

THE  
**aarhus**  
SYSTEM™



A Clinical Guide  
To  
**Aarhus Mini-implants and Skeletal Anchorage**



*“Conventional anchorage is built on the following principles: More teeth against fewer teeth, maximum rigidity, differentiated force systems, extra-oral anchorage, inter-maxillary elastics, reinforcement of occlusion, and, sometimes in adult patients, the use of dental implants.*

*Skeletal anchorage can be used where conventional anchorage cannot be applied, but should not be a replacement of conventional anchorage. In patients with missing teeth and having reduced periodontium, skeletal anchorage provides a framework for the regeneration of the*

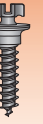
*alveolar process by the movement of teeth into the edentulous regions, thus improving the rehabilitation possibilities for the patient. Patients presenting a therapeutic need for tooth configurations inconsistent with the normal movement, such as the need for the displacement of multiple teeth in the same direction, asymmetric displacements, or borderline surgical cases, are also candidates and can benefit greatly from skeletal anchorage. Mini-implants (TADs), when used as either direct or indirect skeletal anchors, can provide absolute anchorage for a multiplicity of tooth movements. They are easily inserted by the orthodontist and, in almost all cases, loaded immediately. Their success rate is depended on the system used, the operator (technique and experience), and the patient (multiple factors).”*

- Professor Birte Melsen

# Index

## Page

Historical Background	1
Indications For Use	2
Contra-Indications	2
Patient Profile	2
Selecting A Skeletal Anchorage System	3
Mini-implants/Screws	3
Thread Type – General Characteristics	3 - 4
Intraosseous Components	4 - 6
Form	
Diameter	
Length	
Cut	
Tip	
Extraosseous Components	6
Transmucosal Collar	
Neck	
Head Designs	
Driver System	6 - 7
The Sterilization Tray	7
Screw Management and Organization	7
Placement and Insertion Protocols	7 - 8
Patient Information	
Preparation for Insertion	
Selecting the Proper Screw for the Case	8 - 9
Removal of the Mini-implants	9
Appendix A	10
Appendix B	11
References	12 - 13



## Historical Background

The need for skeletal anchorage in orthodontics arose in response to the increase in the numbers of adult patients presenting for treatment. Case workups and analysis disclosed that a large number of these patients could not be treated by conventional anchorage means. Frequently, in a certain percentage of these cases, the number of teeth available was insufficient for the establishment of the classic treatment strategy of using “fewer teeth against more teeth”. Additionally, the force systems necessary to obtain the desired tooth displacements would have generated undesirable movements of the reactive units. In other cases, treatment required that all of the teeth be moved in the same direction, a treatment goal that could not be fulfilled by an orthodontic appliance in balance.

As early as the nineteen seventies, maxillary anterior teeth had been retracted against a surgical wire anchor inserted into a hole drilled through the inferior part of the zygomatic arch. This method of skeletal anchorage, however, was limited to use in those patients who only required retraction of maxillary teeth and thus it did not fulfill the anchorage requirements related to a much broader range of tooth movements needed in the entire adult patient population. An alternative to the zygoma wire was the use of palatal implant as introduced by Werhbein and Glatzmaier (1996). Both the palatal implant as well as the “onplant” met the requirements for anchorage for retraction of maxillary anterior teeth, but these were introduced primarily as an alternative to extra-oral anchorage and other types of anchorage requiring patient compliance.

Dental implants have been frequently used as anchorage in orthodontic patients when the implants are planned as an integral part of a full dental reconstruction (Odman et al. 1994). The same type of implants, but with a slightly different design, were introduced as anchorage for the anterior displacement of lower second and third molars following loss of the first molar due to a variety of reasons (Roberts). The use of these small osseointegrated implants allowed tooth movements that had not previously been possible, i.e. movement of teeth mesially without introducing any forces to the reactive units.

The first use of a surgical screw as anchorage was described by Creekmore in a case report of a single patient but this did not immediately attract a lot of attention (Creekmore and Eklund 1983). Much later, Kanomi demonstrated the use of a small screw as anchorage for the displacement of the lower incisors; Costa et al., also used a surgical screw, primarily as an easier alternative of the zygoma wire. Thus the temporary orthodontic anchorage device

was born. Soon after, the possibility of replacing headgear with Mini-implants was introduced by our Korean colleagues, who, in contrast to the general tendency in the profession, realized a need for establishing maximum “anchorage in the treatment of four premolar extraction cases for the purpose of flattening the profile”. Since then, a large and ever growing number of anchorage screws have been introduced and the use of skeletal anchorage is, according to a recent survey in the Journal of Clinical Orthodontics (Buschang et al., 2008), a commonly used anchorage system.

Development of the Aarhus Mini-implant system was initiated in 1996 by Professor Birte Melsen at the University of Aarhus, based on her prior studies of the use of skeletal anchorage for orthodontic treatment. The primary elements of the system as defined in her initial design requirements are described in the following sections. The current state of the art represents the conclusions drawn from the information gathered over the past 12 years of many mechanical and clinical tests, and various experiments related to the surgical screws; the result of a collaborative effort between two parties – Aarhus University and Medicon eG.

The company responsible for the manufacture of the system, Medicon eG, is highly specialized in the production of surgical screws, instruments, and components for the field of craniofacial surgery and has been a leading manufacturer in this field for many years. The intraosseous component of the Aarhus system is derived from Medicon’s knowledge, expertise in the arena of orthognathic surgery, and ongoing research of the basic parameters related to screw design and function. The extra-osseous components of the Mini-implants have been designed by Professor Melsen to meet specifically defined requirements related to the goal-oriented orthodontics characterizing the Orthodontic Department at the Dental College of Aarhus University, Denmark.

## The Possibility of Skeletal Anchorage

THOMAS D. CREEKMORE, DDS  
MICHAEL K. EKLUND, DDS, MS

JCO: 17: 266, 1983

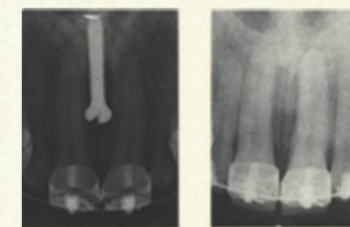
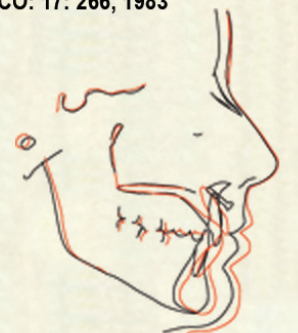
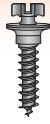


Fig.6 X-rays showing screw at time of placement (left) and the area following removal of the screw (right).







## Indications For Use

Skeletal anchorage has, to a large degree, replaced conventional anchorage in situations where anchorage is considered either critical, insufficient, or likely to result in undesirable side effects such as vertical displacements generated by inter-maxillary force systems. Another frequently found indication for its use is in cases of non-compliance. While many so called “compliance free” anchorage systems have been introduced for orthodontic treatment, none of these have proven to deliver the absolute anchorage generated by skeletal anchorage systems. Finally but perhaps most importantly, skeletal anchorage has widened the spectrum of orthodontics allowing the orthodontist to perform treatments that could not, or, only with great difficulty, otherwise be done with conventional mechanics (Melsen 2004; Melsen 2005a; Melsen 2005b; Melsen & Dalstra 2005; Melsen & Garbo 2004). In general then, it can be stated that skeletal anchorage is indicated where the forces acting on the reactive units are undesirable and cannot be neutralized by occlusal forces.

The most common clinical indications are:

- Insufficient number of teeth and/or lack of occlusion in the anchorage unit, e.g. patients with agenesis or who have lost teeth for various reasons.
- Extrusion or intrusion of single teeth or units of teeth without antagonists (no opposing vertical forces acting on them).
- Asymmetric tooth movements: the displacement of teeth in a single direction, as in the case of A-anchorage, C-anchorage, unilateral expansion; or the displacement of all teeth, in either an arch or quadrant, in the same direction.
- Retraction and/or intrusion of anterior teeth with insufficient anchorage in the reactive unit.
- Mesial movement of molars in cases where the anterior teeth cannot afford to be retracted
- Proclination of anterior teeth in cases where no posterior anchoring element is available, or the reactive forces would have an adverse effect.
- Space closure in maximum anchorage cases.

## Contra-Indications

While there are many legitimate reasons to consider the use of mini-implants in orthodontic treatment, it may also be considered an imprudent use of them when the case can be just as easily treated with conventional biomechanics. In addition, the best treatment plan should incorporate the minimum number of mini-implants necessary to treat the case. Excessive use may

not be considered as either prudent or in the best interests of the patient. There are, however, a number of conditions that absolutely preclude their use. Chief among these contraindications are (Appendix B):

- Patients who are suffering from metabolic bone diseases
- Patients receiving immune suppressive therapy
- Patients on chronic steroid or bisphosphonate medication
- Patients who are incapable of following the instructions for postoperative care. Causes for this are, for example, patients with psychological/mental or neurological problems
- Patients with bone tissue either insufficient or of poor quality to provide primary stability
- Patients with circulatory disturbances or latent infections
- Patients with hypersensitivity to specific materials, i.e. who react to foreign bodies. In these cases, appropriate tests are essential prior to implant (even if merely suspected)
- Acute infections
- Radiotherapy in the head region and patients with tissue damaged by radiation
- Recurring diseases of the oral mucosa and poor oral hygiene

## Patient Profile

Patients as young as 10 years of age can benefit from treatment utilizing skeletal anchorage. Great care, however, should be taken not to insert a Mini-implant in areas where teeth are either un-erupted or where root formation is still developing. Screws inserted into areas of actively resorbing deciduous teeth have a large risk of failure due to the active remodeling of the adjacent bone. The upper age range, on the other hand, is set not by chronological age but by the presence of cortical bone thickness with a minimum of 1.0 mm (Fig 1). In cases of cortical bone thickness of less than 0.5 mm, the primary stability is dependent on either trabecular bone or bicortical bone.

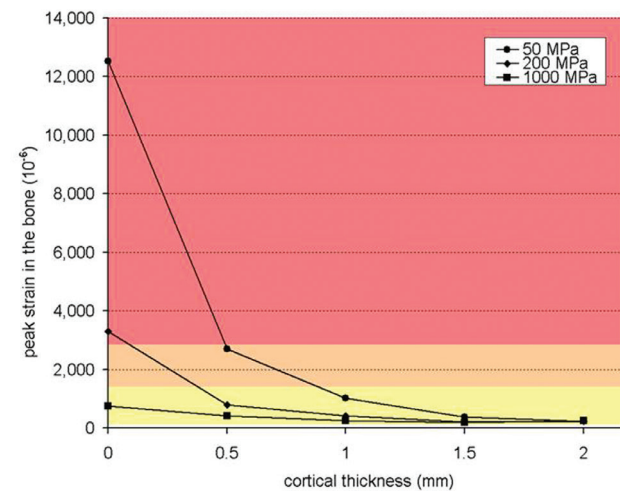


Fig 1 Bone Strain and Cortical Thickness

## Selecting A Skeletal Anchorage System

Screws are naturally at the very core of the (Mini-implant) skeletal anchorage system. When evaluating a system it is natural, therefore, to focus closely on a detailed examination of the screw(s). One should be cautious, however, not to pay attention to the screws to the point of either ignoring completely or paying too little attention to the supporting elements (drivers, screw management and handling, delivery of instrumentation, etc.). It seems fair, then, that, in the decision making process, a more prudent and rewarding approach is to examine a system in its entirety:

1. Is it simple but complete?
2. Does it offer options that apply to all clinical situations?
3. What does the “package” look like?
4. Is it thoughtfully laid out?
5. Is the chair side delivery system user/patient friendly?
6. What about screw management-----packaging, storage, delivery, tracking?

These questions and other details related to the physical makeup and practical use of the Aarhus System are described in the sections that follow.

## Mini-implants/Screws

Using an analogy in anatomical terms, Aarhus screws can be described as having four distinct yet contiguous segments or zones: BODY, COLLAR, NECK, and HEAD (Fig 2).

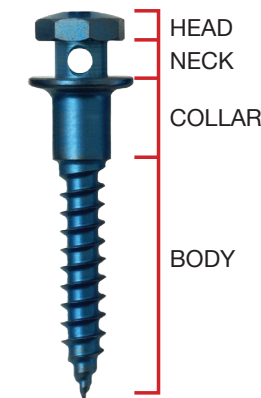


Fig 2 Screw Segments

The screw BODY is comprised of a solid, cylindrical central shaft (core) that terminates in a finely defined sharp tip. Encircling and spiraling around the full length of the shaft are the threads, formed to a specific configuration and cut at a proscribed depth and angle to the shaft.

The COLLAR is a smooth, polished, and thread less transitional zone immediately extending from the screw BODY. It is the portion of the screw that resides in soft tissue. It is also cylindrical in form with a slightly larger diameter than the BODY so as to provide a definite “stop” when placing screws in the host bone. It terminates in a broad, flat plate.

The NECK area of the screw is another transitional area that joins the COLLAR with the HEAD and extends into the oral cavity. It, too, is cylindrical and smooth with a diameter that is narrower than both COLLAR and HEAD. Functionally, it serves as an “under tie area” for the application of ligatures, elastomeric thread and chain, or NiTi spring eyelets.

The HEAD is the terminal segment of the screw and is the “working “end for the orthodontist. The Aarhus system has three distinct HEAD designs that are able to receive force modules of varying types. These three HEAD designs provide the orthodontist a complete range of options when planning and selecting the biomechanics for each specific case. These general descriptions for each segment: BODY, COLLAR, NECK, and HEAD will be discussed below in greater detail.

## Material Specifications

Aarhus mini-implants are manufactured from a biocompatible titanium alloy composition, “Wrought Titanium-6 Aluminium-4 Vanadium ELI (Extra Low Interstitial)”, according to the ASTM F136-02 standards specification. In the medical field of Cranio-Maxillo-Facial surgery, this titanium alloy is the material of choice and has been used for several decades by all established manufacturers of titanium implants. Medicon eG, the manufacturer of the Aarhus system, has been producing screw implants according to the ASTM F 136-02 standard since the early eighties. Furthermore, this specific titanium alloy composition covered has been used for human implants, in contact with bone and soft tissues, for more than 3 decades.

The alloy exhibits a well documented level of biological inertness being characterized as:

- Corrosion Free
- Non Toxic
- Strong
- Having a low module of elasticity
- Anti-magnetic



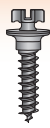
Fig 3 Tip Detail

## Thread Type General Characteristics

Aarhus mini-implant screws have a self-drilling (self-cutting) thread pattern by design. Self-tapping screws require a pre-drilling at full length. The drilling is performed with a bur which has a slightly smaller diameter than the screw diameter and the primary stability then depends on the pressure of the adjacent tissues against the screw when it is manually inserted. The disadvantage is that the orthodontist/clinician does not have a clear tactile perception of the tissues when pre-drilling and damage to the roots can occur without the clinician realizing what has happened – It is therefore recommended to choose a system that utilizes self-drilling screws that have a very fine sharp tip for engaging the host bone (Fig 3).

However, even the Aarhus anchorage system requires pre-drilling in cases of very thick and dense cortical bone, e.g. in the retro-molar area and into edentulous alveolar processes which have been loaded by removable dentures over an extended period of time. However, the pre-drilling in these situations should not be executed at full length; the clinician should drill a hole of only 1 to 2mm in depth, merely perforating the external particularly dense layer of the cortex, before inserting the screw. When pre-drilling in





an area of loose, unattached mucosa, it is of the utmost importance that the mucosa is kept tight during drilling to avoid the tissue being pulled around the bur. This also applies when the screw is being inserted.

### Intraosseous Components

The intraosseous zone, the BODY, of the screw has the following features:

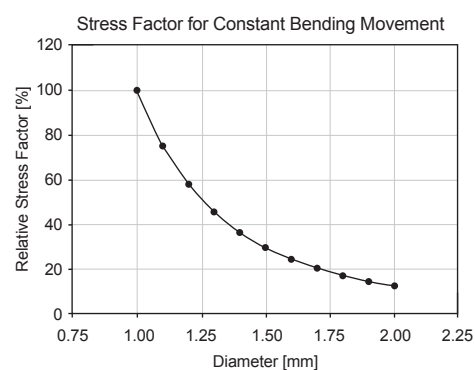
- Form
- Diameter
- Length
- Cut
- Tip

### Form

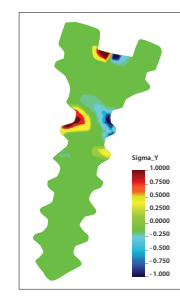
The Aarhus Mini-implant is cylindrical in form. While both conical and cylindrical Mini-implants are available, within the building industry it is well recognized that conical screws are reserved for use in concrete, not plastic materials, and cylindrical screws are used for plastic materials such as wood and, by association, bone. Consequently, screws produced for surgical procedures are cylindrical in form (Fig 4, Appendix A).

### Diameter

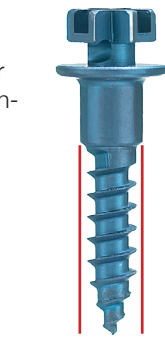
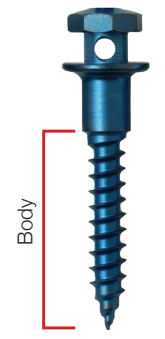
The diameter of Mini-implants (TADs) on the market vary anywhere from 1.1mm to 2.5mm. The rationale for the production of the very thin screws is that there is a reduced risk of damaging the roots when placing the screws inter-radicularly when the space between the roots is limited. The reduction of the diameter does, on the other hand, increase the internal stress of the screw during insertion and removal and thereby there is a greater risk of fracture as seen in Fig 5.1 - 5.2.



**Fig 5.1** Internal Stress vs. Diameter: increasing the diameter from 1.0mm to 1.3mm results in a 50% reduction in stress

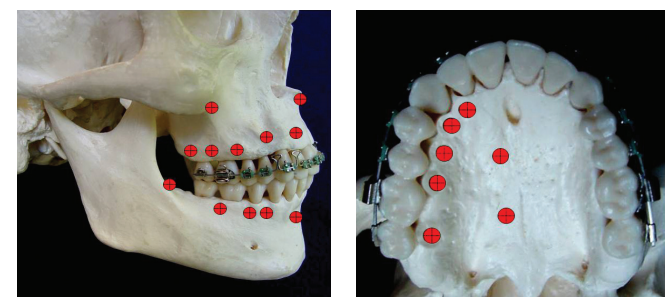


**Fig 5.2** Stress generated on removal. Note: If the neck is weakened, e.g., by a cross slot, it will be prone to fracture.



**Fig 4** Cylindrical Shape

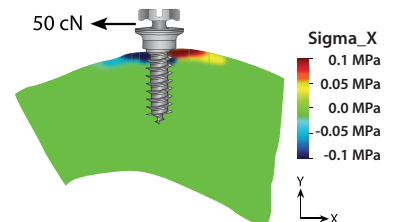
Aarhus Mini-implant screws are produced in three different thread diameters: 1.3 mm, 1.5mm, and 2.0mm. The 1.3mm screw is recommended when the inter-radicular space is narrow or in sites where the cortical bone is thin, e.g., between the roots of teeth in the mandibular anterior region. The 1.5mm screws have application for placing in the alveolar process of both upper and lower jaws on the buccal side, and on the palatal side in the upper arch. The 2.0mm screws are used in sites where the cortical bone is dense and thick, such as the retro molar area of the lower jaw or in areas of the mandible that have been edentulous for a long time. Potential placement sites are shown in Fig 6.1 - 6.2.



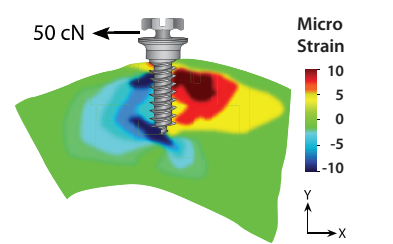
**Fig 6.1 - 6.2** Potential Placement Sites

### Length(s)

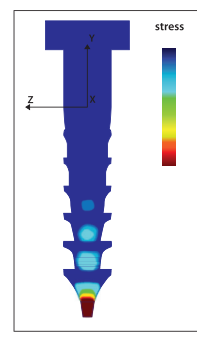
Aarhus mini-implants are produced in three optional thread lengths. The production of different lengths and, hence, the selection of a specific length in treatment is based on the varying quality of bone found in different regions of the maxilla and mandible, and from patient to patient. The three different lengths were chosen based on finite element analysis of the stress/strain distribution related to loading of the screw in different combinations of cortical bone thicknesses and trabecular bone densities. A finite element analysis of Aarhus mini-implants has



**Fig 7.1** Stress Distribution on cortical bone with a 50cN load perpendicular to the long axis.



**Fig 7.2** Strain (deformation) during the same loading parameters. This strain will result in increased density of the trabecular bone.



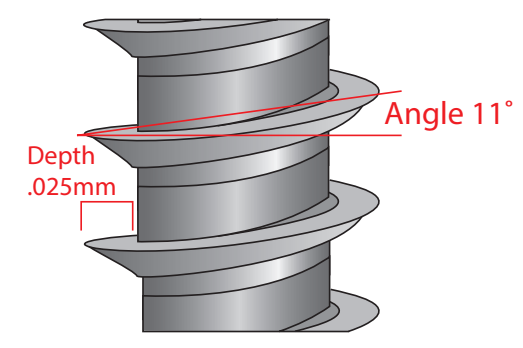
**Fig 7.3** Stress concentration at tip during insertion.

revealed that the center of rotation, when loaded perpendicular to the long axis, corresponded to the endosteal side of the cortex, if the thickness of the cortex was 1.0mm (Fig 7.1 - 7.3).

In the case of thicker cortical bone, the contribution of the trabecular bone is minimal and a short screw will satisfy the requirement for stability. If, on the other hand, the cortex is very thin, stability will be dependent on the trabecular bone and, therefore, a longer screw is required. This applies especially to a screw inserted inter-radicularly or in the retromolar region of the upper jaw. When the cortical thickness is less than 0.5 mm, the primary stability is frequently insufficient and skeletal anchorage cannot be utilized with Mini-implants alone.

### Cut

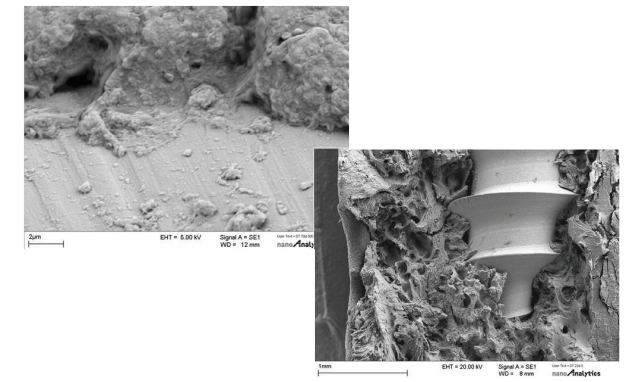
Aarhus mini-implant threads are cut at an angle of 11 degrees in an asymmetrical pattern. This ensures a high resistance against removal in a pull-out test (Fig 8). The thread depth varies in relation to the overall screw diameter and the shaft diameter, e.g. for the 1.5mm diameter screws, the thread depth is 0.025mm. These parameters were determined in order to optimize the screw to the material in which it will be cutting (bone) and to the loading normally applied to it, either perpendicular or as a pull-out. The manner in which the screw penetrates into the bone depends on the cut, the depth, and the angle of the threading. With a smaller angle the surface area of the screw increases; this should, in theory, enhance stability, but it also leads to a higher degree of trauma to the tissue. The angle chosen for Aarhus Mini-implants is the result of an optimization of the need for a larger surface and a minimum of trauma.



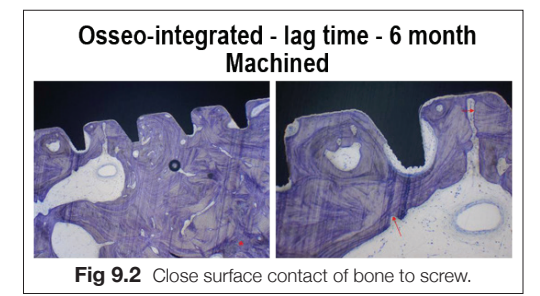
**Fig 8** Cut Detail

For a given diameter, the deeper the thread, the thinner the core diameter and, thereby, the more fragile it becomes. On the other hand, the deeper the thread becomes, the greater the increase in the intraosseous surface area of the Mini-implant. The surface of most Mini-implants are machine polished and the bone will adapt closely to the screw surface rendering an osseointegration on a histological level (Fig 9.1 - 9.2).

The angle of the cut in relation to the core determines how many threads there are and also the rate with which the screw is inserted into the bone at each turn. The more perpendicular



**Fig 9.1** Cellular adaptation to smooth, polished surface of screw (Behrens).



**Fig 9.2** Close surface contact of bone to screw.

to the core, the higher the number of threads and the slower the screw is inserted. The number of threads are, however, also related to the impact on the bone when inserting the screw. The closer the threading, the flatter the resultant angle of the thread with more destruction to the surrounding bone. The sharper the edges of the threads, the more precise the cut is in the bone, whereas the blunter the edges, the more the pressure increases with crushing of the surrounding bone.

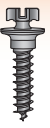
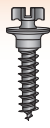
Finally, the threading can be formed either symmetrically or asymmetrically. If the shape is asymmetrical, the angle is usually sharper and if cut so that the oblique part is pointed towards the apex of the screw and the horizontal part towards the head of the screw, it will have a higher resistance in relation to a pull-out test in the lab or in the clinic to an applied extrusive force. An initial loading of 50cN is normally recommended. Higher loadings can be accepted after the primary stability has been replaced by secondary stability, which will continue to increase as the density of the bone adjacent to the screw increases over time. Although the screws may initially resist loosening when loaded with a moment following a period of healing, it can be anticipated that the shearing forces developed in relation to the type of loading will most likely lead to loosening.

### Tip

The tip is cut very fine. Therefore, it should not be forced as it could slide or skip on the surface of the bone at the intended insertion site. This may cause a bending or fracture of the tip.







It is therefore important that, when inserting the screw, the tip should not be held at too oblique an angle to the surface (90-60 degrees). Any necessary change in angulation can be made after the screw has established a purchase in the host bone.

### Extrasosseous Components

The extrasosseous zone of the screw is comprised of:

- Transmucosal Collar
- The Neck
- Head Design(s)

#### Transmucosal Collar

The Aarhus Mini-implants have smooth transmucosal collars in order to reduce the risk of accumulation of plaque and subsequent infection. This zone of the screw that passes through the soft tissue should be smooth and not threaded to minimize irritation and inflammation. The Aarhus mini-implants are produced with two different collar lengths 1.5mm and 2.5mm to accommodate varying tissue thicknesses in the upper and lower jaws (Fig 10).



Fig 10 Collar Lengths

The collar has been purposely manufactured with a slightly larger diameter than the body (threaded section). This difference in diameter is important as it allows the clinician to feel when the collar has reached the periosteum during insertion. At this stage the insertion is complete and further turning of the screw will lead to loosening. In relation to Mini-implants where the neck has the same diameter as the threaded part, the clinician runs the risk of also inserting the smooth neck into bone, resulting in a large pressure zone and eventual ischemia of the bone surrounding the collar. In addition, the collar of the Aarhus mini-implant widens gradually towards the head and ends in a broad flat plate that suppresses tissue overgrowth so that the mucosa is not subject to undue pressure by the plate carrying the head. This design facilitates the maintenance of healthy peri-implant tissues.



Fig 11 Round Hole .032in Diameter

#### Neck

The neck of the screw is a short cylindrical area that joins the tissue collar with the head of the screw. This area is narrower in diameter than both the collar and head; it provides an “under-cut” area for the attachment of various force modules selected by the clinician: the keyends of NiTi coil springs, steel ligatures,

and elastic thread or chain. In the smooth or dome topped head design, there is an .032in. (0.8mm) single round hole that passes through the neck (Fig 11). This hole will accommodate round wire hooks, ties, or auxiliaries as desired by the clinician.

### Head Design(s)

Aarhus Mini-implants are produced with three different head designs: 1. Button Head, 2. Round Head with a single round hole through the neck, 3. Bracket Head with two .022” x .025” slots oriented perpendicular to each other (Fig 12).

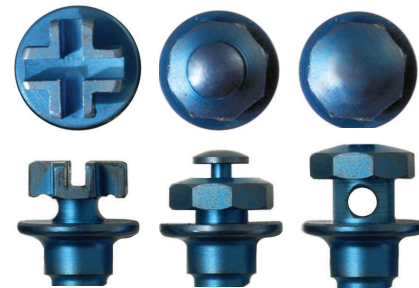


Fig 12 Screw Heads: Bracket Head, Button Head, Through-Hole Head

The heads of Mini-implants on the market vary between those with buttons or hooks allowing only a one point contact. Heads penetrated by holes in one or two directions allow for the insertion of a wire thus providing two point dimensional control while bracket designs allow a three point dimensional control. The latter also make it possible to utilize the screw as indirect anchorage by consolidating the screw to a tooth with a full size stainless steel wire auxiliary. The tooth so consolidated to the screw can then be used as anchorage by conventional appliances and biomechanics.

### Driver System

Unique to Aarhus, the driver blade incorporates a threaded locking sleeve to assist in the engagement, pick-up, and delivery of screws to the host site. Simple advancement of the sleeve to the end of the driver blade securely captures screws and allows them to be easily removed from either sterilization tray or cassette. Once so secured, the screws can be confidently carried and driven without “mini-screw wobble” seen in other



Fig 13 Driver System, Blade and Sleeve

systems. Equally important as screw pick-up, a simple reversal of the sleeve smoothly and easily releases the blade tip from the screw head. This feature helps to avoid unnecessary tugging at the driver to release the screw, a step that could disturb the immediate area of surrounding bone at the placement site and compromise primary stability (Fig 13).

### The Sterilization Tray

The Aarhus Sterilization Tray features a compact design to minimize its footprint on the surgical cart or unit. It is lightweight and roomy for efficient chairside delivery. The sliding cover plate locks securely to hold instruments and screws in place. It is fully vented for superior steam circulation and drainage. Built-in screw cassette slots and multiple wells are thoughtfully laid out for all instrumentation needs. The ‘Handle Well’ has been designed to accept either screwdriver version; the slim-line or the large grip handle. Solid one-piece construction will provide years of dependable, trouble-free, service (Fig 14).



Fig 14 Sterilization Tray - Internal

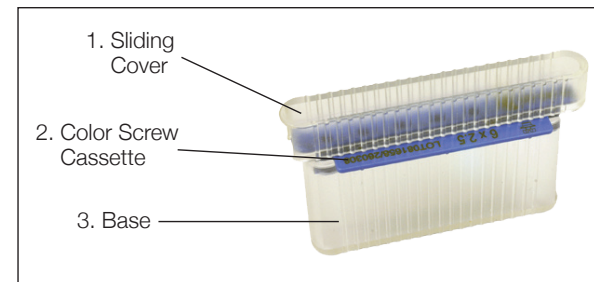


Fig 15 Screw Magazine

### Screw Management and Organization

Aarhus screws are packaged and shipped in self-contained, autoclavable units termed Screw Magazines. There are five (5) screws, of a single type, per magazine. Each magazine is actually a three part unit: sliding cover, base, and removable colored Screw Cassette (Fig 15). With the cover on, each screw is maintained in its individual well and cannot fall out of place. Screw magazines provide safe, secure, hygienic handling, with convenient storage and office to office transfer of screws. The colored screw cassettes are laser marked with complete and instant identification of contents (Fig 16). The ID markings provide positive tracking and traceability, in addition to simplifying inventory control. Screw cassette colors are keyed to screw diameter: WHITE for 1.3mm diameter, BLUE for 1.5mm diameter, and RED for 2.0mm diameter screws. In normal usage, the colored screw cassettes are removed from their magazine base and transferred into the sterilization tray. Alternatively, the magazine, taken together with its companion holding base, can function as a stand-alone “mini” delivery system.

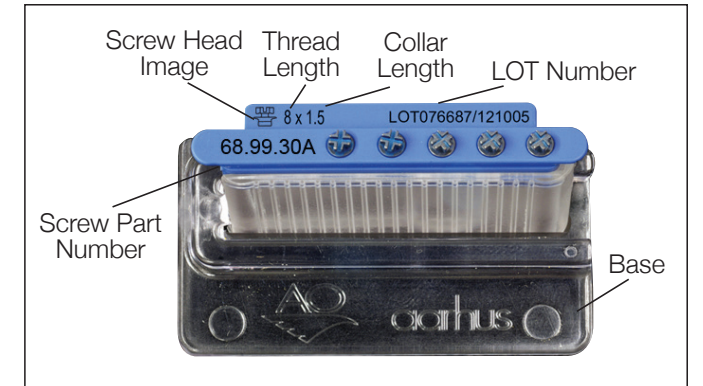


Fig 16 Screw Cassette & Holding Base

### Placement and Insertion Protocols Patient Information

The anatomical site should be chosen so that the risk of root contact is minimized and the clinician should avoid inserting screws in areas where nerves or vessels are located, e.g. the posterior lateral part of the palate. Prior to considering the use of skeletal anchorage, it is important to assess its possibilities carefully. Mini-screws, although generally well accepted, require that the unique biological environment of the individual patient has to be thoroughly evaluated and understood. The bone turn-over of the patient may be influenced by factors that will interfere with the normal tissue reaction surrounding the screw.

A thorough exam and Medical History is required to rule out any contra-indications to treatment. If no contraindications are found, the patient must be informed about the advantages, oral hygiene requirements, and the possible risk-factors before the start of treatment. This can be provided in either written form or verbally presented, e.g. by the hygienist or other qualified person showing clinical images of patients with mini-implants. In either case, a signed Consent Form for Treatment with Mini-screws should be obtained from the patient/parent.

In order to get the first “take” in the bone, the point of the screw is sharp and the point very fine, and the most “apical” part of the screw is therefore conical. [NOTE: It is important not to load

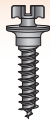


Fig 17.1 Sterilization Tray



Fig 17.2 Tray Cover





the screw hard against the bone. In such cases the point can be bent or even fractured. When starting the insertion, the perforation of the periosteum and the initial introduction into the external layer of the cortex should be made perpendicular to or, as close to, perpendicular to the bone; once the screw feels stable, the direction can be changed to a more apically directed angle.】



Fig 18 Screw Diameters

### Preparation for Insertion Selecting the Proper Screw for the Case

Prior to the actual placement of any Mini-implant, it is mandatory that the desired tooth movements be defined in all three planes of space to insure a successful treatment result. Only with comprehensive and complete planning can sufficient information be obtained of the specific anchorage requirements and force system necessary to treat the case. With this available information at hand, the decision is then made as to whether the anchorage screw is to be used directly or indirectly (through consolidation of screw and tooth which, as a unit, will provide the anchorage).

Head selection-The manner in which the skeletal anchorage is used, direct or indirect, will determine the type of head to select. If indirect anchorage is indicated, (meaning that the point of force application is not identical to the screw head) a Mini-implant with a bracket like head is indicated.

Diameter selection-The diameter of the screw to use depends on the placement site. Between roots in the upper jaw a 1.3mm screw of 11mm is recommended as the stability is also dependent on the trabecular bone. In the alveolar process the 1.5 mm diameter with a shorter length is recommended. In areas with very thick cortical bone, as in the retromolar area of the mandible, it is recommended that a 2.0mm screw be used, as the torsion necessary for insertion in this region may lead to fracture of a thinner screw. Aarhus Mini-implants, like other screws from the manufacturer, are color coded for positive visual identification. The 1.3mm diameter is YELLOW, the 1.5 mm is BLUE and the 2.0 mm is GREY (Fig. 18).

Thread length selection-In patients with a cortical thickness of 1mm or more, a 6mm screw may provide sufficient primary stability. When the cortical bone is thin and the primary stability is primarily dependent on trabecular bone, a Mini-implant with longer thread length (8mm or more) may be indicated. In edentulous areas where the cortex may be very thin, bi-cortical anchorage may be the only alternative and should be considered. It has been shown (Brettin et al. 2008, Buschang, Carillo, Ozenbaugh & Rossouw 2008) that bi-cortical anchorage is superior to uni-cortical anchorage. If planning for bi-cortical anchorage, both the total thickness of the alveolar processes and the thickness of both labial and lingual mucosa should be measured and the insertion direction accurately determined (Fig 19.1 - 19.2). [NOTE: Perforation of the lingual cortex and trauma to the periosteum will frequently lead to inflammation and loss of the screw, therefore one must be very precise when attempting bi-cortical placement.]

Site Selection - Once the most desirable insertion site has been determined based on the force system selected, the possibility of actually being able to insert the screw in that site has to be verified based on a radiographic image. The optimal information can be obtained from CBCT slices through the region of interest. If CBCT imagery is not available, PA (Peri-apical) intraoral radiographs are preferable to panoramic radiographs as the latter can distort the mutual position of the roots, especially in the canine region. One recommendation is to bend a small wire template and to fixate this to either a bracket with a ligature wire or to

Fig 19.1 Uni-cortical Anchorage



Fig 19.2 Bi-cortical Anchorage



Fig 20.1 Template on typodont



Fig 20.2 Template positioned in place with acrylic

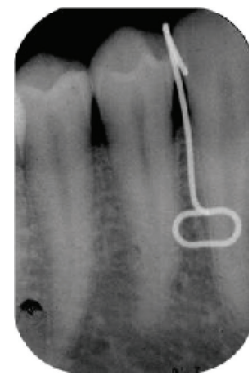


Fig 20.3 PA film of template

the occlusal surface in the proximity with a light cured acrylic (Fig 20.1 – 20.3). While the PA radiograph with the template in place provides an excellent guide for the insertion of the screw, information about the cortical thickness cannot be obtained by either OTP or PA radiographs; therefore, the doctor is referred to surveys provided in the literature (Costa).

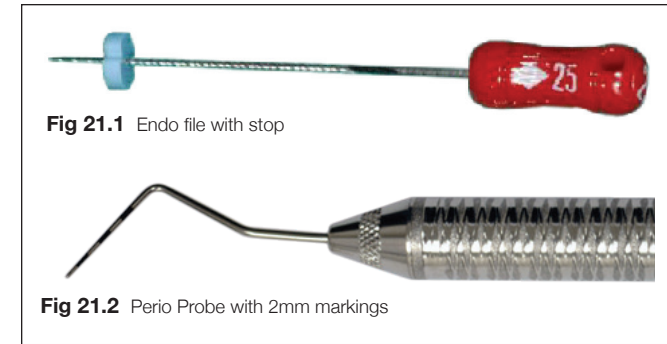


Fig 21.1 Endo file with stop

Fig 21.2 Perio Probe with 2mm markings

A placement site with attached gingiva is much preferred. If this is not possible due to the low border between attached gingival and the free mucosa, screws can be inserted in the mucosa and then covered so that only a coil spring or a wire passes through the mucosa. [NOTE: It is important that the mucosa is held tight when the screw is inserted in order to avoid the mucosa winding around the screw.]

Soft tissue consideration - Not only the bony cortex but also the thickness of the mucosa has to be considered in the selection of the proper screw – the lengths of both thread and transmucosal collar. Because it is desirable to avoid the presence of any threads in the soft tissues, the threadlength of the screw has to be chosen giving due consideration to the mucosal thickness at the placement site.

Selection of the proper transmucosal collar length is determined by the mucosal thickness e.g., in areas with a thicker mucosa, such as in the palate or in the retromolar area, a longer transmucosal collar type should be selected. The thickness of the mucosal can be assessed using either an endodontic file with rubber stop as a marker, or a perio probe with millimeter markings. In cases where the mucosa exceeds 3mm in thickness e.g. in the palate, Mini-implants should not be considered for skeletal anchorage as the point of force application will be too far from the centre of resistance of the screw and the potential for failure is significantly increased. (Fig 21.1 – 21.2).

Once the placement site has been determined:

1. The patient is asked to rinse thoroughly (2 min.) with a 0.2% chlorhexidine mouth wash.
2. Local anesthesia of the mucosa at the insertion site is administered either by an injection of .5ml local anesthetic or by an alternative anesthesia of the mucosa.
3. Following the administration of anesthesia, the doctor has to prepare for the screw insertion procedure according to established sterile field standards established for intraoral surgery.

4. A sterile surface has to be available and prepared to receive all of the surgical armamentarium determined necessary for placement of the screws.
5. The doctor and assistants prep according to established protocols for oral or periodontal surgery (surgical scrub, surgical head cover, mouth mask, and sterile gloves).
6. The screw is picked up with the screwdriver, the grip on the screw tightened, and the insertion performed (Fig 22).

When starting the insertion, the screw is kept perpendicular, or close to perpendicular, to the bone surface. Once the screw is felt to have engaged the bone, the direction can be altered to a more apical direction. Keeping this direction steady, the screw driver is slowly and continuously turned until the clinician feels an increase in resistance; a sign that the transmucosal collar has reached the periosteal surface. At this point, the turning of the screw is completed; continued turning would lead to a loosening of the screw.

Following insertion, the peri-implant tissues are gently rinsed with sterile saline solution before the screws are loaded. It is recommended that the initial load not exceed a maximum force of 50cN and that the force be applied perpendicular, or as near to perpendicular, to the long axis of the screw as possible. An intrusive or extrusive pull-out force can also be accepted immediately following insertion; on the other hand, a moment in either the clock or counter clockwise direction will lead to a shearing force resulting in a loosening of the screw with a loss of primary stability. It is important to instruct the patient in proper care and oral hygiene related to Mini-screws before dismissing them.

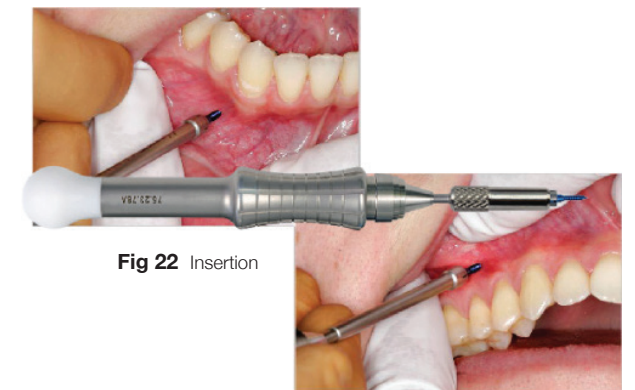
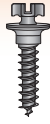


Fig 22 Insertion

### Removal of the Mini-implants

The removal of the Mini-implants is easily accomplished with the same screw driver as used for insertion. The procedure can usually be done under application of a local anaesthetic gel. The removal site should be gently swabbed with a 0.2% Chlorhexidine. The wound present at time of screw removal is minimal and usually closes within a few days. In most cases, healing will continue uneventfully.



## Appendix A

### Bone Types

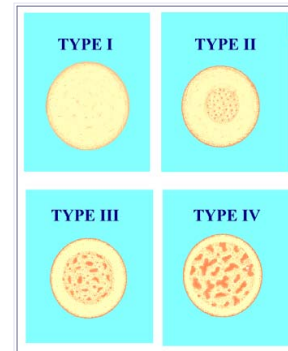
There are four types of bone in the human face and the length of treatment for placing and restoring implants with a “tooth” and crown depends on which type of bone the implant is placed in. Implants have to integrate with the surrounding bone before a tooth and crown is placed on it.

**Type I** bone is comparable to oak wood, which is very hard and dense. This type of bone has less blood supply than all of the rest of the types of bone. The blood supply is required for the bone to harden or calcify the bone next to the implant. Therefore, it takes approximately 5 months for this type to integrate with an implant as opposed to 4 months for type II bone.

**Type II** bone is comparable to pine wood, which isn't as hard as type I. This type of bone usually takes 4 months to integrate with an implant.

**Type III** bone is like balsa wood, which isn't as dense as type II. Since the density isn't as great as type II, it takes more time to “fill in” and integrate with an implant. 6 months time is suggested before loading an implant placed in this type of bone. Extended gradual loading of the implant can, however, improve the bone density.

**Type IV** bone is comparable to styrofoam, which is the least dense of all of the bone types. This type takes the longest length of time to integrate with the implant after placement, which is usually 8 months. Additional implants should be placed to improve implant/bone loading distribution. Incremental loading of the implants over time will improve bone density. Bone grafting or augmentation of bone are often required. Bone expansion and or bone manipulation can improve initial implant fixation.



### Bone Types and Locations

Lekholm and Zarb explain the classification system of bone as follows<sup>4</sup>: Based on its radiographic appearance and the resistance at drilling, bone quality has been classified in four categories: Type 1 bone in which almost the entire bone is composed of homogenous compact bone; Type 2 bone in which a thick layer of compact bone surrounds a core of dense trabecular bone; Type 3 bone in which a thin layer of cortical bone surrounds a core of dense trabecular bone; and Type 4 bone characterized as a thin layer of cortical bone surrounding a core of low density trabecular bone of poor strength. These differences in bone quality can be associated with different areas of anatomy in the upper and lower jaw. Mandibles generally are more densely corticated than maxillas and both jaws tend to decrease in their cortical thickness and increase in their trabecular porosity as they move posteriorly. It has been shown, although there are have been some studies that argue the point that there is a decrease in success rates as the bone type increase. There have been a range of statistics that have been reported from a 2% difference from type 1 (98% in 36 months) to type 4 (96% in 36 months) and a 14% difference in another group (90% type 1 vs. 76% type 4 in 36 months). These are important statistics as it indicates firstly that the bone quality is significant when considering an implant placement site, and secondly that there appears to be other factors in the success rates of implants as one considers the vast discrepancy between the results.

<sup>4</sup> Lekholm U, Zarb GA, Albrektsson T. Patient selectino and preparation. Tissue integrated prostheses. Chicago: Quintessence Publishing Co. Inc., 1985;199-209.

## Appendix B

### Contra-Indications:

The Aarhus Mini-implant System must not be used when the following contraindications exist:

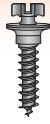
- Patients who are incapable of following the instructions for postoperative care; for example, patients with psychological/mental or neurological problems.
- Patients with insufficient or poor quality bone tissue.
- Patients with circulatory disturbances or latent infections.
- Patients with hypersensitivity to specific materials, i.e. who react to foreign bodies. In these cases, appropriate tests are essential prior to implant (even if merely suspected).
- Patients with acute infections.
- Patients having received Radiotherapy in the head region and patients with tissue damage resulting from radiation treatment.
- Recurring diseases of the oral mucosa and poor oral hygiene.

### Complications and side-effects:

- Complaints of pain, abnormal sensations or palpability of the implant.
- Material hypersensitivity of the patient due to the foreign bodies in the form of allergic reactions.
- The use of different materials may cause corrosion.
- Increased reaction of the connective tissue in the area of the implant.
- Inadequate bone formation, osteolysis, osteomyelitis, osteoporosis, inhibited revascularization or infection alignment that may result in loosening, bending, cracking or breakage of the implants.
- Breakage, bending, migration, or loosening of the implant.
- Inadequate osseointegration that could result in loosening or breakage of the implant and failure of the orthodontic treatment.
- Decrease of bone density as a result of stress shielding.

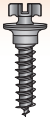
This surgical procedure may cause not only the above-mentioned side-effects and complications, but also problems such as injuries to nerves, infections, pain etc., which are not necessarily caused by the implant. If complications occur, they are often the result of incorrect selection of the patient, inexperience, or lack of preoperative planning rather than caused by the implant itself.





## References

1. Block MS. and Hoffman DR. (1995) A New Device for Absolute Anchorage for Orthodontics. *American Journal of Orthodontics and Dentofacial Orthopedics*. 107 (3):251-258.
2. Brettin BT., Grosland NM., Qian F., Southard KA., Stuntz TD., Morgan TA., Marhsall SD., Southard TE. (2008) Bicortical vs. Monocortical Orthodontic Skeletal Anchorage. *American Journal of Orthodontics and Dentofacial Orthopedics*. Nov; 134(5):625-35.
3. Costa A., Raffaini M., and Melsen B. (1998) Miniscrews as Orthodontic Anchorage: A Preliminary Report. *The International Journal of Adult Orthodontics and Orthognathic Surgery* 13 (3):201-209.
4. Creekmore TD. and Eklund MK. (1983) The Possibility of Skeletal Anchorage. *Journal of Clinical Orthodontics*. 17 (4):266-269.
5. Dalstra M., Cattaneo PM., and Melsen B. (2004) Load transfer of Miniscrews For Orthodontic Anchorage. *Orthodontics*. 1:53-62.
6. Godtfredsen, Laursen M., Melsen, B. (2009) Multipurpose Use of a Single Mini-implant for Anchorage in an Adult Patient. *Journal of Clinical Orthodontics*. Mar:43(3):193-9.
7. Kanomi R. (1997) Mini-implant for Orthodontic Anchorage. *Journal of Clinical Orthodontics*. 31 (11):763-767.
8. Kofod T., Wurtz V., Melsen B., (2005) Treatment of an Ankylosed Central Incisor by Single Tooth Dento-Osseous Osteotomy and a Simple Distraction Device. *American Journal of Orthodontics Dentofacial Orthopedics*. Jan;127(1):72-80.
9. Kyung HM., et al. (2003) Development of orthodontic micro-implants for intraoral anchorage. *Journal of Clinical Orthodontics* 37 (6):321-328.
10. Luzi C., Verna C., Melsen B. (2009) Guidelines for Success in Placement of Orthodontics Mini-implants. *Journal of Clinical Orthodontics*. Jan;43(1):39-44.
11. Luzi C., Verna C., Melsen B. (2009) Immediate Loading of Orthodontic Mini-implants: A Histomorphometric Evaluation of Tissue Reaction. *European Journal of Orthodontics*. Feb;31(1):21-9.
12. Luzi C., Melsen B., Verna C., (2007) A prospective clinical investigation of the failure rate of immediately loaded mini-implants used for orthodontic anchorage. *Prog Orthod.*, 8(1):192-210.
13. Melsen B, (2006) VIP interview: Birte Melsen. Interview by Samir E. Bishara. *World J Orthod*. Fall;7(3):313-6.
14. Melsen B., (2005) Mini-implants: Where are we? *J Clin Orthod*. Sep;39(9):539-47.
15. Melsen B., Costa A., (2000) Immediate Loading of Implants Used for Orthodontic Anchorage. *Clin Orthod Res*. Feb;3(1)23-8.
16. Melsen B., Lang NP., (2001) Biological Reactions of Alveolar Bone to Orthodontic Loading of Oral Implants. *Clin Oral Implants Res*. Apr;12(2):144-52.
17. Melsen B, Petersen JK, and Costa A (1998) Zygoma Ligatures: An Alternative Form of Maxillary Anchorage. *Journal of Clinical Orthodontics* 32 (3):154-158.
18. Park HS et al (2001) Micro-implant Anchorage for Treatment of Skeletal Class I Bialveolar protrusion. *Journal of Clinical Orthodontics* 35 (7):417-422.
19. Park HS and Kwon TG (2004) Sliding Mechanics with Microscrew Implant Anchorage. *Angle Orthod* 74 (5):703-710.
20. Roberts WE et al (1989) Rigid Endosseous Implants for Orthodontic and Orthopedic Anchorage. *Angle Orthod* 59 (4):247-256.
21. Roberts WE, Marshall KJ, and Mozsary PG (1990) Rigid Endosseous Implant Utilized as Anchorage to Protract Molars and Close an Atrophic Extraction Site. *The Angle Orthodontist* 60 (2):135-152.
22. Veltri M., Balleri B., Goracci C., Giorgetti R., Balleri P., Ferrari M. (2009) Soft Bone Primary Stability of 3 Different Miniscrews for Orthodontic Anchorage: A Resonance Frequency Investigation. *Am J Orthod Dentofacial Orthop*. May; 135(5):642-8.
23. Wawrzinek C., Sommer T., Fischer-Brandies H. (2008) Microdamage in Cortical Bone Due to the Overtightening of Orthodontic Microscrews. *J Orothofac Orthop*. Mar; 69(2):121-34.
24. Wehrbein H et al (1996) The Orthosystem--A New Implant System for Orthodontic Anchorage in the Palate. *J Orofac Orthop*. 57 (3):142-153.
25. Wilmes B., Su YY., Sadigh L., Drescher D. (2008) Pre-drilling Force and Insertion Torques During Orthodontic Mini-implant Insertion in Relation to Root Contact. *J Orthofac Orthop*. Jan; 69(1):51-8.
26. Melsen B, The Role of Skeletal Anchorage in Modern Orthodontics. *Clinical Orthodontics*. Chapter 7, Current Concepts, Goals and Mechanics. Edited by Ashok Karad, 2010, Elsevier.



## **NOTES**



THE  
aarhus  
SYSTEM™



3524 Washington Avenue  
Sheboygan, Wisconsin, 53081 USA

Phone: +1 920 457 5051  
Email: [cs@americanortho.com](mailto:cs@americanortho.com)  
Web: [americanortho.com](http://americanortho.com)



©2018 American Orthodontics Corporation  
All Rights Reserved

FOLLOW US ON

