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A Review of the Related Factors and Measurement Methods of Maxillary Palatal Masticatory Mucosa Thickness

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Abstract: *In the field of oral medicine, the main donor site of autologous soft tissue transplantation is its own maxillary and palatal masticatory mucosa, and the thickness of the own mucosa often directly determines the success or failure of the operation. Therefore, if we can accurately evaluate the masticatory mucosa of the maxillary palatal side, it will provide an anatomical basis for clinicians to select the feeding site and make treatment plans for autologous soft tissue transplantation. Therefore, this article will affect maxillary palatal side related factors and the method for measuring the thickness of the soft tissue to conduct a comprehensive overview.*

Keywords: *Palatal side, The thickness of chewing mucosa, Methods of measurement*

1. Introduction

The palatal side of the upper jaw is composed of two parts: the anterior two-thirds of the hard palate and the posterior one-third of the soft palate. The anterior two-thirds of the hard palate belongs to the masticatory mucosa. Maxillary palatal side of masticatory mucosa lamina propria, thick collagen fiber bulky, closely packed net-like, and lamina propria of the nipple and more long, and the epithelial spikes in finger sets, formed the good mechanical attachment, the action of external force can effectively prevent the epithelium and the connective tissue separated [1-2]. As the main donor site, the palatal masticatory mucosa has the following advantages: the tissue structure is consistent with the keratinized tissue attached to the alveolar ridge; The elasticity and number of epithelium can be taken into account to provide a comfortable base for the denture. Provides adequate organization for the retreat of one or more adjacent areas; The grafted connective tissue was color-matched with the adjacent tissue. Surgical sequelae (if any) are rare [3].

The application of maxillary palatal masticatory mucosa not only includes the periodontal problems for the purpose of widening the keratinized gingiva around natural teeth or implants and correcting the root exposure of gingival recession, but also can effectively control plaque and slow down the process of gingival tissue recession, so as to maintain good oral function, aesthetics and comfort. In addition, vestibular groove deepening and alveolar ridge expansion can not only improve the thin alveolar ridge, provide sufficient keratinized gingiva, but also effectively increase the depth of vestibular groove, creating favorable conditions for the restoration of later removable denture [4]. 2mm keratinized gingiva is the minimum biological width of the implant. Otherwise, it will increase the risk of peri-implantitis, directly affect the osseointegration of the implant, and reduce the survival rate of the implant. However, most of the edentulous patients have insufficient width of the attached gingiva due to prolonged tooth loss, excessive bone defects, and gingival atrophy. Therefore, for patients with poor soft tissue quantity and quality in implant surgery, it is necessary to perform mucogingibular surgery to adjust the structure of dental silver tissue, which can not only increase the thickness of soft tissue, the width of keratinized gingiva, and improve the aesthetic effect of restoration. It can also greatly reduce the risk of peri-implant gingival recession and lay the foundation for long-term functional and aesthetic coordination in the later stage [5]. At the same time, it can solve the related repair of cleft area in cleft palate patients and reduce the probability of periodontal disease caused by difficulty in cleaning. It can also perform preventive connective tissue transplantation before orthodontic treatment to increase the thickness of labial soft tissue and change the thin gingival type, which can effectively reduce the problems of gingival recession, "black triangle" formation, and poor stability of palatal side anti-graft implantation [6]. In addition, the mucosal tissue in this area has been widely used in various fields of medical research, such as eyelid surgery, lip reconstruction, tracheoplasty, and closure of tongue and cheek defects after tumor resection

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[1].

The importance of maxillary palatal masticatory mucosa has reached a consensus in related fields: it is the basis of various oral soft tissue augmentation surgery and the main donor site. Therefore, this article will provide a comprehensive overview of the related factors and measurement methods that affect the thickness of maxillary palatal soft tissue.

2. Related factors affecting the thickness of palatal masticatory mucosa

2.1 The age

Age is a related factor for the thickness of the maxillary palatal masticatory mucosa. In the study of 40 patients by Kuriakose and Raju[7], the average thickness of the maxillary palatal masticatory mucosa was found to be (2.48±0.03) mm, ranging from 2.07 mm to 3.00mm. Young (17-29) set of mucous membrane thickness (2.40±0.04 mm) than the old group (30 to 45 years old) of mucous membrane thickness (2.56±0.04 mm) to thin, is through the application of bone detection technology to measure directly, Compared with the study of Wara-aswapati et al. [8], the data of Kuriakose and Raju's study were smaller, which was similar to the results of Stipettić et al. [9]. Heil A et al. [10] found that with the increase of age, the thickness of palatal mucosa continued to increase, and the largest increase occurred at the age of 40. Song et al. [11], when using CT to measure the palatal mucosal thickness, also found that the mucosal thickness increased with age. The possible reasons are as follows: 1) The normal keratinized epithelium on the surface of soft tissues increases and the cellular component decreases with aging, and the hard palate tissue shows age-related changes and becomes thicker; 2) The palate contains submucosa, which contains adipose tissue, and adipose glands will be deposited with the increase of age [12]. Therefore, clinically, it is not that the older the age and the thicker the palatal mucosa are, the better the connective tissue will be obtained. It is possible that this increase in thickness is caused by the deposition of adipose glands, but the actual available dense fibrous connective tissue is not increased. However, Wara-aswapat et al. [8] believed that the mucosal thickness of the younger age group was thin, but the measured mucosal thickness was still between 1.9 mm and 5.0mm, from which enough soft tissue could be obtained for autologous transplantation.

2.2 Gender

It was found that [13-14] when the thickness of palatal and maxillary nodule soft tissue was measured by direct method in 50 periodontal healthy people, it was found that the palatal mucosa thickness of male patients was thicker than that of female patients except for the first molar and maxillary nodule area. Wara-Aswapati [8] measured the palatal masticatory mucosa thickness of 31 females and 31 males. Data analysis showed that the mucosal thickness of the female group was 2.93mm, and that of the male group was 3.1mm. There was a significant difference between males and females, and the thickness of the male palatal mucosa was greater than that of the female at the same age, which was similar to the results of Muller HP et al. [15]. However, Heil A et al. [10] showed that there was no statistically significant difference between genders in palatal masticatory mucosa thickness. The reasons for the two different results may be attributed to factors such as case selection criteria, measurement methods, and ethnic differences, so further exploration is needed.

2.3 Race

Kuriakose et al. [7] measured the palatal mucosal thickness of healthy Indians and found that the average mucosal thickness from canine to premolar was (2.48±0.03) mm. This thickness was different from that found by Wara-aswapat et al. [8] in Asians. However, Yaman et al. [16] found that the average thickness of Turkish palatal mucosa was (2.55±0.49) mm when studying the thickness of Turkish palatal mucosa with gingival recession by direct detection method, which was also found to be slightly thinner than the previous measurement of palatal soft tissue thickness by the same or different methods. Khalid N. Said et al. [17] measured the palatal mucosa thickness of 60 healthy Jordanian (Middle East) people using the penetrating gingival detection technique and found that the average thickness was 3.23±0.46 mm, which was higher than the results of previous studies. This difference may be related to race and measurement methods.

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2.4 Morphology of palatine fornix and position of teeth

Reiser et al. [18] believed that the morphology of the palatine fornix is an important parameter, which is the key to obtain more soft tissue for transplantation without damaging the palatine neurovascular bundle. Therefore, in their study, they classified the palatine fornix into the following categories according to the distance between the cementoenamel junction and the maxillary palatine neurovascular bundle: When the soft tissue was extracted from the premolar area, it was found that the high and middle foraminal groups had thicker mucosal thickness than the low foraminal group, which had a safer boundary for operation. SHormdee D [19], etc. The study also showed that the thickness of palatal vault shape can be used as evaluation of graft of one of the supporting data. Zhang Jianzhong et al. [20] found that the mucosal thickness of maxillary anterior teeth in high palatal fornices was greater than that in low palatal fornices. Shen Luchen et al. [21] also found that there was no difference in the palatal mucosal thickness of the first premolar, second premolar and first molar in different palatal fornices, but the second molar mucosal thickness of the high palatine fornices was less than that of the low palatine fornices, and the canine mucosal thickness of the low palatine fornices was less than that of the high palatine fornices. Cheng Xiaofan et al. [22] found that the maxillary premolar area should be selected as the main donor site for maxillary palatal flap transplantation. Karadag I et al. [23] also observed that the thickest mucosa in the palatal region was located in the premolar region, and the palatal mucosa was thinner in females. In addition, in patients with palatal vault deeper, palatal mucosal thinner. To define the anatomical distribution of the greater palatine nerve canal bundle and the greater palatine foramen can not only ensure the effectiveness of anesthesia, but also help to determine the shape trend of the greater palatine nerve vascular bundle, and guide the clinical work such as the acquisition of palatal tissue flaps, palatal surgery and maxillary implant implantation. Reduce the possibility of complications such as hemorrhage, tissue necrosis or paesthesia caused by damage to the greater palatine neurovascular bundle, and provide reference for the formulation and implementation of surgery and accurate evaluation of prognosis [39]

2.5 Periodontal biotype

In 1969, Ochsenbein and Ross proposed two main gingival morphologies, namely thin fan type and thick flat type. Subsequently, Seibert and Lindhe proposed the term "periodontal biotype" and also divided it into thin fan type and thick flat type [24]. When Muller HP et al. [25] studied the chewing mucosa in individuals with different periodontal biotypes, they divided 40 healthy subjects into three groups according to the standard parameters of cluster analysis (tooth width/length ratio of maxillary anterior teeth, gingival thickness, and gingival width) : ClusterA1 (8 male and 6 female, thin gingiva, narrow gums, teeth, long and thin), ClusterA2 (5 male, 10 female, slender thin gingiva, gums, teeth, wide), ClusterB (wide thick gum, gum, fangyuan teeth); Multiple linear regression analysis showed that the mucosal thickness was significantly related to gender. The mucosal thickness of females was 0.3mm thinner than that of males. At the same time, it was found that the palatal mucosa of individuals with thin and narrow labial gingival (ClusterA1) was significantly thinner than that of individuals (ClusterA2 and ClusterB), which proved the hypothesis. In other words, the palatal mucosa of individuals with thin gingiva and narrow gingiva on the labial side of the maxillary anterior teeth was significantly thinner than that of individuals with thin gingiva and wide gingiva on the labial side. In addition, Yaman et al. [16] also confirmed that there is an interaction between the mucosal thickness of the buccal and palatal areas.

3. The palatal side masticatory mucosa thickness measurement method

3.1 Bone probe or transgingival probe technique

Bone probing or trangingiva probing technique is a method to measure the thickness of palatal tissue after direct invasive puncture to the bone surface with calibrated instruments such as periodontal probes under local anesthesia [26]. Detection of bone or wear gum detection technology is required under local anesthesia, is the most common clinical technology, but will bring the patient discomfort and fear; At the same time, the accuracy of general measurement data is poor under the double influence of local anesthesia and inflammation. More importantly this approach is usually implemented immediately before the surgery, and must be under local anesthesia, may lead to clinical doctors in donor area for organizations found local anesthesia zone thickness is not enough to connective tissue transplants, thus affect the operation process; In addition, tissue displacement and re-exploration during exploration may

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affect the measurement results [27-28].

3.2 Magnetic resonance imaging (MRI)

MRI is the preferred method for head and neck imaging, which can provide good visualization of soft tissues. It is also a non-invasive method, its imaging technology is widely used, and does not involve ionizing radiation. However, MRI has not been demonstrated in oral imaging. Due to the lack of three-dimensional sequence, relatively low resolution, long examination time, high cost, long imaging time, many contraindications, complex interpretation of signal changes, and limited equipment, its application in oral soft tissue measurement is limited [10]

3.3 Ultrasonic measuring

Kydd et al. [29] proposed for the first time that the thickness of oral mucosa could be obtained by ultrasonic devices. At present, scholars have invented many ultrasonic devices to measure the thickness of masticatory mucosa. The main principle is to send ultrasonic waves towards the bone surface at the site of the mucosal surface, reflect ultrasonic waves after touching the bone surface, and then receive back sound waves, and then calculate the thickness of the mucosa [15]. Some scholars [30-31] have studied the accuracy and reliability of ultrasonic measurement of oral mucosal thickness. They believe that the difference in the accuracy of ultrasonic measurement of mucosal thickness in different parts of the mouth depends on repeated measurement, and ultrasonic measurement is difficult to be repeated. Ultrasonic measurement is a non-invasive method, tissue trauma is small, easy to operate; However, there are also disadvantages such as high price, high technical requirements, poor repeatability and low reliability [32]. Due to the differences in the anatomy of the palatal soft tissue, especially in the thicker tissue area, when the height of the palatal dome is greater than 6mm, the data measurement is limited due to the influence of tissue signal attenuation and adjacent structures [11].

3.4 CBCT

Cone beam computerized tomography (CBCT) measurement is a direct or indirect measurement of the thickness of the palatal masticatory mucosa using a palatal soft tissue isolation device and impression technology. It was first used in the department of Stomatology in 2000. Now through the 3 d image display each anatomical structures are widely used in the oral cavity, provides high quality diagnosis basis for clinicians, and became one of the necessary tool use in dental clinical doctors work [33-34]. Barriviera etc. [35] for the first time, the reform of CBCT, thus found the palatal side of soft tissue can be clearly observed and measuring, data on the thickness of CBCT provide accurate mucosal thickness measurements in measurement, similar to the previous application of physical methods of measuring values. Gupta et al. [27] found that there was no significant difference between the data of palatal mucosa thickness obtained by CBCT and the data obtained by direct bone detection, which again proved that CBCT was a reliable measurement method of palatal soft tissue. CBCT is also a reliable measurement method for the other anatomical structures of hard tissues on the palatal side of the maxilla: the morphology of the palatal vault and the position of the greater palatine foramen [5, 36]. CBCT has the following advantages: concentrated beam, low radiation, high image quality, patient comfort, and reasonable price. The image acquisition ratio of CBCT is 1:1, and the data accuracy is high, which can be reused for multiple times and obtain a large amount of information. Bilateral measurements can be performed in the same image, which is helpful for clinicians to select the appropriate donor site. In addition, the image can be saved and multiple measurements can be performed on the computer or hard disk. CBCT as a non-invasive measuring method, for clinical doctors to provide a high quality, accurate diagnostic images, to get the extensive application in the field of oral medicine, especially in periodontics, planting and oral and maxillofacial surgery [37-38].

4. Conclusions

The application of autologous tissue transplantation has been extended from periodontal root coverage to restoration, aesthetic remodeling before implant treatment, and prevention and treatment of orthodontic patients with thin gingiva. However, the condition of soft tissue defect sites and individual palate donor sites are different in clinical practice, which leads to the change of surgical plan and operation method with the specific object of clinical implementation [39-40]. The hard palate mucosa in the anterior teeth area has palatal wrinkle, which affects the appearance after transplantation. Therefore,

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the area of hard palate mucosa for soft tissue graft is mainly concentrated in the posterior teeth area. At present, most relevant studies are limited to the hard palate mucosa within 12mm from the gingival margin, and it is believed that graft obtained within this range can avoid intraoperative damage to the greater palatine neurovascular bundle [11]. Measurement of the hard palate mucosa thickness within this range shows that the premolar area is significantly larger than the molar area, so the premolar area is an ideal donor site for graft in the hard palate.

The thickness and volume of soft tissue grafts are important factors in determining the prognosis of soft tissue transplantation. Soft tissue grafts with sufficient thickness can fully cover the root surface of gingival recession and ensure a good blood supply after transplantation. Thin palatal mucosa often leads to too thin grafts extracted from the donor site, causing graft shrinkage and necrosis, and affecting the long-term stability of soft tissue transplantation. At the same time, the smaller the thickness of the residual soft tissue on the periosteum of the donor site, the incidence of postoperative pain and other discomfort symptoms will also increase the mucosal thickness. There is a large difference between individuals. The size of the graft is significantly correlated with the position of the greater palatine neurovascular bundle and the thickness of the palatal mucosa. Therefore, it is necessary to measure the thickness of the maxillary palatal mucosa and determine the appropriate donor site before surgery. This article for the palate for transplant flap in the preparation of the foundation, the premise of the maxillary palatal side chewing the related factors affecting mucosal thickness, and its measuring method, a summarizes the advantages and disadvantages, the key points of operation, in order to provide the clinical workers more film gum surgery options, improve the patient's oral health and gingiva teeth aesthetic effect. More scholars are needed to conduct in-depth research on the mucosa of the maxillary and palatal donor sites.

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