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Considerations Regarding Treatment Options and Technique For Cortically Anchored Implants in the Distal Maxilla

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Abstract: *Dental implantology has made possible the replacement and restoration of function, aesthetics and phonetics in the lost dentition. And although, new research in the field of dental implantology and osseointegration has surpassed various expectations, restoration of the resorbing maxilla has always posed a problem to the practicing dentist. The distal segment of the upper jaw appears especially prone to the effects of aging and it suffers early from deterioration due to various reasons. Implant rehabilitation has demonstrated high success rates of 84–92 %, when sufficient bone is available in maxilla. However, atrophy in maxilla is not an uncommon finding and conventional implant placement in this region can often be challenging. In this review, we discuss the various obstacles in the path towards restoring the atrophic maxilla as well as surgical, prosthetic and other implant techniques imperative towards a successful outcome.*

Keywords:*Strategic Implant®, posterior maxilla, pterygoid implants, cortically anchored implants*

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I. Introduction

It has been reported that the stomatognathic system demonstrates accelerated ageing in comparison to the remainder systems in the body, owing to the fact that an individual loses all or most of his teeth long before he can lose his life[1]. Hence, Modern dentistry is aimed towards restoring the normal contour, function, comfort esthetics, speech, and health regardless of the atrophy, disease, or injury of the stomatognathic system[1]. However, conventional methods and techniques in dentistry are incompetent with regard to meeting these goals. With a view towards addressing this concern, dental implantology was introduced[1]. Dental implantology is a term used today to describe anchoring of alloplastic material into the jaws to provide support and retention for prosthetic replacement of teeth that has been lost. Furthermore, advances in the field of implantology have resulted in the implementation of novel implant materials, designs and techniques that are now available for use in rehabilitation of different clinical problems[1]. The increased need and use of implant-related treatments result from the combined effect of a number of factors including psychological aspects of tooth loss, aging population, tooth loss related to age, anatomic consequences of edentulism, poor performance of removable prosthesis, and predictable long-term results of implant-supported prostheses.In the severely atrophic maxilla, factors such asmaxillary sinus pneumatization, the resorption of the alveolar ridge, presence of nasal cavities, and type 3 or 4 bone quality reduces the success rate of conventional dental implant[2, 3].Hence, several treatment options have been proposed to solve this situation, including bone grafting techniques—block bone grafts and sinus lifting via crestal or lateral approach—and nongrafting techniques, which are modifications of the conventional implant procedure, such as placement in the zygomatic bone, the pterygoid process or the maxillary tuberosity, and use of short or tilted implants. In this paper, we discuss the considerations for the treatment options and techniques for cortically anchored implants in the distal maxilla

Bone density considerations for implant placement:

Len Tolstunov[4, 5] divided maxilla and mandible into two zones, each depending upon the prognosis of the survival of the implants. According to his classification, Zone 1 in the Maxilla includes the area between 1st premolar – 1st premolar ("traumatic zone" or "premaxilla ") and Zone 2 ("sinus zone") represents the area extending from the 2nd premolar distally until the end of the maxilla. Likewise the mandible is also divided into two zones: i.e. the inter-foraminal region (Zone 3) that demonstrates (for conventional 2-stage-implants) higher implant survival rates compared to the area of the premolars and molars (Zone 4). The distal or posterior segments of maxilla and mandible that are considered as Zone 2 and Zone 4 (ischemic zone) atrophies at a faster rate than Zone 1 (traumatic zone) and zone 3. The need for restoring the distal jaws with implants occurs as soon as the posterior teeth are lost, which may precede the loss of the anterior teeth. The distal maxilla does not possess good stability for the anchoring of the implants, because the bone volume is considerably low due to the remodeling, both from the oral and the maxillary sinus side. Moreover, the mineralization decreases progressively and rapidly as soon as the function is lacking. The posterior maxilla is usually rated as Type 4 bone (D4) according to the classification of Lekholm[6] and class 4 to class 6 of Cawood and Howell classification[7, 8].

According Schnitman et al[9], osseointegration is often not achieved in the posterior maxilla, only 72% of the implants are successful. Techniques have been developed to use mainly the Zones 1 and 3 in both jaws with All on 4 or All on 6 being the most popular techniques. Disadvantages of this strategy are higher stresses on bone and implants and the necessity to place the implants under an angle to surface of the bone. Cantilevers longer than 15mm have been associated with increased implant failure rates. Implants anchored in the dense cortical bone of the pterygomaxillary region take advantage of the high local mineralization for their anchorage in the cortical bone areas[10, 11],**Fig. 1a and 1b**. Conventional 2-stage implant strategies in Zone 2 include sinus augmentations, these procedures increase the available bone without solving the problem of the lower mineralization in this zone.

Usage of the pterygoid plate of the sphenoid bone seems a logical strategy, considering the anatomy and the high quality of that bone. Tuberosity implants[1213]and implants in the zygomatic bone[14] are two other options availed to restore the distal segment of maxilla. They utilize the fact, that the bone of the maxillary tuberosity allows good implant integration, although it is not used in immediate loading protocols.Tulasne[11, 15] first described the technique of tubero-pterygoid implants. The technique includes to pass through the tuberosity of the maxilla and to anchor implants into the pterygoid plate of the sphenoid bone.Ihde[16-18] and Scortecci[19] et al described the usage of tubero-pterygoid screw implants in combination with lateral basal implants (Disk Implants, BOI). They recommended this combination for immediate loading protocols.

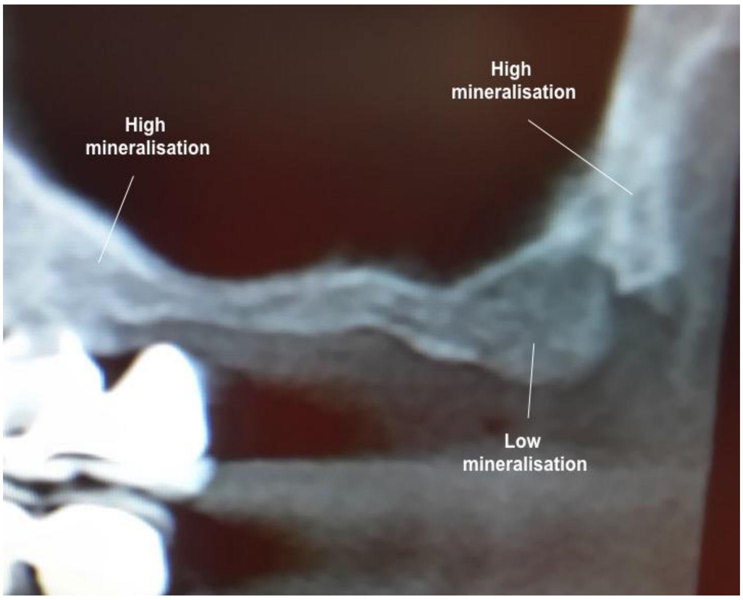

Fig. 1a: Panoramic picture of the distal maxilla, showing differences in mineralization. High mineralization if found in the premaxilla (left in the picture) and in the area of the pterygoid plate of the sphenoid bone (right in the picture). The distal maxilla provides low mineralized bone (D4) and the 1st cortical is almost missing in the area of the maxillary tuberosity.

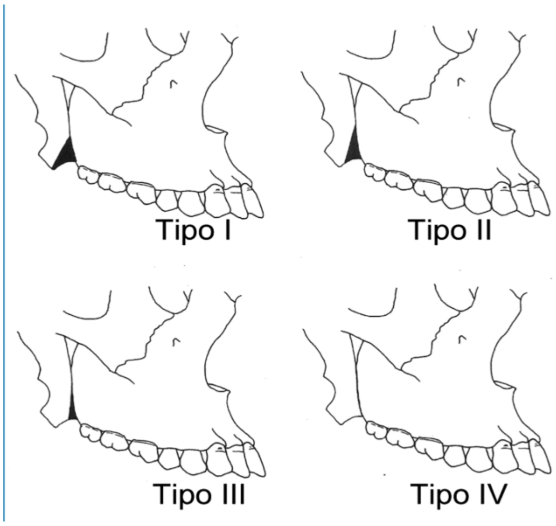

Fig. 1b: In lateral view different shapes of pterygoid apophysis

Implant techniques for the posterior maxilla:

Implants

Treatment options for cortically anchored basal screw implants (BECES) (Strategic Implant® brand, Manufacturer Simpladent GmbH, CH-8737 Gommiswald) are described, **Fig. 2,3 and 4**.The standard treatment includes placement of one or two implants with an apical thread of 3.6 mm diameter in the adequate length into the pterygoid plate of the sphenoid bone. Mostly implants in 17 mm, 20 mm, 23 mm or 26 mm are used. Our approach differs from the technique described by Scortecci et al[19], who uses implant in lengths of up to 44mm length.The implants are then splinted with a metal-to-acrylic or metal-to-ceramic bridge within maximum of 3 days, and the construction is then right away subjected to full functional immediate loading.

Instruments

The slot for the implant has to be prepared up to a width of 2mm and in adequate length. It is advisable to use a thin and conical “pathfinder” drill first to explore the location of the cortical plate. The drills can be used on the straight hand-piece or on the handgrip for manual use. We prefer to use the handgrip for implant insertion because it allows to direct the implant into the desired direction.

Fig 2: Fully polished , single-piece screwable basal implant (BECES) (Strategic Implant ® , Manufacturer: Simpladent GmbH, Dorfplatz 11, 8737 Gommiswald, Switzerland)I ncl. an abutment head for cementation.

Fig. 3: Drills and instrument kit. The drills are used preferably in a straight handpiecewith 1:1 transmission.

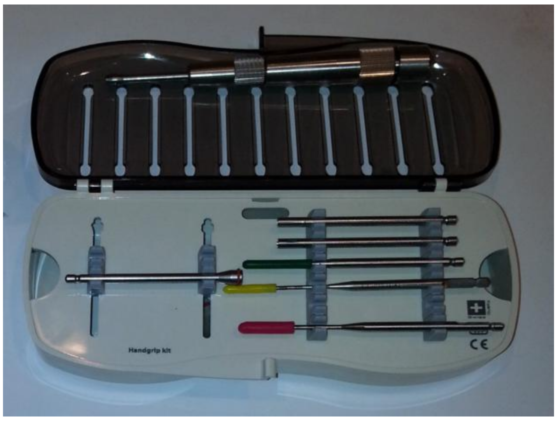

Fig. 4 Instruments required according to manufacturer. Drills and pathfinder drill may be used with the handgrip instead of using the straight handpiece 1:1.

Anatomical Considerations:

The target area for the apical thread of the implant is the fusion area between the distal maxilla and the pterygoid plate, where two corticals are usually fused. An ideally placed implant would perforate the cortical of the pterygoid process into the pterygoid fossa, thus contacting the attachment area of the medial pterygoid muscle, **Fig5& Fig. 6**.The average height of the fusion zone between maxilla and sphenoid bone is around 13mm, the anterior-posterior thickness of this zone can be between 3mm and over 6.5mm , the medio-lateral distance (width) being 9.5mm[20]. The average length from the tuberosity to the most apical point of the pterygoid apophysis is 22.5mm + – 4.8mm[21, 22].The pterygoid site is reasonably safe surgical site if operated under full knowledge of the anatomy and with caution, sinceno anatomically significant structures are presentin the vicinity of the implant. The maxillary artery passes along the outer side of the lateral pterygoid muscle upwards, until the pterygo-palatatine fosse. There it crosses medially over the muscle into the center of the skull[23]. The medial pterygoid muscle occupies the majority of the space between the pterygoid plates. The fusion are is the thickest area of the plate, and it is located in the (vertically) middle part of the pterygoid process. This area is the ideal site for one or two implants.

If the implant is inclined too much medially, it will engage rather in the lateral wall of the nose. If the implant is inclined too much laterally, it will engage into the lateral pterygoid muscle and typically this will cause pain during changes in the mouth opening. The palatal artery will be hit only, if the implant crosses over too much to the medial side. This is typically a minor complication if no flap ismade: the bleeding is stopped by placing the implant and application of pressure. The direction of insertion depends on the atrophy of the jaw: Because the maxilla grows much longer than the pterygoid process, it reaches a larger width. If the implant is placed right after extracting the 2nd or 3rd molar, the drilling and later implant will be directed medially, **Fig. 7**.In moderate maxillary atrophy the implant will be more in the sagittal plane, with less angulation towards the medial, **Fig. 8**.If the maxilla is heavily atrophied however the implant points directly dorsally, or it even may be directed to the lateral. This is true independently if one or two tubero-pterygoid implants are placed, **Fig. 9**.The angle to the horizontal plane depends on the spatial relationship between the maxillary tuberosity and the pterygoid process of the sphenoid bone. If the pterygoid process is much more cranial compared to the maxilla, the direction is almost vertical or the point of penetration into the first cortical must be chosen far more anterior,**Figs. 10&11** show examples of this angle. **Fig. 12** shows an example with very anterior implant placement and insertion of the implant under an adequate angle into the pterygoid plate.

Fig. 5: The tubero-pterygoid implant penetrates the pterygoid plate of the sphenoid bone and it is in contact with the attachment area of the medial pterygoid muscle.

Fig.6: Lateral view displaying the fusion zone of pterygoid plate (incl. Hamuli) and the distal maxilla. Above the fusion area the pterygo-maxillary fissure is visible.

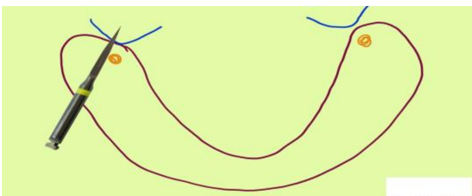

Fig. 7: The pathfinder drill points distally and medially in cases when the maxilla is (not yet) atrophied.

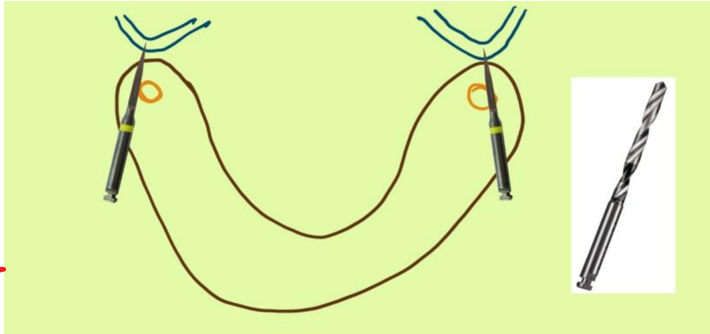

Fig. 8: In moderate atrophy (Type 2) where the pterygoid apophysis is closer to posterior border of tuberosity cranially. The bucco palatal width is also sufficient but less than the Type 1. So the bucco-palatal angle is kept closer to 80 degree , keeping the Hamulus as reference point for direction.

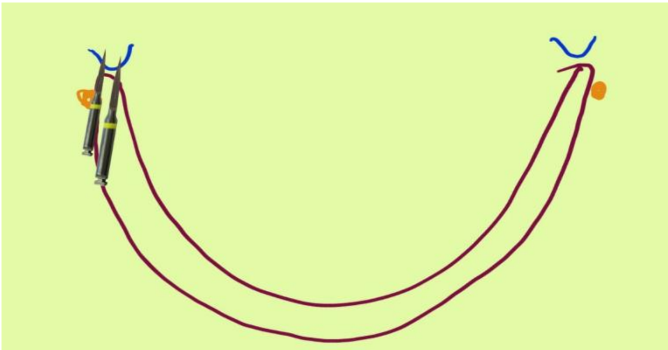

Fig. 9: In cases of a severe atrophic posterior of maxilla (Type 3); the pterygoid not medial to the maxillary tuberosity any more, but either right behind it or even disto-vestibular to it. This has a direct influence on the direction of drilling and insertion.

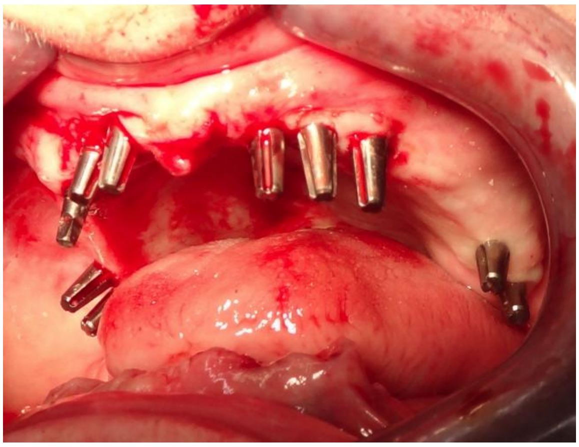

Fig. 10: In cases where tubero-pterygoid implants are placed in medial direction, the heads show a buccal inclination. This allows free movements for the tongue. This figure shows also, that typically there will be no parallelism between the abutments of the anterior implants and the abutments in the distal maxilla.

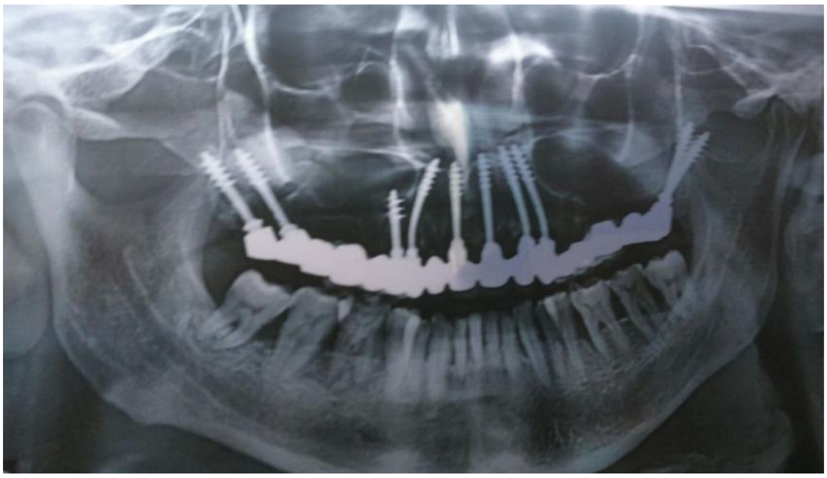

Fig. 11: Left side parallel two implants engaging the pterygoid apophysis . Different angles are used in reference to Frankfurt plane to achieve the similar engagement variating from 60 degree to 80 degree.

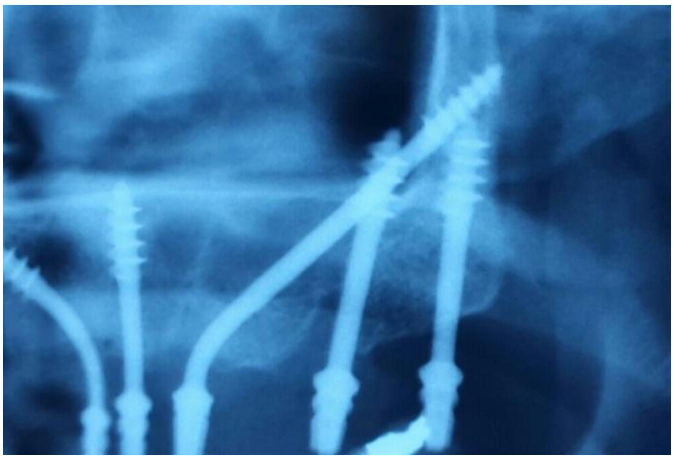

Fig. 12: In order to engage into the tubero-pterygoid region under an adequate angle, the point of insertion for the implant must be more medially. In this example the tubero-pterygoid implant is the 3rd from the back. Two more implant are placed distally, their direction is by far more vertical, and the engage in the palatal bone of the maxilla and in the maxillary tuberosity only.

Surgical technique:

After the assessment of the pre-operative clinical requirements and radiological examination, the need for pterygoid implants is defined. Typically the placement of tubero-pterygoid implant is required for distal support in the maxilla and the patients often request for a treatment involving immediate loading.Local anaesthesia of lignocaine with adrenaline is infiltrated into the retro maxillary area and on the palate, near the palatal foramen. We used the technique described by Valeron and Valeron[24] and Penarrocha et al[25] and modified by Ihde[16]. They have advocated to engage the pterygoid apophysis with combination of tapping with pathfinder drill attached to handgrip and to use a final cylindrical twist drill, 2mm diameter, with an irrigated handpiece 1:1. The technique requires to percuss medial Hamulus notch from palatal aspect and extending to the Hamular process on the Medial Hamular Notch in the Oropharynx. This is the landmark which an operator feel and consider as a point not to deviate medially from it. The target area is around 5mm lateral to the notch. An angle of 45 degree to 75 degree +or- is kept in relation to the Frankfurt plane.

The implant is inserted at about 70 degrees towards the distal (measured against the vertical). The start point on at the crest will varies according to the atrophies treated. Here author classify the distal atrophy of maxilla in relation of pterygoid to tuberosity. The entrance point with a pathfinder attached with handgrip is taken at 2nd molar region as if entered from ideal 3rd molar region or tuberosity will be out at distal wall of tuberosity being short of pterygoid is tapped till it reaches the pyramidal process of palatine bone. A sudden "Bell" sound is observed indicating engagement of mineralized cortical bone. The procedure is followed by using the gradation marked 2mm twist drill by 1:1 reduction hand piece. It's needed to perforate the pterygoid bone with twist drill to know the length required for the site. The medial Hamulus is used as the reference point for the flapless pterygoid placement. But when in doubt, the tissue can be reflected and with the periosteal elevator / rasper extending anterio-posteriorly at the vestibular sulcus the pterygoid bone is felt and the same direction used to place implant.

Prosthetic considerations:

The importance of the pterygoid implants becomes obvious when we leave the panoramic view and realize in 3D-approach that support for all 4 corners of the maxilla is necessary and not only for the front. As soon as the distal maxilla is equipped with a reliable support, restoration becomes easy and implant dentistry becomes reliable. Rigid cross arch fixation keep the micro motion at minimal under 150 microns avoiding the fibro osseointegration[26, 27].

Unfortunately the direction of insertion into the maxilla is not vertical for these implants. Hence the unparallel abutments is a concern, **Fig. 10**. If the bone of the pterygoid plate is sufficiently mineralized- this can be verified during the process of drilling and implant insertion-, also the implants in this region can be bent manually. We use the medium size insertion tool in combination with the ratchet for this procedure. It is also possible to use the handgrip for bending. In any case some manual pressure from the back of the implant must be exerted to make sure the really the implant bends backwards and that the pterygoid process and/or the maxillary tuberosity do not break off.

The second concern is the influence on speech function through distal abutment heads. If the heads are too much inclined to the midline (as shown in **Figs 7,8** and **9**), they may block the movement of the tongue. This negative influence on the speech is especially pronounced, if this functional blockage is given only on one side.

II. Discussion:

The pterygoid plate of the sphenoid bone is a reasonably safe surgical site if operated under full knowledge of the anatomy and with caution. If the placement of the implant is done correctly, no other anatomical structures can be harmed: The maxillary artery is located either vestibular to the lateral pterygoid muscle or above the muscle, and hence in regular cases more than 40 mm away from the point of implant insertion in the 1st cortical of the maxilla[28, 29]. The pterygoid muscles occupy the majority of the space between the hamuli. The thickest area being the middle part of the pterygoid process between the plates, an ideal site for implant anchorage. Care has to be taken not to deviate palatally, more than the reference point of the hamuli as we might encounter in its path, the greater palatal artery. When traumatized, the bleeding from this vessel can be controlled easily, especially if no flap was reflected.

The Mandible is excellent for absorptionand has thick corticals and trabeculae, maxilla acts for dispersion of forces and possesses thin cortical bone and sparse trabeculae and is also the weaker than the maxilla. Apparent density is lowest in the posteriormaxilla than any other region. We primarily lose 1st and 2nd molars due to periodontal diseases and because of high occlusal forces generated at the distal , thus leading to poor clinical success rate of implants in posterior maxilla[30] .To overcome the weak quality bone of posterior maxilla and avoidance of cantilever in immediate functional loading protocol , pterygoid implants have become the atmost importance. Always the anchorage of 3rd cortical, extramaxillary cortical is desired[30]. In the stable pterygoid cortical minimal of 60N torque is achieved making the distal support most stable. When comparing the other restorative technique for posterior maxilla like sinus lift[28, 29], short implants onlay grafts ,Zygoma, Le forte 1 surgery and intrapostional grafting, the flapless pterygoid is the most accepted technique . But the position of pterygoids in relation to Frankfurt plane can't be made as standard as the angle of pterygoid implants in relation to antero posterior plane and frontal plane (bucco palatal) varies by different approaches related to atrophies presented by different patients[23].

III. Conclusion:

Placement of tubero-pterygoid implants has been reported in literature as a safe procedure in implant dentistry. Due to the high mineralization of the target bone, the implants are typically loaded immediately, i.e. within three days. Circular bridges or segment bridges **(Fig. 13)** for missing premolars and molars are the key indications. Even 2nd molars can be replaced in immediate load protocols, using 1-3 Strategic Implants, with at least one of them engaging in the tubero-pterygoid region, i.e. the pterygoid plate of the sphenoid bone.The procedure for the placement of this implant is easy to comprehend and practice, however it requires a profound understanding of the individual anatomic situation.

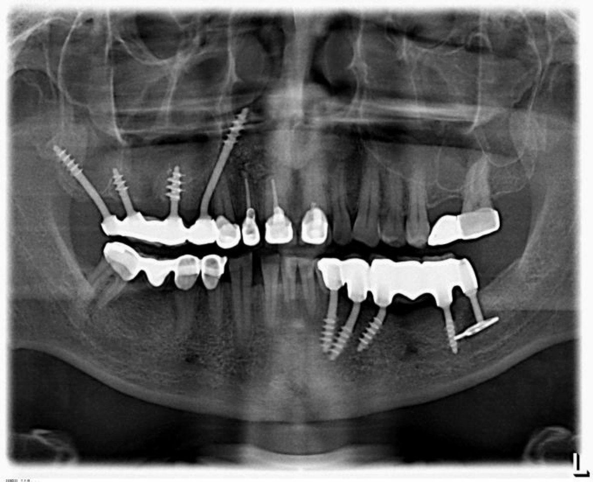

Fig. 13: In this case a tubero-pterygoid implant serves as a distal support for a segment bridge in the upper right jaw. Totally 4 implants are included. The anterior implant was placed utilizing canine bypass-technique. Loading was done within 48 hrs.

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