The significance of bone density in Mini-implants

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ABSTRACT

In order to uncover potential explanations for diverse clinical events, researchers have typically given more attention to tissue reactions occurring within the periodontal ligament and bone and less attention to the underlying bone density. Regional variations in jaw morphology, bone density, and other aspects of bone structure have recently attracted significant attention as potential explanations for various clinical practise variations involving tooth mobility, implant success rates, anchoring loss, and other factors. The purpose of this review is to analyse several approaches and categories that have been put out to identify bone density in a specific area and discuss its significance in the orthodontics industry. Several clinical trials and pieces of research on bone density were looked up in PubMed. The goal of this study is to synthesise the studies on mandibular and maxillary bone density. Numerous clinical studies have shown a connection between several clinical dental abnormalities and bone density. Knowing the bone density in a specific area of the oral cavity can assist the doctor determine the best location for implant placement and different anchoring augmentation strategies to boost the success rate of the procedure.

Keywords: Bone density, Maxilla, Mandible, Mini-implant, Anchorage.

INTRODUCTION

The term "density" has been employed by different skeletal tissue researchers to signify a range of distinct things. Some people think of density as the radiopaqueness of roentgenograms. Based on the observation that x-ray absorption is related to the mass of calcium in that unit of bone volume, the weight-pervolume theory was developed. Density has also been defined as the weight of bone per unit volume as shown by the exterior bone envelope of an organ.

The specific gravity of bone tissue has been expressed as a function of density. Last but not least, the density of marrow gaps within a unit of bone tissue has been described [1]. For dental research and clinical practise, knowing the maxillofacial region's bone density offers many benefits. Both bone density and bone production are influenced by muscle loading forces. The understanding of the three-dimensional distribution of bone density would enable a more thorough analysis of the complex interaction between the skeleton's adaptive deformation and its biomechanical surroundings. Bone density on the skeletal surface increasing denotes active mineral addition. Its distribution may change during growth, revealing the growth locations. Evaluation of orthodontic tooth movement as well as planning implant sites, determining bone healing, and measuring these qualities would all benefit from measurement [2].

Various methods of assessing bone density

On typical anteroposterior roentgenograms of the hand, radiogrammetry (RG) assesses the thickness of the cortex of the metacarpal or other tubular bones from which various derived indices of cortical bone volume are derived. This commonly used, straightforward method just needs the ability to acquire repeatable bone roentgenograms and take precise measurements. Radiogrammetric measures are often accurate, repeatable, and comparable to a sizable normal population. It does not, however, accurately reflect the absolute bone mineral content. It mostly applies to the appendicular skeleton and only gives data on the relative change in bone volume [3] The Compton scattering technique uses the scattering of a gamma ray beam into a detector, where the activity level is dependent on the density of the bone target. It reflects the volume of bone studies' organic and inorganic components [4]. With high precision, the scattering volume can be identified entirely within weight-bearing trabecular bone.

Radiographic Photodensitometry (RP) measures the amount of bone minerals indirectly by using the bone mineral picture on normal radiographic film as a sign of photon absorption by bone. Utilizing a photodensitometer, the degree of film whitening is determined. Each film is calibrated by simultaneously exposing a reference wedge made of an aluminium alloy that absorbs X-rays at a rate similar to that of bone [3]. Since commonly obtained radiographs have a broad range in density, it is crucial for these measurements to adhere to precise standards for kilovoltage, exposure time, and film processing. Appendicular bones can only be treated with this technique because it is so sensitive to changes in the tissue overlaying the bone [5].

Using a radioisotope that produces photons at two different energy levels, dual-energy photon absorptiometry (DPA) modifies the single-energy method. Dual photon absorption measurement evaluates the total integrated mineral in the beam's path and does away with the need for a consistent soft tissue thickness along the scan route. The first person to describe using DPA to determine the mineral content of the mandibular bone was Von Wowern [6].

Classifications of bone density

Bone density was divided into three categories in 1970 by Linkow LI and Chercheve R [7]: Class I, Class II, and Class III bone structure. The optimum bone type is class I, which has trabeculae that are regularly spaced and have little cancellated voids. Class II bone structure refers to the bone that has less homogeneous osseous pattern and slightly bigger cancellated gaps.

Large marrow-filled gaps appear between trabeculas in class III bone structure.

Based on macroscopic cortical and trabecular bone features, Misch CE (1988) identified four bone densities in the edentulous areas of the maxilla and mandible [8]. D1 bone is mostly dense cortical bone, D2 bone has dense to thick porous cortical bone on the crest and coarse trabecular bone underneath, D3 bone has a thinner porous cortical crest and fine trabecular bone inside, and D4 bone consists virtually entirely of fine trabecular bone according to the clinical hardness of the bone as felt during drilling before implant placement Misch CE (1993) divided the four types of bone density into subgroups [9]. The tactile analogue of drilling and implant placement in D1 is oak or maple wood. The physical experience of drilling through spruce or white pine wood is comparable to that of D2 bone. Balsa wood is the tactile equivalent of drilling through D3 bone. Drilling through D4 bone is like drilling into styrofoam.

Bone density as a parameter in treatment planning of mini-implants

Influence of bone density on the load transfer: Because primary retention of mini-implants is accomplished by mechanical methods rather than by osseointegration, bone density appears to be a significant determinant for stationary anchorage of mini-implants in the sites with insufficient cortical bone thickness during the early stages.[10].

Bone density and method of insertion: Bone density in the area should be taken into account while choosing the method of implant implantation. When mini-implants are inserted into dense, thick cortical bone, the insertion torque rises [11, 12], increasing the risk of implant fracture or breakage and the amount of bone injured. Therefore, it is advised to employ the predrilling approach for inserting the mini-implants in the thick and dense cortical bone area.

Bone density and implant failure: It has been determined that areas of the D1eD3 bone are suitable for the implantation of temporary anchoring devices (TADs). TADs inserted into the D1 and D2 bone show less stress at the screw-bone interface and might offer more stable anchorage when being loaded. Since placement in the D4 bone has a significant failure probability, it is not advised (35e50 percent) [13]. Previous studies examining the effectiveness of screw implants revealed significant failure rates in the posterior jaw.

Considering that moveable soft oral mucosa is more prone to inflammation, Cheng et al hypothesised that this was the cause [14]. However, due to the presence of strong and solid cortical bone in the posterior jaw, Park hypothesised that failures may be brought on by moveable oral mucosa, gastrointestinal irritation, or excessive heat created during implantation [15]. The success of dental implants may be harmed by the bone necrosis that is known to result from heat generated at 47 C. With rising temperatures and prolonged heat exposure, bone necrosis spreads widely.

Bone density and rate of tooth movement

The rate of tooth movement accelerates when bone density declines. It has been discovered that mandibular molars have a higher anchorage value than maxillary molars. Mandibular molars are supported by an alveolar structure that has been discovered to be denser than maxillary molars, providing higher resistance to tooth movement. The high density bone that is created as the leading roots are shifted mesially contributes to the improved anchoring value of mandibular molars. After a few months of mesial translation, the velocity of tooth movement slows down as the trailing roots encroach on the high density bone created by the leading root. In general, the bone density has an adverse relationship with the rate of tooth movement. The discovery that tooth movement happens more quickly in children than in adults lends credence to this theory [16]. Therefore, it is vital to increase the anchoring as needed in locations with low bone density.

CONCLUSION

Prior to implant placement, the clinician can employ lengthier implants at low density sites to enhance retention by being aware of these sites. The pre-drilling procedure helps prevent implant breakage in locations with high bone density. In order to avoid the bone in that area from overheating, enough irrigation should be performed. The greater bone density throughout the cortical bone makes immediate loading of mini-implants possible. It is vital to strengthen the anchoring when appropriate in areas with low bone density**.**

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