2011년 2월
석사학위논문

Thickness of palatal masticatory mucosa with reference to the autogenous graft

조선대학교 대학원

치의학과

유 선 경

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자가이식을 위한 지표로써 입천장 씹기점막의 두께

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지도교수 김 홍 중

이 논문을 치의학 석사학위신청 논문으로 제출함.

2010년 10월   일

조선대학교 대학원

치의학과

유 선 경

유선경의 석사학위 논문을 인준함

위원장   조선대학교   교 수   국 중 기   인

위 원   조선대학교   교 수   김 도 경   인

위 원   조선대학교   교 수   김 홍 중   인

2010년   11월   일

조선대학교 대학원

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ABSTRACT

Thickness of palatal masticatory mucosa
with reference to the autogenous graft

Yu, Sun-Kyoung

Advisor: Prof. Kim, Heung-Joong, D.D.S., M.S.D., Ph.D.

Department of Dentistry,

Graduate School of Chosun University

The palatal masticatory mucosa is widely used the donor site for periodontal plastic surgery and posterior lamellar reconstruction of the eyelid. The purpose of this study was to measure the thickness of palatal masticatory mucosa and to assess the histologic characteristic with reference to the autogenous graft.

Ten cadaver heads (20 hemi-maxillae) with normal teeth were examined (8 male and 2 female, median: 59.3 years). These maxillae were decalcified and sectioned at interdental line from canine to 2nd molar perpendicular to midpalatal suture. The thickness of palatal masticatory mucosa was assessed at 24 standard measurement points defined according to the cementoenamel junction and midpalatal suture using a periodontal probe. And then the sectioned specimens were processed for embedding in paraffin and were stained with haematoxylin-eosin (H&E).

The mean thickness of palatal masticatory mucosa according to tooth site was 3.73 ± 1.19 ㎜ (canine distal), 3.65 ± 1.11 ㎜ (first premolar distal), 3.46 ± 1.11 ㎜ (second premolar distal), 2.93 ± 1.08 ㎜ (first molar midline), 2.98 ± 1.11 ㎜ (first molar distal), and 3.24 ± 1.86 ㎜ (second molar distal), with the thinnest area at the first molar midline region. And they

increased from the cementoenamel junction towards midpalatal suture, with 2.40 ± 0.85 ㎜ (3 ㎜ under the cementoenamel junction), 2.75 ± 0.82 ㎜ (6 ㎜), 3.63 ± 1.05 ㎜ (9 ㎜), and 4.51 ± 1.29 ㎜ (12 ㎜). On histologic features, the lamina propria decreased towards the posterior palatal area and mid palatal suture. In contrast, the submucosa which presents the glandular and adipose tissue increased towards the posterior palatal area and mid palatal suture.

These results suggest that the most appropriate donor site for gingival and posterior lamella repair is the 6 ㎜ to 9 ㎜ area under the cementoenamel junction on canine to premolar region.

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Key Words: Palatal masticatory mucosa, autogenous graft, lamina propria, submucosa

I. INTRODUCTION

The palatal masticatory mucosa is widely used a various field, because it is a rigid and unmovable tissue and contains the dense collagen fibers and abundant capillary loops. In plastic surgery, it is used the donor site to reconstruct posterior lamellar of the eyelid for the tarsus and the conjunctiva (Ito et al. 2007). In dental surgery, it is also used as an autogenous donor material to recover the function and the esthetic in periodontal plastic surgery for root coverage, for alveolar ridge augmentation, for vestibuloplasty, and for papilla reconstruction, etc. (Langer and Langer 1993, Seibert and Salama 1996, Hall and O'Steen 1970, Azzi et al. 2001). And it can be placed the orthodontic implant, because the palatal masticatory mucosa provides stable, biocompatible, and free from site specificity for intraoral anchorage (Kim et al. 2006).

Especially, when the palatal masticatory mucosa is used as an autogenous donor material for connective tissue graft, the grafted material can be shrinkage if it is too thin, and be problems with revascularization and healing if it is too thick (Mörmann et al. 1981). So, Hwang and Wang (2006) recommend that for use the palatal masticatory mucosa as an autogenous donor material in periodontal plastic surgery needs to exist a critical threshold thickness more than 1.1 ㎜. Therefore, the thickness and dimensions of donor tissue harvested are important for the successful attachment and treatment.

The many researchers evaluated the thickness of palatal masticatory mucosa for various methods. Östlund (1958) investigated histological and histopathological features on oral masticatory mucosa under biopsy, and Studer et al. (1997) measured the thickness as direct bone sounding using a periodontal probe in patients. Müller et al. (1999) measured the thickness of oral soft tissue using an ultrasonic device, and Song et al. (2008) measured the thickness using the computerized tomography. However, these results can occur some errors, because the hard palate features in various sizes and shapes and each method has limitations of measurement; technique sensitive, bleeding after probing, hematoma formation, paresthesia, and limit with a depth, etc.. Also, the research materials related histological evaluation of palatal masticatory mucosa are relatively few as donor site.

Therefore, this study was carried out to measure the thickness of palatal masticatory mucosa using a periodontal probe and to assess the histologic characteristics in human cadavers for determining the dimensions of donor site obtained with reference to the autogenou graft.

II. MATERIALS AND METHODS

1. Materials

In this study, ten Korean cadaver heads (20 hemi-maxillae) were examined (8 male and 2 female). The cadavers were donated to Department of Anatomy, Chosun University School of Medicine for educational purposes. This cadaver heads were with the age at death ranging from 40 to 74 years (median: 59.3 years). To measure the thickness of palatal masticatory mucosa according to tooth site was chosen the sample included from first premolar to second molar.

2. Sample preparation

All the specimens were decalcified in a decalcification solution (8 N formic acid + 1 N sodium formate) for 1 month. Then the specimens were neutralized in the distilled water for 12 hours. Each maxilla specimen was horizontally sectioned at interdental line from canine to second molar perpendicular to midpalatal suture included midline of the first molar using a Microtome blade (Feather Co, Osaka, Japan) (Fig. 1).
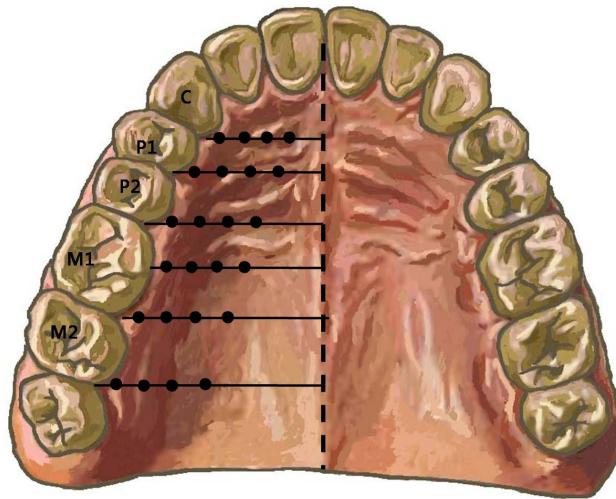

Fig. 1. Diagram showing the definition of the 24 points for measurement of the palatal masticatory mucosa. C, canine; P1, first premolar; P2, second premolar; M1, first molar; M2, second molar.

3. Measurement of the palatal masticatory mucosa

The sectioned specimens were evaluated at the total 6 coronal planes in canine distal, first premolar distal, second premolar distal, first molar midline, first molar distal, and second molar distal (Fig. 1). The sectioned specimens were measured at 4 points starting from the 3 ㎜ under cementoenamel junction with an interval of 3 ㎜ parallel to the surface of palatal masticatory mucosa (Fig. 2). This 3 ㎜ under cementoenamel junction for first point was chosen because periodontal disease is a common phenomenon in the old aged. And the thickness of palatal masticatory mucosa at 24 standard measurement points was assessed in direction perpendicular to the surface of palatal masticatory mucosa using a Periodontal probe (PCPNT156, Hu Friedy, USA) with a rubber stoper. For accuracy of the measurement, the rubber stoper was placed in contact with the palatal mucosal surface, and measurements attained on a probe were taken using a Vernier caliper (Mitutoyo, Japan) to a 0.01 ㎜ level. All measurements were carried out by the four investigators. Inter-observer agreement was high, therefore, the average of the 4 measurements was used as the final measurement for the thickness at each point.
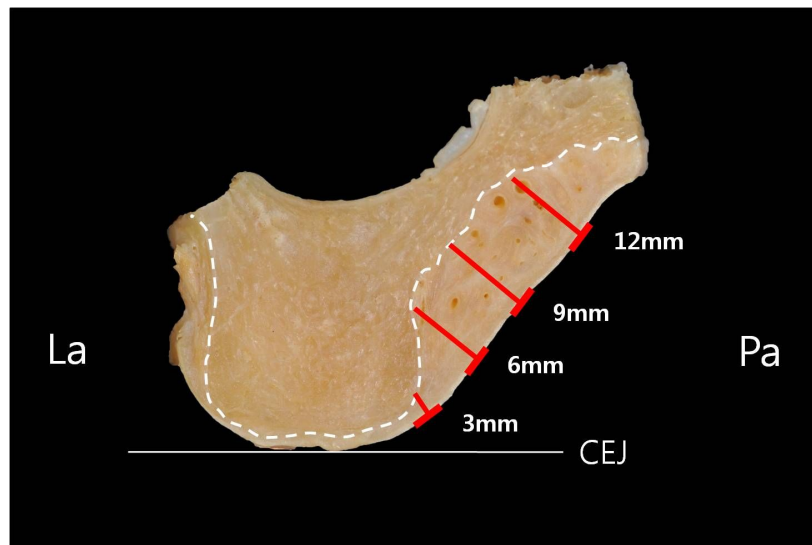

Fig. 2. Coronal view of interdental areas for measurement on the sectioned specimen. La, labial side; Pa, palatal side; CEJ, cementoenamel junction.

4. Tissue preparation

As an ordinary method, the sectioned specimens which were 4 coronal planes in canine distal, second premolar distal, first molar midline, and second molar distal were processed for embedding in paraffin and microsectioned to 7 μm thickness. The sectioned specimens were stained with haematoxylin-eosin (H&E), and observed by a light microscope with a 12.5 x and 40 x magnifications.

5. Statistical analysis

The data were analyzed the difference inter-observer using one-way ANOVA, and then evaluated post-hoc comparison. Also, the difference of between right and left sides was analyzed using one-way ANOVA. There was no significant difference, so each side measurement counted the same group. And all measurements were evaluated mean and SD. All statistical analysis was performed using SPSS 12.0 (Chicago, Illinois, USA). The significance level was set at $P < 0.05$.

Ⅲ. RESULTS

1. The thickness of palatal masticatory mucosa

1) The thickness of palatal masticatory mucosa at 24 standard measurement points

The thickness of palatal masticatory mucosa on tooth site decreased from canine distal to first molar midline but increased again in second molar distal, with the thickest at the canine distal region and the thinnest at the first molar midline region. At all tooth sites, the thickness of palatal masticatory mucosa increased towards under the cementoenamel junction. Overall, the thickness at 3 ㎜ under cementoenamel junction on the first molar midline (1.94 ± 0.55 ㎜) was the thinnest, and the thickness at 12 ㎜ on the second molar distal (5.09 ± 1.94 ㎜) was the thickest at all other points in the hard palate (Table 1).

Table 1. The thickness of palatal masticatory mucosa at 24 standard measurement points (mean±SD, (minimum – maximum), unit; ㎜)

	C-D	P1-D	P2-D	M1-Mid	M1-D	M2-D
3 ㎜	2.67±0.74 (1.75-4.50)	2.63±0.67 (1.60-3.98)	2.34±0.76 (1.25-3.75)	1.94±0.55 (1.13-2.80)	2.43±0.83 (0.88-3.98)	2.42±1.24 (0.73-6.05)
6 ㎜	3.45±0.78 (2.28-5.75)	3.10±0.62 (1.83-4.13)	3.01±0.56 (2.18-4.03)	2.36±0.46 (1.75-3.33)	2.43±0.62 (1.50-4.05)	2.23±1.02 (0.50-4.40)
9 ㎜	4.15±0.96 (3.08-6.60)	4.17±0.77 (3.13-5.98)	3.99±0.64 (2.90-4.90)	3.34±0.68 (2.33-5.05)	2.95±0.67 (1.88-4.13)	3.23±1.63 (1.33-6.98)
12 ㎜	4.64±1.23 (3.00-7.53)	4.70±0.90 (3.38-6.15)	4.49±0.95 (3.00-6.03)	4.08±0.98 (3.03-6.28)	4.10±1.28 (2.48-6.30)	5.09±1.94 (2.05-8.63)

Abbreviations; C, canine; P1, first premolar; P2, second premolar; M1, first molar; M2, second molar; D, distal surface of the tooth; Mid, midline of the tooth.

2) The mean thickness of palatal masticatory mucosa according to tooth site

The mean thickness of palatal masticatory mucosa according to tooth site was 3.73 ± 1.19 ㎜ (canine distal), 3.65 ± 1.11 ㎜ (first premolar distal), 3.46 ± 1.11 ㎜ (second premolar distal), 2.93 ± 1.08 ㎜ (first molar midline), 2.98 ± 1.11 ㎜ (first molar distal), and 3.24 ± 1.86 ㎜ (second molar distal), with the thinnest area at the first molar midline region (Table 2).

Table 2. The mean thickness of palatal masticatory mucosa according to tooth site (unit; ㎜)

	C-D	P1-D	P2-D	M1-Mid	M1-D	M2-D
Mean±SD	3.73±1.19	3.65±1.11	3.46±1.11	2.93±1.08	2.98±1.11	3.24±1.86

3) The mean thickness of palatal masticatory mucosa according to distance from the cementoenamel junction

The mean thickness of palatal masticatory mucosa according to distance from the cementoenamel junction increased from the cementoenamel junction towards midpalatal suture, with 2.40 ± 0.85 ㎜ (3 ㎜ under the cementoenamel junction), 2.75 ± 0.82 ㎜ (6 ㎜), 3.63 ± 1.05 ㎜ (9 ㎜), and 4.51 ± 1.29 ㎜ (12 ㎜) (Table 3).

Table 3. The mean thickness of palatal masticatory mucosa according to distance from the cementoenamel junction (unit; ㎜)

	3 ㎜	6 ㎜	9 ㎜	12 ㎜
Mean±SD	2.40±0.85	2.75±0.82	3.63±1.05	4.51±1.29

2. The histologic characteristics of palatal masticatory mucosa

On histologic features, the thickness of palatal masticatory mucosa decreased towards the posterior palatal area and mid palatal suture. Especially, the papillary layer thickness of lamina propria distributed plenty of capillary loops and the reticular layer thickness of lamina propria

composed of dense collagen fibers also decreased in the same direction. In contrast, the submucosa thickness increased towards the posterior palatal area and mid palatal suture. The majority of increased submucosa was composed the glandular and adipose tissue protected the palatal neurovascular bundle (Fig. 3).
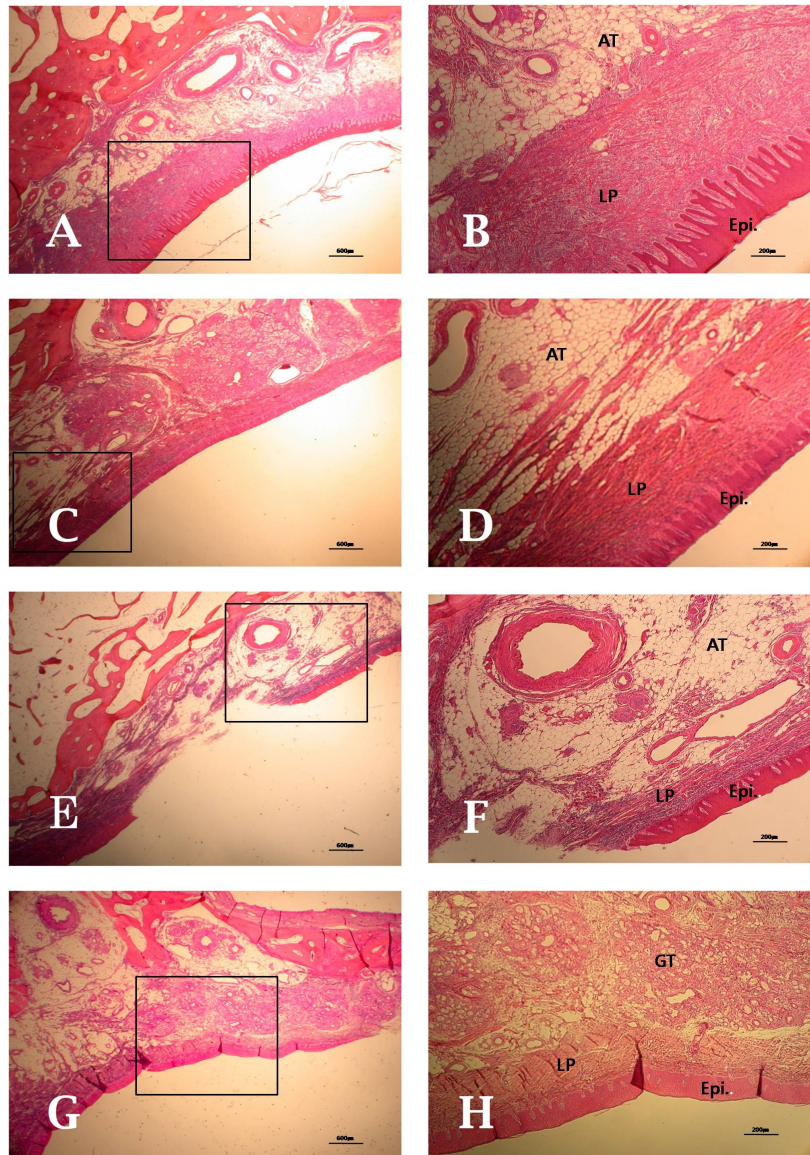
Fig. 3. The histologic characteristics of palatal masticatory mucosa. The thickness of palatal masticatory mucosa decreased towards the posterior palatal area and mid palatal suture. In contrast, the submucosa thickness increased towards the posterior palatal area and mid palatal suture. A and B, canine distal; C and D, second premolar distal; E and F, first molar midline; G and H, second molar distal. A, C, E, and G with a 12.5 x, and B, D, F, and H with a 40 x magnifications. H & E stain. (AT, adipose tissue; Epi, epithelial layer; GT, glandular tissue; LP, lamina propria layer)

IV. DISCUSSION

The palatal masticatory mucosa is widely used the donor site for periodontal plastic surgery and posterior lamellar reconstruction of the eyelid. During and after surgery, thick graft donor tissue simplifies manipulation and maintains vascularity, but delays a period of healing (Hwang and Wang 2006). And thin graft donor tissue promotes a period of healing, but could be shrinkage (Mörmann et al. 1981). Therefore, before surgery, surgeons should have a thorough knowledge of the anatomy of palatal masticatory mucosa for the successful attachment and treatment.

In this study, the thickness of palatal masticatory mucosa on tooth site decreased from canine distal (3.73 ㎜) to first molar midline (2.93 ㎜) but increased again in second molar distal (3.24 ㎜). These results have a few differences with the results measured by other methods. Wara-aswapati et al. (2001) reported using a bone sounding method that the thickness according to distance from gingival margin on canine was 2.0 ㎜ (3 ㎜ under gingival margin), 2.7 ㎜ (6 ㎜), 2.4 ㎜ (9 ㎜), and on first molar was 2.1 ㎜ (3 ㎜), 2.9 ㎜ (6 ㎜), 4.1 ㎜ (9 ㎜), and on second molar was 2.7 ㎜ (3 ㎜), 3.8 ㎜ (6 ㎜), 6.0 ㎜ (9 ㎜). Although it has the difference at the placement of the measurement points, that thickness were thinner than this study. These differences could appear because of the pressure against the palate on probing and the presence anesthesia (Kydd et al. 1971). Müller et al. (1999) reported using an ultrasonic device that the thickness of the first and second premolar were 2.71 ㎜ and 3.50 ㎜, respectively. Also, they found that this technique was non-invasive, valid, and reliable method but presented a measurement error of 0.54 ㎜ and had limitations in sites with a mucosal thickness more than 6 ㎜. And Song et al. (2008) reported using the computerized tomography that the mean thickness of palatal mucosa was 3.46 ㎜ at canine, 3.13 ㎜ at first molar, and 3.39 ㎜ at second molar. Moreover, this method was non-invasive, free in sites, and the data can be stored, but an error during tomographic taken and the difference interexaminer on reading could occur. Although the result of this study was a little the difference the thickness of previous researches, the tendency was similar that the thickness of palatal masticatory mucosa decreased from canine distal to first molar midline but increased again in second molar distal.

Likewise, it was presented the difference in the various measurement method. However, it is

possible that the difference of palatal masticatory mucosa thickness may be due to the race, the age, and the body weight. Stipetić et al. (2005) reported that the mucosa for the individuals of higher body weight was significantly thicker than that of lower body weight. It is to hypothesize that body weight has an effect on the amount of adipose tissue in the palatal submucosa layer, as a result, the palatal masticatory mucosa thickness was also increased (Wara-aswapati et al. 2001). These hypothesis could explain that the thickness in Caucasians reported by Studer et al. (1997) was thicker than that in Asian obtained many researchers (Wara-aswapati et al. 2001, Stipetić et al. 2005, Kim et al. 2006), the older age reported by Wara-aswapati et al.(2001) was thicker than the younger age, and in males reported by Östlund (1958) was thicker than in females. This study was not evaluated the comparison with the gender and age because of the limitation in a number of cadavers. Further studies will reveal the difference with the gender and the age on the palatal masticatory mucosa thickness.

In this study, the thickness on the first molar midline was the thinnest at all other points in the hard palate. This corresponded with the results of Studer et al. (1997). This results could explain that the palatal mucosa on the palatal root of the first molar is subject to restriction for graft harvesting. And the thickness at 12 ㎜ under cementoenamel junction on the second molar distal was the thickest, the same retromolar tissue reported by Müller et al. (1999) was thick with 4.46 ㎜. It may be due to the presence of exostoses transitional to maxillary tuberosity. Studer et al. (1997) also reported that the soft tissue thickness of tuberosity was more thicker than the palate. However, according to Methathrathip et al. (2005), the greater palatine foramen located at the palatal aspect of the third molar and 2.1 ㎜ anterior to the posterior border of the hard palate. Although the palatal mucosa on second molar distal region was thick, therefore, it required more careful during the graft harvesting.

On histologic features, as the thickness of palatal masticatory mucosa decreased towards the posterior palatal area, the lamina propria layer also decreased in the same direction. In contrast, the submucosa included the glandular and adipose tissue increased towards the posterior palatal area and mid palatal suture. These results also showed that the donor site for connective tissue graft become narrow toward the posterior palatal area. And some first molar distal samples appeared soft palate muscle, it also required more careful.

Guyot et al. (2004) reported that the graft on the hard palate mucosa can be harvested up to a 40 x 20 ㎜ for posterior lamella repair. Reiser et al. (1996) reported that the donor tissue

could be taken approximately 5 to 8 ㎜ in height. Thus, to provide the dimensions of the donor site obtained, this study evaluated the distribution of the various palatal masticatory mucosa thickness under consideration both the thickness and histologic characteristic of palatal masticatory mucosa on Fig. 4. The white color showed a danger zone for the thin palatal mucosa, and the gray color showed a safety zone for the thick palatal mucosa and an abundant lamina propria and a little submucosa to use the donor site. And the black color appeared a careful zone because a palatal neurovascular bundle exists 7 to 17 ㎜ away from the cementoenamel junction in the palatal bony groove (Reiser et al. 1996) (Fig. 4).
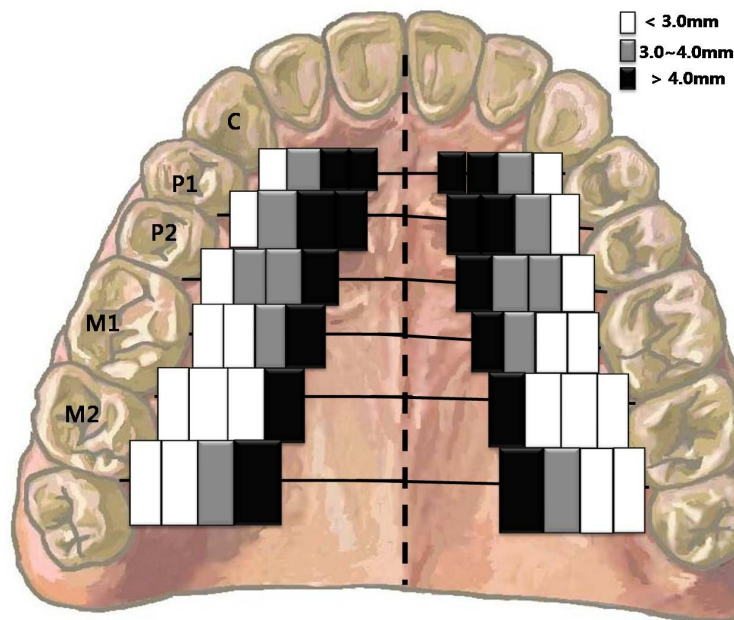

Fig. 4. Topography showing the distribution of the various palatal masticatory mucosa thickness.

In conclusion, the thickness of palatal masticatory mucosa was the thickest at the canine distal region and the thinnest at the first molar midline region. Therefore, the 6 ㎜ to 9 ㎜ area under the cementoenamel junction on canine to premolar region seems to be the most appropriate donor site for gingival graft and posterior lamella reconstruction, because it contains uniformly abundant lamina propria and a few submucosa.

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ABSTRACT in KOREAN

자가이식을 위한 지표로써 입천장 씹기점막의 두께

유 선 경

조선대학교 대학원 치의학과
(지도교수 : 김 홍 중)

입천장 씹기점막은 치주 성형수술이나 눈꺼풀의 후방 층판 재건을 위한 공여 부위로 널리 사용되고 있다. 따라서 본 논문의 연구에서는 자가이식을 위한 지표로써 입천장 씹기점막의 두께를 계측하고 그 조직학적 특징을 평가하고자 하였다.

정상 치아를 가지고 있는 시신 10구에서 얻어진 위턱뼈를 사용하였으며, 사망 시 연령은 40에서 74세로 평균 59.3세였다. 얻어진 위턱뼈를 탈회시킨 후, 정중입천장봉합에 수직으로 송곳니부터 둘째 큰어금니 사이 부위를 절단하였다. 시멘트질사기질접합에서 정중입천장봉합 부위를 따라 설정한 24개의 표준 계측점에서 치주 탐침을 이용하여 입천장 씹기점막의 두께를 계측하였다. 이후 절단된 절편은 조직학적 관찰을 위하여 통법에 따라 파라핀 포매 과정을 거쳐 haematoxylin-eosin (H&E) 염색을 시행하였다.

치아 위치에 따른 입천장 씹기점막의 평균 두께는 송곳니 원심에서 3.73 ± 1.19㎜, 첫째 작은어금니 원심에서 3.65 ± 1.11㎜, 둘째 작은어금니 원심에서 3.46 ± 1.11㎜, 첫째 큰어금니 중앙부위에서 2.93 ± 1.08㎜, 첫째 큰어금니 원심에서 2.98 ± 1.11㎜ 및 둘째 큰어금니 원심에서 3.24 ± 1.86㎜로 첫째 큰어금니 중앙부위에서 가장 얇았다. 또한 시멘트질사기질접합부터 정중입천장봉합 부위까지 거리에 따른 입천장 점막의 두께는 시멘트질사기질접합 하방 3㎜에서 2.40 ± 0.85㎜, 6㎜에서 2.75 ± 0.82㎜, 9㎜에서 3.63 ± 1.05㎜ 및 12㎜에서 4.51 ± 1.29㎜로 아래로 내려갈수록 두꺼워지는 경향을 보였다. 조직학적인 특징은 고유층의 두께가 후방 부위와 정중입천장봉합 부위로 갈수록 점점 감소하였다. 이와 대조적으로, 샘조직과 지방조직을 포함하고 있는 점막하층의 두께는 후방 부위와 정중입천장봉합

부위로 갈수록 점점 두꺼워졌다.

　본 연구의 결과로, 송곳니와 작은어금니 부위 시멘트질사기질접합 하방 6㎜부터 9㎜까지의 부위가 균일하고 풍부한 고유층을 가지고 있으며 점막하층이 얇기 때문에 치주 수술이나 눈꺼풀 후방 층판 재건을 위한 공여 부위로써 가장 적합하다고 사료된다.

저작물 이용 허락서

학 과	치의학과	학 번	20097147	과 정	석사
성 명	한글: 유 선 경　　　　　영문: Yu, Sun-Kyoung				
주 소	(500-838) 광주광역시 북구 오치동 968-6번지				
연락처	E-MAIL: moonlight-sky@hanmail.net				
논문제목	한글: 자가이식을 위한 지표로써 입천장 씹기점막의 두께 영문: Thickness of palatal masticatory mucosa with reference 　　　 to the autogenous graft				

　본인이 저작한 위의 저작물에 대하여 다음과 같은 조건아래 조선대학교가 저작물을　 이용할 수 있도록 허락하고 동의합니다.

- 다　　　음 -

1. 저작물의 DB구축 및 인터넷을 포함한 정보통신망에의 공개를 위한 저작물의 복제,
　 기억장치에의 저장, 전송 등을 허락함
2. 위의 목적을 위하여 필요한 범위 내에서의 편집·형식상의 변경을 허락함. 다만,
　 저작물의 내용변경은 금지함.
3. 배포·전송된 저작물의 영리적 목적을 위한 복제, 저장, 전송 등은 금지함.
4. 저작물에 대한 이용기간은 5년으로 하고, 기간종료 3개월 이내에 별도의 의사 표시가
　 없을 경우에는 저작물의 이용기간을 계속 연장함.
5. 해당 저작물의 저작권을 타인에게 양도하거나 또는 출판을 허락을 하였을 경우에는
　 1개월 이내에 대학에 이를 통보함.
6. 조선대학교는 저작물의 이용허락 이후 해당 저작물로 인하여 발생하는 타인에 의한
　 권리 침해에 대하여 일체의 법적 책임을 지지 않음
7. 소속대학의 협정기관에 저작물의 제공 및 인터넷 등 정보통신망을 이용한 저작물의
　 전송·출력을 허락함.

동의여부 : 동의(O)　반대(　)

2011년　 2월　　 일

저작자:　　 유 선 경　　　 (서명 또는 인)

조선대학교 총장 귀하