

Original report

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The Anatomical Study of the Sinew String Observed on the Buccal Mucosa of Mandibular Second Molar and Posterior of Retromolar Pad

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This study is clinical research about the sinew string observed on the buccal mucosa of mandible that did not attract attention very much so far. In case of the dentulous jaw, this sinew string was observed between distal areas of the second molar and the third molar of mandible. And in case of the edentulous jaw, it was observed on the retromolar pad. The incidence of this sinew string was about 10% by ocular inspection in both dentulous and edentulous jaws. In case of the dentulous jaw, the origin of this sinew string was positioned at 2.9 mm buccal and 2.3 mm distal from the center of distal margin of the second molar. In case of the edentulous jaw, the origin was positioned at 2.4 mm buccal and 1.4 mm distal from the center of anterior ridge of retromolar pad.

Author thought that this sinew string was working to regulate moving of buccal mucosa and to retain horizontal buccal space on the buccal shelf. And it helped to block posterior region of vestibule of the mouth.

Key words : sinew string, retromolar pad, functional movement of oral mucosa

I. Introduction

Precise observation of human oral cavity may reveal frenum like or wrinkle like irregularity of buccal mucosa from about the distal surface of the lower second molar through the third molar as for dentulous jaws, and from around the anterior border of the retromolar pad through posterior regions for edentulous jaws (**Fig.1**). Furthermore, when you push to extend the external oblique line of buccal mucosa outwardly, you will see one or more sinew like lines of mucosal tension in white color. They can be seen more clearly by pushing it even when

simple eye observation can hardly discern it. Although its width, thickness, and attachment origin are varied among individuals in minor difference, it often rises in sinew like string at predefined positions. The author has reported in many occasions that this mucosal tension is not a simple mucosal wrinkle but a sinew like small string of mucosa that appears in association with buccal mucosal movement and tension^{1,2}. This sinew string has been confirmed widely among denture border design drafts, morphology diagrams that suggest its exhibition consciously, anatomy drawings and photos³⁻⁵, but its anatomical name has not been established since its physiological function or prosthodontic significance are not clearly defined⁶⁻¹¹. Furthermore, its proper name is not given nor its presence

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Fig.1 (Category 1) when it was simply seen - Left side.



Fig.2 (Category 2) when it was seen by pulling out the cheek sideways with finger or dental mirror - Left side.



Fig.3 (Category 3) when it became seen by pushing the buccal mucosa on the oblique line with finger or dental mirror - Right side.

is pointed out in partial prosthodontics or complete prosthodontics, either ¹²⁻²¹ .

For the past few years, however, various clinicians' articles are slowly referring to the sinew strings that move to attract the buccal mucosa inwardly as well as reports on establishing denture borders by taking into consideration of the sinew strings ²²⁻²⁷ .

The author, therefore, will demonstrate our observation methodology throughout the oral mucosa in regard to the sinew string and its involvement with other oral functions as far as our knowledge is available to the present.

II. Observation Method

We have both possible cases where the sinew string is clearly seen or it is hardly seen. And so we used three different categories of observation method as to cases when it was simply seen (**Fig.1**), when it was seen by pulling out the cheek sideways with finger or dental mirror (**Fig.2**), and when it became seen by pushing the buccal mucosa on the oblique line with finger or dental mirror (**Fig.3**). And five-grade assessment was made as follows,

1. Clearly visible
2. Visible
3. Slightly visible
4. Hardly visible
5. Not visible

Assessment was recorded in the survey chart which we designed originally (**Fig.4**).

This kind of assessment and recording is not based on any independent surveying device but on visual sketching, and so it is a kind of study that is less objective relying on a sole operator who observes and fills in the survey record. For instance, any possible human error of observation and

recording do happen and it cannot be prevented since no one but an author may confirm the presence of sinew string with excessive consciousness of its presence. Therefore in this study, the assessment grade of "1. Clearly visible" is taken as objective appearance ratio throughout each different observation method, and the grades of "1. Clearly visible", "2. Visible" and "3. Slightly visible" are accepted as appearance ratio in broad sense of the terms.

Period of assessment was limited to a month of August 20, 2001 through September 19, 2001 in order to prevent overlap, and 33 males and 44 females totaling 77 subjects were observed at right and left distal area of lower second molars and retromolar pads on both sides (n=154) without regard to dentulous and edentulous jaws.

As for the location of sinew string, in case of dentate arch, as shown in **Fig.4**, the line that runs through the mesial and distal pits of the lower second premolar and the central fossae of the lower first and second molars is assumed as X axis of orthogonal coordinates. And the perpendicular line against this line that runs tangent to the posterior border of lower second molar is assumed as Y axis and they are recorded in the survey chart by measuring visually for calculating standardized values and standard deviation.

And in case of edentulous jaw, the line that connects the bucco-lingual center of retromolar pad and the residual ridge crest is assumed as X axis of orthogonal coordinates. And the perpendicular line against this line that runs tangent to the anterior border of retromolar pad is assumed as Y axis and they are recorded in the survey chart by measuring visually for calculating standardized values and standard deviation.

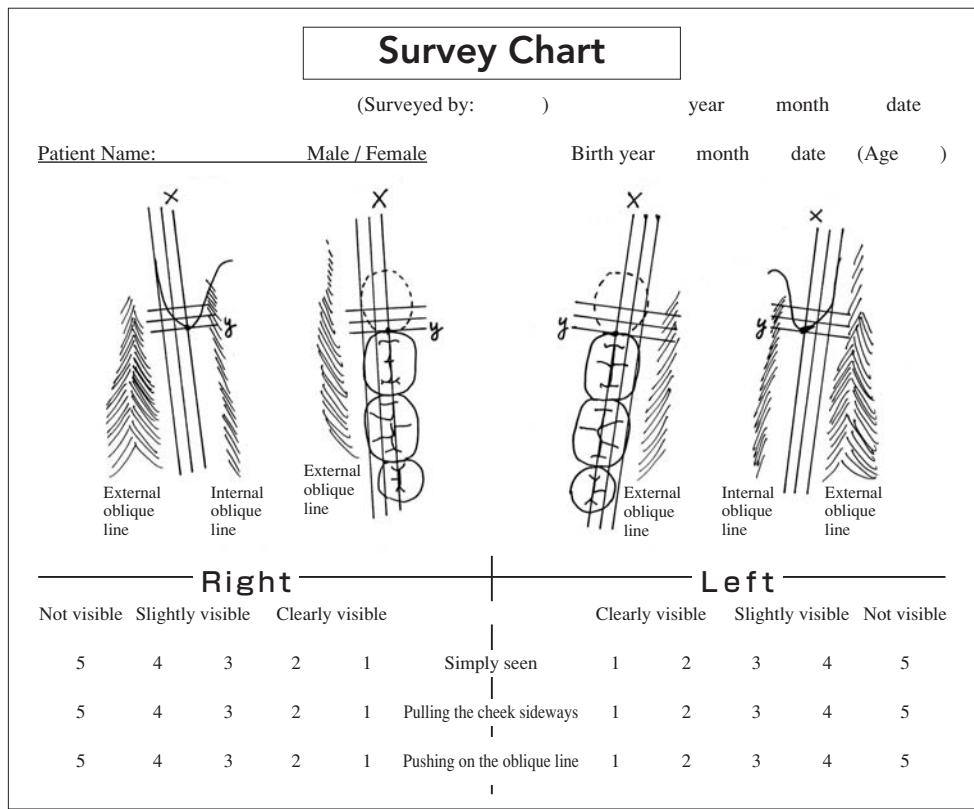


Fig.4 Survey chart of the sinew string.

	X	Y
Dentulous subjects n = 98	2.9 ± 0.6	2.3 ± 0.4
Edentulous subjects n = 56	2.4 ± 0.7	1.4 ± 0.4

Table 1 Mean coordinate values of origin points of sinew strings both in dentulous and edentulous subjects
Unit : mm(mean ± SD).

III. Results

1. Points of origin of sinew string

The points of origin were confirmed among dentulous subjects in 42 points for males, 56 points for females totaling 98 points. And among edentulous jaws, they were 24 points for males and 32 points for females totaling 56 points. And their coordinates were calculated for mean values and standard deviation. The results are shown in **Table 1** and **Fig.5**.

2. Appearance ratio and the ratio of broader sense

The results are shown in (**Figures 6~11**).

1) Case of dentulous jaws (Fig.6 ~ 8)

Appearance ratio (the ratio of broader sense in parentheses) of males (n=42) that belonged to category when it was simply seen was 12% (38%), and the assessment grade "5. Not visible" was 43%. As for females (n=56), ratio was 7 % (43%), and the assessment grade "5. Not visible" was 46%. As for totaling subjects (n=98), ratio

was 9% (31%) and the assessment grade "5. Not visible" was 45%.

Next, appearance ratio (the ratio of broader sense in parentheses) that belonged to category when it was seen by pulling out the cheek sideways with finger or dental mirror was 21% (60%) for males and 25% (81%) for females, totaling 23% (72%). And, appearance ratio (the ratio of broader sense in parentheses) that belonged to category when it was seen by pushing the buccal mucosa on the oblique line with finger or dental mirror was 26% (71%) for males and 13% (39%) for females, totaling 21% (53%).

In addition, as far as males and females with wisdom teeth are concerned (n=12), any sinew strings were nearly confirmed with eyes, but only 2 cases were confirmed when pushed on the oblique line in the buccal mucosa.

2) Case of edentulous jaws (Fig.9~11)

Appearance ratio (the ratio of broader sense in parentheses) of males (n=24) that belonged to category when it was simply seen was 9% (25%), and the assessment grade "5. Not visible" was 57%. As for females (n=32), ratio

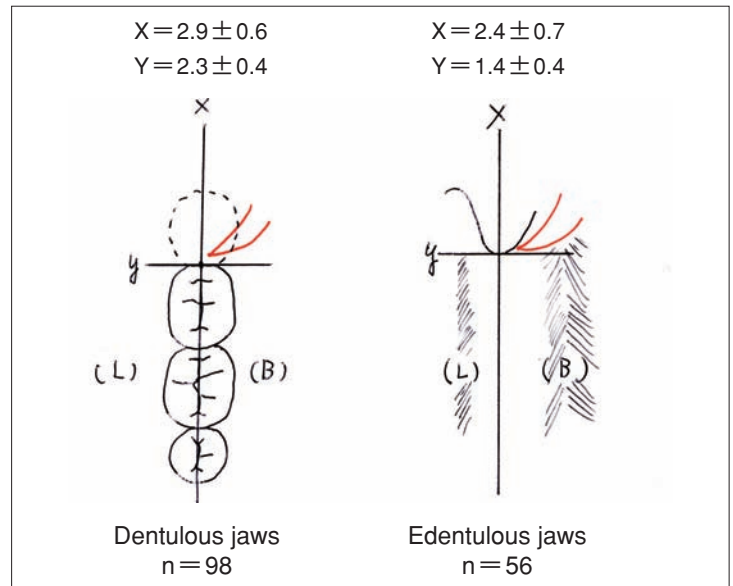


Fig. 5 Mean coordinate values of origin points of sinew strings both in dentulous and edentulous subjects.

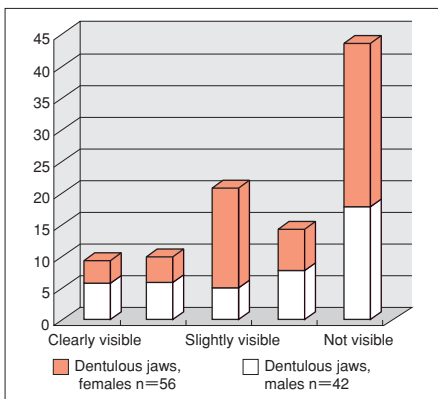


Fig.6 Sinew strings observed results by dentulous males/females (Simply seen).

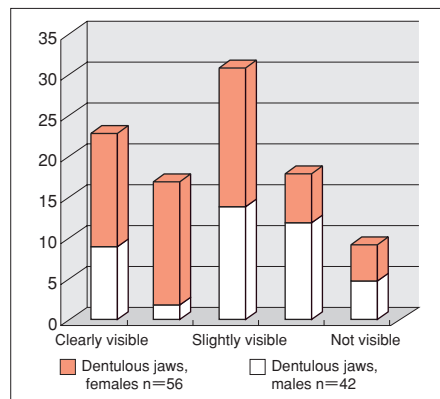


Fig.7 Sinew strings observed results by dentulous males/females (Cheek pulled with a mirror).

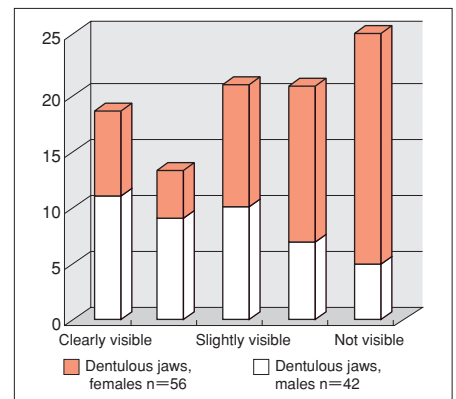


Fig.8 Sinew strings observed results by dentulous males/females (Pushed on the external oblique line).

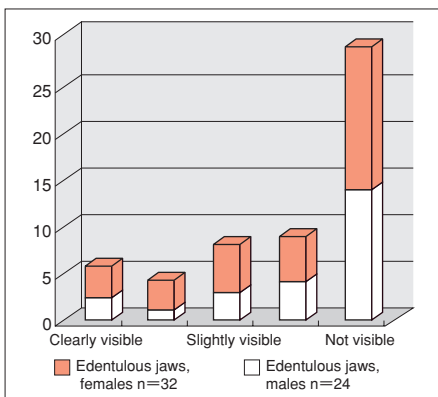


Fig.9 Sinew strings observed results by edentulous males/females (Simply seen).

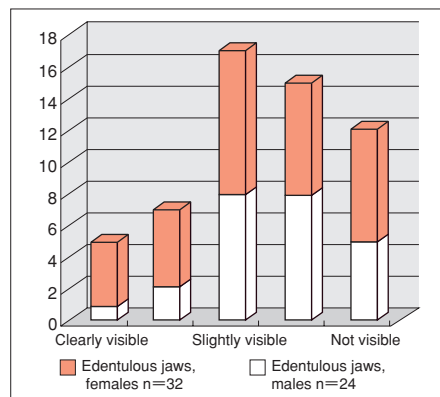


Fig.10 Sinew strings observed results by edentulous males/females (Cheek pulled with a mirror).

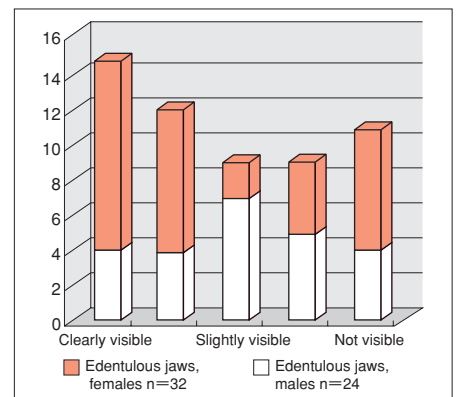


Fig.11 Sinew strings observed results by edentulous males/females (Pushed on the external oblique line).

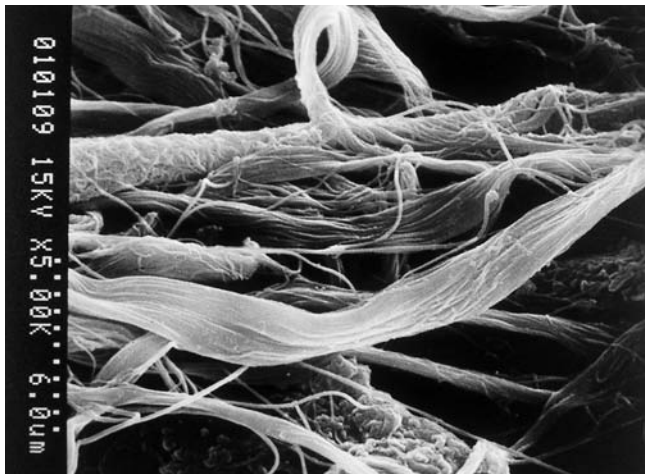


Fig.12 SEM image of sinew strings. Collagen fiber bundles running parallel to the sinew strings were confirmed below the sinew. (Courtesy of Department of Anatomy, Tokyo Dental College)

was 13% (36%), and the assessment grade "5. Not visible" was 47%. As for totaling subjects (n=56), ratio was 11% (32%) and the assessment grade "5. Not visible" was 51%.

Next, appearance ratio (the ratio of broader sense in parentheses) that belonged to category when it was seen by pulling out the cheek sideways with finger or dental mirror was 4% (46%) for males and 13% (56%) for females, totaling 9% (52%). And, appearance ratio (the ratio of broader sense in parentheses) that belonged to category when it was seen by pushing the buccal mucosa on the oblique line with finger or dental mirror was 17% (63%) for males and 34% (66%) for females, totaling 27% (64%).

3. Observation by SEM images (Courtesy of Department of Anatomy, Tokyo Dental College)

The tissues immediately below the sinew string that was macroscopically observed were dissected for SEM inspection, and collagen fiber bundles running parallel to the sinew strings were confirmed (Fig.12).

IV. Discussion

1. Close observation of the sinew string

In the dental arch with the second molar existing while the third molar missing, the anterior segment of the sinew is originated from the alveolar mucosa around the distal portion of the second molar and inserted into the buccal

mucosa while extending toward posteriorly. In case the portion that is originated from the alveolar mucosa (origin point) is attached to the underneath alveolar bone and periosteum with connective tissues, it is easy to identify the sinew untouched even with eyes. On the other hand, if the sinew is pulled with finger or dental mirror, it happens to move together with the alveolar mucosa from the base of origin point. In other words, the sinew may not be attached with the periosteum in this instance, and then in such a case it is difficult to identify the sinew with eyes. Also when the jaw has a half-impacted wisdom tooth, the sinew strings are often originated from the buccal mucosa that is not attached with the bone or periosteum that covers the wisdom tooth. And it is considered that they are hardly detected only with eyes.

And in the dental arch where the first, second and third molars are missing, the retromolar pads are created. In this case the sinew strings are originated from around the anterior border of the retromolar pads and are extended and inserted into the buccal mucosa.

2. Survey results

1) Origin point of sinew string

Survey standard of sinew strings for dentate jaws is based on the distal portion of lower second molar, and their average origin points among males and females are 2.3 mm posterior from the lower second molar antero-posteriorly, and, horizontally, about 2.9 mm in the buccal direction from the line that connects the mesial and distal pits of the lower second premolar, and the central fossae of the lower first and second molars.

And for edentulous jaws, survey standard of sinew strings is based on the retromolar pads, and their average origin points throughout males and females are about 2.4 mm posterior to the retromolar pads antero-posteriorly, and, horizontally, about 1.4 mm in the buccal direction from the most anterior border of the pads.

These mean values will help us to find the sinew strings more effectively for effective occasion.

2) Appearance ratio

Such a low value of 10% of appearance ratio showed without regard to dentulous or edentulous jaws in the observation category when it was simply seen. Furthermore the ratio of absolutely no visibility of sinew

showed about 40~50% and no significant difference between dentulous and edentulous subjects.

As described above, discovery rate of clinicians who are not conscious of sinew strings will be 10% or around. But for a dentist like the author who has been long conscious of sinew strings, the discovery is easy and is confirmed about twice as much as 20 % of ratio as shown in the broader sense of terms throughout dentulous and edentulous males and females.

Now as for the different categories of observation, appearance ratio when it was seen by pulling out the cheek sideways with finger or dental mirror was about 20% among dentulous males and females. Next as for appearance ratio when it was seen by pushing the buccal mucosa on the oblique line with finger or dental mirror, which is more easily found, was higher rate of about 30% among dentulous males and females. Therefore it is known that these observation methods are effective to raise the appearance ratio by pulling out the cheek sideways with finger or dental mirror or by pushing the buccal mucosa on the oblique line with finger or dental mirror, even when the sinew is not seen simply with eyes.

For edentulous jaws, however, the appearance ratio was not improved so much as for dentulous jaws even when alternative observation method was taken. Reasons may be speculated that occlusal forces (masticating forces) are decreased due to the tooth loss and associated with decline in function of oral mucosa with weak mucosal responses that prevent to uplift the sinew strings.

3. Involvement of sinew strings with oral functional movements

Research of sinew strings for roles in oral functions is not yet advanced from fields of physiology and prosthodontics. Functional movements of oral mucosa in the mouth closing are not visible because they are inside the cheek. And any observation device has not yet been developed to track their behaviors scientifically, either. And so, as an advance notice, the author admits that the following views regarding functions and roles of the sinew string are not yet scientifically established, but they are organized with fragmentary knowledge gathered together from observing impressions, stone models, and status of oral mucosa at the time of the mouth opening and closing.

Meanwhile the author believes that this report will help clarify the functional movement of oral soft tissues in the future, and so only personal opinion will be presented here suggesting anatomical significance of existence of sinew string and its role.

1) Functional movement of oral cavity as digestive canal

In conventional dentistry, what to expect of various organs in the oral cavity is firstly the presence of teeth to chew food with, to occlude, and next the tongue moves to help for occlusal and masticatory functions. Then the buccal mucosa moves together with lips of mouth, and finally ends in swallowing.

But when viewpoint is switched to see the oral cavity as part of digestive canal and assume to take the dentition away from the oral cavity, the mouth is an entrance of long cannular opening enclosed with mucous membrane which is similar to other digestive ducts. At the same time it is the opening of air duct. And food intake is processed for feeding into this duct space, and then lips of mouth, teeth, dentition, alveolus, tongue and oral mucosa are all the organs where the food is segmented and mixed together (mastication) with liquid component (saliva). And the food mixture is carried deep into the digestive canal (swallowing), and for this purpose, the oral mucosa is present here backed up with muscles of the tongue and the cheek.

2) Morphological characteristics of oral cavity in digestive canals

Tooth contact of upper and lower arches through mouth closing and occluding will separate the cannular form of oral cavity into the lingual space and buccal space (oral vestibule). When the mouth opens, the buccal mucosa will touch the dental arches tightly and the vestibule will be closed. And again the oral cavity returns to a state of single cannular space and this cycle of return will repeat. In this instance the space volume of oral cavity will vary extensively.

3) Structural aspects of oral cavity

Moreover one surface of this canal is backed up with bones, and the hard parts (palate, dentition, alveolus) attached to the bones are always present. Even when the space is divided in two segments through occluding, one surface is all the same with hard tissues such as dentition

and alveolus.

As above, the oral cavity, contrary to the digestive ducts located further than the pharynx, is the digestive canal that is comprised surrounding with immovable mucosa (palate, dentition, and alveolus) and movable mucosa (mucosa of tongue, cheek and lips) with their forms changeable. In other words, this is the digestive canal that is surrounded with a large, powerful, active and elastic tongue, a stretchable and resilient cheek, a soft oral mucosa which is movable through pushed with muscle layers inside, and an immovable hard palate, dentition and alveolar mucosa.

4) Oral functional movement viewed from different hardness of oral mucosa

In addition to above, in order to find some functions of tongue and oral mucosa, movements associated with mastication will be discussed taking an example. Assume that you have a rubber bag and two different kinds of food inside. You try to crash the food in the sealed bag from outside to mix them, but it cannot be mixed well because the bag is elastic to blow up toward the other side. But if you hold and push the bag on the hardness of floor or wall surface, you can mix them easier. When this analogy is applied to an oral cavity, you have the softness of tongue within the dental arch of hardness alongside as well as the hard palate above. The dentition holds and crashes the food while the tongue mixes it with the help of wall hardness of arches and palate. If you perceive sensation of food size too large yet to be swallowed, you repeat the crashing by loading the food again on the hard arches. Then you push the tongue to palate, alveolus and dentition sequentially in order to narrow the oral cavity from forward to backward, and then swallow finally.

5) Oral functional movement viewed from the balance of oral cavity and food bolus

The oral cavity opens to expand its space to take food and narrows it when you crash food on dentition by closing the lips trying not to let it out of the mouth. When you close the lips, the oral cavity is narrower than at the time of food intake, and so the occluded food bolus cannot be accommodated only within the lingual side and extra is pushed outside into the buccal side. Its volume is variable every time, and a temporary balance is given to this kind of protrusion by absorbing the extra protrusive force with the help of soft cheek wall. And the food bolus, together with

what runs off outside of the dentition, is mixed with soft cheek and hard teeth as like a hard wall and is guided to the lingual side where the mastication is more efficient by carrying the food mixture which is on the teeth arches or which is from the posterior region of the arches.

As above, the digestive duct called the oral cavity, contrary to the digestive organ such as stomach and intestines that carry the food bolus in thick paste sequentially (vermicular motion), is extremely peculiar enough to combine the hard and soft tissues cooperatively in order to crash, mix, and change the food bolus properly in size for swallowing.

Now like this, the author thinks that the sinew string, our main subject here, is deeply involved with the functional movement of buccal mucosa.

6) Masticatory movement and sinew string

At the time of occlusion and mastication of food bolus, as described above, extra food volume that is not contained in the dentition and buccal space (buccal oral vestibule) would extend and blow up the buccal mucosa temporarily in the outward direction. This bloated up cheek would attract to raise the sinew string that is present in the posterior portion of the oral vestibule. Owing to the fact that the sinew string which is buried in the cheek mucosa is made of collagen bundle with quality of rigid extension (**Fig.12**), the sinew string would show up to rise relatively as the cheek blows up, the mucosa extends and the hard part gets left behind. The buccal mucosa surrounding the sinew string would create a border between the mucosal space which is capable with various functions including food mixture and the space which is not capable with the mixture movement in this area where mass of undigested food should not be long retained. And this border would become building up a wall in the posterior portion of the buccal vestibule. This wall at the same time works to guide food mass into the oral vestibule with sufficient space which is already lax and available after prior mastication completed, and this guidance will help to enter another new masticatory cycle to compress food mass to alveolus and dentition.

Because the origin point of sinew string is normally about 2 ~ 3 mm away from the distal site of the second molar (**Table 1, Fig.5**), it seems that the sinew string would rarely influence the periodontal tissues even if it moves

jointly according to the buccal mucosal movement.

The wall of mucosa, majorly consisting of the sinew string, which is raised with the masticatory movement, is in the distal region of the second molar, and so the wall works to envelope the distal surface of the second molar. This repeated mucosal movement linking with mastication moves to push out the food bolus of the distal surface of the second molar, where the food is likely left behind, in cooperation with concerted compression of tongue and sublingual mucosa.

7) Missing teeth and sinew string

In case of missing first and second molars, the mucosa, being pulled by the sinew string, works as a separator around the distal and buccal region in the oral cavity, but in this missing area the sinew looks no help to oral functions more than this function, because the area may have already spacious room enough.

But if once any alternative alveolus and dentition is given with prosthesis in this missing area, the sinew string would pull in the surrounding mucosa to help masticatory efficiency like when the dentition existed at one time. And even when mastication is off working, the sinew string would help the denture plate border seal and marginal seal in the retromolar pad from the buccal area over the posterior buccal shelf, and the sinew string contributes greatly to stability of lower denture.

And contrary to the buccal frenum, being present also in the oral vestibule, that moves largely in the antero-posterior direction through linking with the buccal mucosa and that moves autonomously in responses to oral surrounding muscles, this sinew string does reveal when pulled by the buccal mucosa movement and is considered as more passive tissues.

But even if you push down the buccal mucosa strongly

to extend the external oblique line, no sinew string will show up in some case. And even in such a mouth, any defective oral functions are not seemingly confirmed by way of diagnostic interviews of objective or subjective means. Presumably the mucosal surface movement that is pressed from internally with submucosal tissues and muscles of temporal and cheek may function the posterior sealing in the buccal space in the same way that the sinew strings show up on the surface in the mouth.

V. Conclusion

1. Appearance ratio was about 10% both for dentulous and edentulous subjects.
2. The origin point of sinew string is present in 2.9 mm buccally, and 2.3 mm posteriorly from the distal site of lower second molar in a dentulous jaw, and in an edentulous jaw, it is in 2.4 mm buccally and 1.4 mm posteriorly from the center of anterior border of retromolar pad.
3. The sinew string supports functional changes of extension and contraction of oral vestibule while masticating, and, at the same time, it helps to seal the distal oral vestibule as needed in working harmony with dentition and alveolus.
4. In the missing posterior arch, presence of the sinew string contributes greatly to the marginal seal and stability of denture base in the oral mucosa over the areas from the buccal retromolar pad to the posterior buccal shelf, while on- and off-mastication and at mouth opening and closing. With the help of proper denture design that corresponds to the sinew string's behavior, it does not inhibit the mucosal movement here.

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