted by expansion adjustment screw 605A which allows for positioning the expansion stage. Vector orientation of distractor 600 may be controlled/adjusted by means of vector adjustment pivot/screw 607, which allows pivoting of positioning base 618 so that vector adjustment may be in the buccal direction (oriented towards an inside of a cheek). Optionally, vector adjustment may be in the lingual direction (oriented towards the tongue). Optionally, vector adjustment may range from 0° - 60°, for example, 0° - 20°, 20° - 40°, 40° - 60°.
Reference is made to Fig. 7A which schematically illustrates an exploded view of an exemplary distractor 700 for performing alveolar ridge elevation, expansion, and vector control/adjustment, and to Fig. 7B which schematically illustrates a perspective view of the distractor attached to an exemplary segment of an alveolar ridge in a gum 724 and including a stationary ridge segment 720, and a buccal section 721 and a lingual section 722 in a movable ridge segment, all in accordance with some embodiments of the present invention. Optionally, distractor 700 may simultaneously perform alveolar ridge elevation and ridge expansion. Stationary ridge segment 720, buccal section 721 and lingual section 722 may be similar to that shown in Figs. 1D and IE at 120, 121 and 122 respectively. Optionally, distractor 700 may include similar functional characteristics as those of distractors 100—600 previously described.

Distractor 700 includes a pivoting chassis 704 with a circular threaded distal end 712 for inserting into a threaded hole (not shown) in stationary ridge segment 720. Chassis 704 is configured to pivot about an axis 704A for vector control/adjustment of the ridge bone as part of the distraction process. The threaded hole may be similar to that shown in Figs. 1D and IE at 130.

Elevation distraction is performed by rotating a core cap 706A on a core 706 which fits inside chassis 704 and includes a pivot axis 706A at a distal end which aligns with axis 704A on the chassis. Rotation of core cap 706A causes elevation stage 708 to move away from stationary ridge segment 720. Expansion distraction is performed by a leaf-spring expansion stage 705 as the movable ridge sections 721 and 722 move further away from stationary ridge segment 720 and forcibly driven further into the expansion stage. Core 704 is shaped to support expansion stage 705 pushing further into buccal section 721 as elevation stage 708 moves further away from stationary ridge segment 722. Vector orientation of distractor 700 may be controlled/adjusted by rotating vector adjustment pivot lock 704B which is configured to lock pivot axis 704A (and 706A) when a desired vector is achieved. Pivoting of chassis 704 and core 706 for vector adjustment may be in the buccal direction (oriented towards an inside of a cheek). Optionally, vector adjustment may be in the lingual direction (oriented towards the tongue). Optionally, vector adjustment may range from 0° - 60°, for example, 0° - 20°, 20° - 40°, 40° - 60°.
Reference is made to Fig. 8 which schematically illustrates an exemplary automatic distractor 800 for automatically adjusting alveolar ridge elevation distraction gaps and/or ridge expansion distraction gaps in a patient, in accordance with some embodiments of the invention. Optionally, automatic distractor may perform automatic vector control/adjustment. Automatic distractor 800 may include a distractor with similar functional characteristics as those of distractors 100 - 700 previously described, the distractor configured to include servo mechanisms and controls for moving the elevation stage, the expansion stage, and/or the vector control, or any combination thereof.

In some embodiments, automatic distractor 800 includes a reduction gear 828 and a motor 826 enclosed in a sealed cylinder 831. Reduction gear 828 may connect to a pinion gear 830 through gear output shaft 832, the pinion gear coupled to a gear wheel 825. Gear wheel 825 may then be connected to the distractor elevation mechanism, expansion mechanism, and/or the vector control, or any combination thereof, such that rotation of the gear will cause operation of these mechanisms. Optionally, any kind of suitable coupling mechanism may be used to couple the motor gear assembly to the distractor such as, for example, friction wheels and/or belts (V-shape, flat, O-ring shape, synchronous belts, and the like).

In some embodiments, motor 826 may be powered by a battery (not shown). Activation of the motor may be through remote control, for example, through an RF signal received by an invasive antenna in the automatic distractor activating an "enable" switch. Control of motor 826 may be by means of a servo controller which may optionally include timers and an embedded controller for starting the motor according to a certain pre-programmed timing or sequence. Optionally, doctor or patient interfacing to activate the motor is reduced to a minimum, and may not be required at all. Optionally, the adjustments may be made by remote control by a patient or a doctor using wireless communications technology. Optionally, wired communications technology may be used for connecting to the remote control. Additionally or alternatively, a combination of wired and wireless communication technology may be used.

In some embodiments, the invasive antenna may be located below a gum tissue or within cylinder 831. Optionally, in each distraction sequence, the patient or the doctor
may insert an RF transmitter (the remote control) in proximity to the patient’s mouth, optionally inside the mouth, and activate the motor. Optionally, motor 826 may be activated by an induced current in the antenna.

Reference is made to Fig. 9 which illustrates a flow chart for an exemplary optional alveolar bidirectional operational process using distractor 100, in accordance with an embodiment of the present invention. The process described is not intended to be limiting and it should be evident to an ordinary person skilled in the art that there are other ways of carrying out the process. Furthermore, the process may be used with any of the distractors 100 - 800 previously described, optionally with variations in the steps (including the actions, order, and number of steps).

Optionally at 901, perform an upper mid crestal incision and elevate a full thickness buccal flap with one or two releasing incisions; elevate full thickness lingual flap (upper half).

Optionally at 902, mark the borders of the U-shape osteotomy by a round burr.

Optionally at 903, perform buccal U-shape osteotomy to create a bone segment to be raised. The bone cut to include only cortical bone of the ridge.

Optionally at 904, the horizontal section of the U-shape osteotomy is positioned at least 5mm from the deficient ridge top and at least 4 mm from a bottom of stationary ridge segment 120 for interior region (2 mm above mandibular nerve in posterior region).

Optionally at 905, buccal fastener plate 108 and lingual fastener plate 114 are screwed to buccal section 121 and lingual section 122, respectively.

Optionally at 906, perform one mid crestal bone cut (cortical bone only).

Optionally at 907, perform one 1.5mm-drill 3-8 mm below horizontal osteotomy.

Optionally at 908, closure of the tissue using standard techniques (keep upper parts of the plates supra-gingival).

Optionally at 909, latency 2-3 weeks.
Optionally at 910, an upper full thickness mid crestal incision expose only upper margin of the crest.

Optionally at 911, in extremely atrophic ridge with crestal width less than 5mm perform split of the two (buccal and lingual) parts of the segment to be distracted before making the final drill of 2 mm.

Optionally at 912, in ridges wider than 5 mm you can make both drills (1.5 and 2 mm) before splitting the segment.

Optionally at 913, insert device in the drilling; chassis 104 is screwed vertically through transported segment into stationary bone 120.

Optionally at 914, connect elevation stage 118 and expansion stage 110 to lingual fastener plate 114 and buccal fastener plate 108, respectively.

Optionally at 915, perform closure of the tissue using standard techniques.

Optionally at 916, patient sent home for 10-30 days of manual distraction. Optionally, patient uses automatic distraction.

Optionally at 917, patient rotates jack screw 102 for elevation distraction.

Optionally at 918, patient rotates expansion screw 106 for expansion distraction (during elevation process or after completion thereof).

Optionally at 919, patient visits doctor for vector adjustment.

Optionally at 920, patient may require up to three months of consolidation.

Optionally at 921, distractor 100 is extracted.

Optionally at 922, implant insertion.

The terms "comprises", "comprising", "includes", "including", "having" and their conjugates mean "including but not limited to". This term encompasses the terms "consisting of" and "consisting essentially of". The phrase "consisting essentially of" means that the composition or method may include additional ingredients and/or steps,
but only if the additional ingredients and/or steps do not materially alter the basic and novel characteristics of the claimed composition or method.

As used herein, the singular form "a", "an" and "the" include plural references unless the context clearly dictates otherwise. For example, the term "a compound" or "at least one compound" may include a plurality of compounds, including mixtures thereof.

The word "exemplary" is used herein to mean "serving as an example, instance or illustration". Any embodiment described as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments and/or to exclude the incorporation of features from other embodiments.

The word "optionally" is used herein to mean "is provided in some embodiments and not provided in other embodiments". Any particular embodiment of the invention may include a plurality of "optional" features unless such features conflict.

Throughout this application, various embodiments of this invention may be presented in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the invention. Accordingly, the description of a range should be considered to have specifically disclosed all the possible subranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed subranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

Whenever a numerical range is indicated herein, it is meant to include any cited numeral (fractional or integral) within the indicated range. The phrases "ranging/ranges between" a first indicate number and a second indicate number and "ranging/ranges from" a first indicate number "to" a second indicate number are used herein interchangeably and are meant to include the first and second indicated numbers and all the fractional and integral numerals there between.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for
brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other described embodiment of the invention. Certain features described in the context of various embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

All publications, patents and patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention. To the extent that section headings are used, they should not be construed as necessarily limiting.
WHAT IS CLAIMED IS:

1. An osteogenic distractor for increasing a height and a width of an alveolar ridge comprising:
   an elevation stage for distracting a movable ridge segment of said alveolar ridge relative to a stationary ridge segment of said alveolar ridge;
   an expansion stage for distracting a buccal section and/or a lingual section of the movable ridge segment; and
   an element for causing the elevation stage to move relative to the stationary ridge element.

2. The distractor of claim 1 wherein the elevation stage is attached to the lingual section of the movable ridge section by means of a fastening plate.

3. The distractor of claim 1 wherein the elevation stage comprises means for supporting an underside of the movable ridge segment.

4. The distractor of claim 3 wherein the means for supporting an underside of the movable ridge segment comprises an anchoring latch.

5. The distractor of claim 1 wherein the elevation stage comprises a threaded bore adapted to receive the moving element.

6. The distractor of claim 1 wherein the expansion stage is attached to a buccal section of the movable ridge by means of a fastening plate.

7. The distracter of claim 1 wherein the expansion stage is wedge-shaped for widening an expansion free volume.

8. The distractor of claim 1 comprising an expansion screw for causing the expansion stage to move relative to the elevation stage.
9. The distracter of claim 1 comprising at least one horizontal linear guide for causing the elevation stage to be aligned with the expansion stage.

10. The distracter of claim 1 comprising a chassis for supporting the elevation stage.

11. The distracter of claim 10 wherein the chassis comprises a threaded distal end for insertion into the stationary ridge segment.

12. The distracter of claim 10 wherein a distal end of the chassis is attached to a mounting plate for affixing to the stationary ridge element.

13. The distracter of claim 1 comprising a post for insertion in the stationary ridge segment.

14. The distracter of claim 13 wherein the post is adapted to receive the moving element.

15. The distracter of claim 1 wherein the moving element is a threaded element.

16. An osteogenic distractor for increasing a height and a width of an alveolar ridge and configured to be endosseously mounted inside a gum, comprising: an elevation stage for distracting a movable ridge segment of said alveolar ridge relative to a stationary ridge segment of said alveolar ridge; and an expansion stage for distracting a buccal section and/or a lingual section of the movable ridge segment.

17. An osteogenic distractor for increasing a height and a width of an alveolar ridge comprising:

   a flexure chassis comprising an upper flexure for expansion (widening) distraction of a movable ridge segment of said alveolar ridge relative to a
stationary ridge segment of said alveolar ridge, and an inferior flexure for anchoring the flexure chassis to the moveable ridge segment; a jack screw for insertion through the flexure chassis; and a post for mating with a distal end of the jack-screw.

18. The distractor of claim 17 wherein the jack screw comprises a conical head for causing the upper flexure to push on the buccal section and the lingual section of the movable ridge segment.

19. The distractor of claim 17 wherein the inferior flexure comprises anchoring latches to support the movable ridge from an underside.

20. An osteogenic distractor for increasing a height and a vector orientation of an alveolar ridge comprising: an elevation stage for distracting a movable ridge segment of said alveolar ridge relative to a stationary ridge segment of said alveolar ridge; and a vector adjustment mechanism for adjusting a vector orientation of said distractor.

21. The distractor of claim 20 wherein the vector orientation of said distractor may range from 0° - 60°.

22. The distractor of claim 20 wherein the vector orientation of said distractor may range from 0° - 30°.

23. The distractor of claim 20 wherein the vector orientation is in a buccal direction.

24. The distractor of claim 20 wherein the vector orientation is in a lingual direction.
25. A automatic osteogenic distractor for increasing a height and a width of an alveolar ridge comprising:
   a distractor comprising an elevation stage for distracting a movable ridge segment of said alveolar ridge relative to a stationary ridge segment of said alveolar ridge, an expansion stage for distracting a buccal section of the movable ridge segment relative to a lingual section of the movable ridge segment, and a moving element for causing the elevation stage to move relative to the stationary ridge element;
   a mechanism for actuating the moving element.

26. A method for increasing a height and a width of an alveolar ridge by osteogenic distraction comprising:
   attaching a chassis of a distractor to a stationary ridge segment of said alveolar ridge;
   attaching an elevation stage in the distractor to a first section of a movable ridge segment of said alveolar ridge;
   attaching an expansion stage in the distractor to a second section of the movable ridge segment opposite the first section;
   distracting the movable ridge segment relative to the stationary ridge segment; and
   distracting a buccal section of the movable ridge segment relative to a lingual section of the movable ridge segment.

27. The method of claim 26 wherein attaching the chassis comprises screwing the chassis into a hole in the stationary ridge segment.

28. The method of claim 26 wherein attaching the chassis comprises affixing the chassis onto a mounting plate on the stationary ridge segment.

29. The method of claim 26 comprising inserting a post into a hole in the stationary ridge segment.
30. The method of claim 26 wherein attaching an elevation stage in the distractor to a first section of a movable ridge segment comprises supporting an underside of the movable ridge segment.

31. The method of claim 26 wherein the elevation stage is attached to the first section of the movable ridge section by means of a fastening plate.

32. The method of claim 26 comprising supporting an underside of the movable ridge segment.

33. The method of claim 26 comprising attaching the expansion stage to a buccal section of the movable ridge by means of a fastening plate.

34. The method of claim 26 wherein the expansion stage is wedge-shaped for widening an expansion free volume.

35. The method of claim 26 comprising an expansion screw for causing the expansion stage to move relative to the elevation stage.

36. The method of claim 26 comprising at least one horizontal linear guide for causing the elevation stage to be aligned with the expansion stage.

37. The method of claim 26 comprising a chassis for supporting the elevation stage.

38. The method of claim 37 wherein the chassis comprises a threaded distal end for insertion into the stationary ridge segment.

39. The method of claim 37 wherein a distal end of the chassis is attached to a mounting plate for affixing to the stationary ridge element.

40. The method of claim 26 comprising a post for insertion in the stationary ridge segment.
41. The method of claim 26 wherein the post is adapted to receive the threaded element.

42. The method of claim 26 wherein the threaded element is a jack screw.

43. A method for automatically increasing a height and a width of an alveolar ridge comprising:
   distracting a movable ridge segment of said alveolar ridge relative to a stationary ridge segment of said alveolar ridge using an elevation stage;
   expansionly distracting a buccal section of the movable ridge segment relative to a lingual section of the movable ridge segment using an expansion stage;
   causing the elevation stage to move relative to the stationary ridge element using a moving element; and
   actuating the moving element.
FIG. 4B

SUBSTITUTE SHEET (RULE 26)
FIG. 8
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/66

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

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

Electronic database consulted during the international search (name of database and where practical search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<td>X</td>
<td>WO 97/20512 A1 (WALKER DAVID A [CA]; ALTUNA GURKAN [CA]; FREEMAN ERIC [CA]) 12 June 1997 (1997-06-12) figure 12</td>
<td>1-2, 6, 9-10, 12, 15-16, 25 3-5, 8, 10-11, 13-14, 17-24</td>
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Further documents are listed in the continuation of Box C.

Date of the actual completion of the international search:
16 March 2010

Date of mailing of the international search report:
31/03/2010

Name and mailing address of the ISA/EP Office:
European Patent Office, P B 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel (+31-70) 340-2040,
Fax (+31-70) 340-3016

Authorized officer:
Fernandez Ari l lo, J
<table>
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<th>Citation of document, with indication, where appropriate of the relevant passages</th>
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This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons.

1. [Y] Claims Nos.: 26-43

   because they relate to subject matter not required to be searched by this Authority, namely

   Pursuant to Rule 39.1(i,v) PCT, the subject-matter of claims 26-43 has not been searched, since it is directed to a method for treatment of the human body by surgery.

2. [I] Claims Nos.:

   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically

3. [I] Claims Nos.:

   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

This International Searching Authority found multiple inventions in this international application, as follows:

1. [I] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [I] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of additional fees.

3. [I] As only some of the required additional search fees were timely paid by the applicant, this international search report covers

   by specifications enclosed from

   by specifications enclosed from

4. [I] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.

Remark on Protest

[Y] The additional search fees were accompanied by the applicant's protest and, where applicable, the

[Y] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[I] No protest accompanied the payment of additional search fees.
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