A retrospective study of risk factors for Suction-Effective Mandibular Complete Dentures

J Acad Clin Dentistry 2016;36:184-191.

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Keyword:mandibular complete denture, suction denture, suction concept, risk factors, mandibular tori

A suction-effective mandibular complete denture, which builds negative pressure on the interior surface by creating an effective seal around the entire border of the denture base with the oral mucosa, is resistant to lifting during mouth opening, and thus provides excellent clinical results in mandibular complete denture fabrication for fully edentulous patients. However, denture suction cannot be achieved in all cases. A questionnaire survey was conducted to identify and examine potential risk factors for denture suction.

Results: The extent of alveolar ridge resorption, amount of spongy tissue in the sublingual fold region, retromylohyoid fossa space available for denture base extension, shape of the retromolar pad, tongue retraction, and occlusal stability were identified as risk factors. The success rate of denture suction was significantly decreased when these factors were less favorable. There was no significant difference in the success rate with or without mandibular tori. The overall success rate of mandibular complete denture suction was 86.9%.

Conclusion: These findings suggest that it is important to pay attention to the 6 risk factors during patient examination and diagnosis in order to achieve a high success rate of mandibular complete denture suction.

Ii H. A retrospective study of risk factors for Suction-Effective Mandibular Complete Dentures. J Acad Clin Dentistry 2016;36:184-191.

INTRODUCTION

Suction effective mandibular complete dentures have been gaining popularity globally since the introduction of the underlying suction effective denture concept by Abe[1,2] in 1999 (Fig. 1). The reason behind this is that we can now reliably fabricate mandibular dentures that do not lift during function without the help of commercially available denture adhesives or implants by following the suction concept.

Suction effective dentures are based on the concept of generating strong negative pressure between the denture border and the alveolar mucosa by creating an effective seal around the entire denture border with mobile oral mucosa. This effective seal comprises 4 types of closure:

1) Internal/external double closure in the labiobuccal area
2) Internal/external double closure when the sublingual fold region is abundant with spongy tissue
3) Compensatory closure between the lateral aspect of the tongue root and the polished lingual surface of the denture base in the retromylohyoid fossa region
4) Contact closure between the interior surface of the denture base and the mucosal surface of the retromolar pad (interior seal), and contact closure created by the side of the tongue and the buccal mucosa above the retromolar pad (exterior seal)

Mandibular complete denture fabrication according to the suction concept greatly increases the chances of achieving effective suction compared with conventional denture fabrication techniques[3].

However, effective suction may not always be achieved even with the use of this technique. What is the probability of obtaining effective suction when mandibular complete dentures are fabricated based on the suction concept? What are the effects of factors inhibiting mandibular denture suction on the success rate? Answers to these questions are unknown.

I therefore conducted a questionnaire survey involving dentists and dental technicians well versed in the suction concept with the aim of identifying factors inhibiting mandibular complete denture suction, and performed statistical analyses of their responses.

METHODS

This study included 11 dentists and 2 dental technicians with 10 years or more of clinical experience who are familiar with the suction concept. They were asked about their fully edentulous mandibular cases treated with mandibular complete dentures fabricated according to the suction concept. The number of cases enrolled in this study totaled 175. Denture stability was tested with the thumb and forefinger pulling the denture horizontally in parallel with the occlusal plane. When the examiner felt negative pressure during this test, the denture was rated as “suction effective”. When no negative pressure was felt, it was rated as “suction ineffective”. Seven factors potentially inhibiting mandibular denture suction were also investigated in each case. Odds ratios and 95% confidence intervals (CIs) were calculated. P values of less than 0.05 were regarded as statistically significant in this study. The probability of achieving effective suction

Fig. 1 Suction-effective mandibular complete denture
A suction-effective mandibular complete denture is fabricated with the objective of sealing the entire border of the denture base. Negative pressure generated on the internal surface of the denture base prevents the denture from lifting, which greatly improves patient satisfaction.

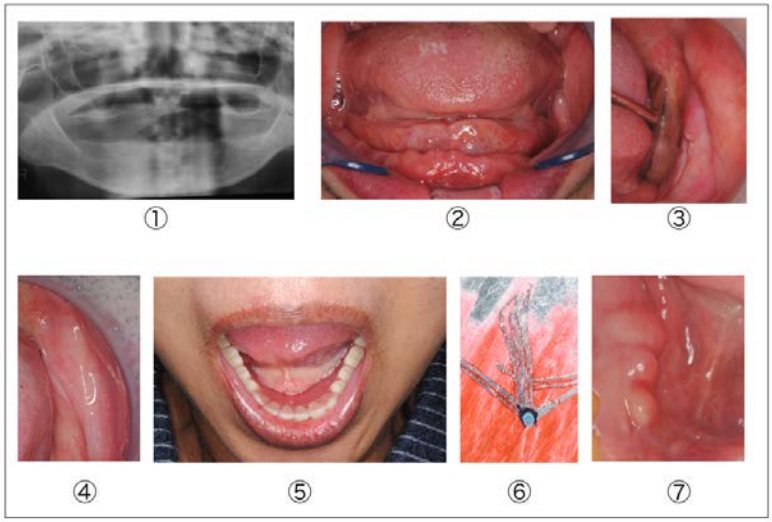

Fig. 2 Potential risk factors investigated in this study
1. Extent of alveolar ridge resorption, 2. Amount of spongy tissue in sublingual fold region, 3. Amount of space in retromylohyoid fossa region, 4. Shape of retromolar pad, 5. Distance of tongue retraction, 6. Occlusal stability, 7. Presence of mandibular tori

of mandibular complete dentures fabricated according to the suction concept was also determined.

Factors potentially inhibiting mandibular denture suction (Fig. 2)

1. Extent of alveolar ridge resorption

Alveolar ridge resorption was classified by residual mandibular bone height according to the ACP (American College of Prosthodontists) guidelines[4,5] for complete edentulism:

(1) Type I and II: residual bone height of 16mm or greater at the least vertical height of the mandible
(2) Type III and IV: residual bone height of 15mm or less at the least vertical height of the mandible

2.Amount of spongy tissue in the sublingual fold region

(1) Sufficient amount of spongy tissue: spongy tissue is higher than the anterior alveolar ridge in closed mouth position when examined by retracting the cheeks with cheek retractors and asking the patient to open and close several times.
(2) Insufficient amount of spongy tissue: spongy tissue is not higher than the anterior alveolar ridge.

3.Amount of space in the retromylohyoid fossa region

(1) Sufficient space: a dental mirror can be inserted into the retromylohyoid fossa region without difficulty, indicating that sufficient space is available for denture base extension.
(2) Insufficient space: resistance is felt when inserting a dental mirror, indicating that sufficient space is not available for denture base extension.

4.Shape of the retromolar pad

(1) Favorable: large and pear-shaped
(2) Unfavorable: small and not pear-shaped

5.Distance of tongue retraction

(1) Less than 2 cm
(2) 2 cm or greater but less than 4 cm
(3) 4 cm or greater

6.Occlusal stability

(1) Stable: less than 2 mm distance between the gothic arch apex and tapping point
(2) Unstable: 2 mm or greater distance between the gothic arch apex and tapping point

7.Presence or absence of mandibular tori

(1) Absent
(2) Present

RESULTS

For 6 of the 7 risk factors investigated, except the presence or absence of mandibular tori, the probability of achieving effective suction was significantly decreased when unfavorable conditions were present (Table 1). The overall success rate of mandibular denture suction was 86.9%. The suction success rate for each of the 7 factors is shown below.

		odds ratio	95% confidence interval		p-value
			lower limit	upper limit	
Extent of alveolar ridge resorption		8.04	2.82	22.96	< 0.05
Amount of spongy tissue in sublingual fold region		11.67	2.64	51.51	< 0.05
Amount of space in retromylohyoid fossa region		6.33	2.50	16.00	< 0.05
Shape of retromolar pad		4.67	1.87	11.84	< 0.05
Distance of tongue retraction	2 ≦ x < 4cm	6.04	1.68	21.77	< 0.05
	≧4cm	33.75	5.87	194.00	< 0.05
Occlusal stability		8.92	3.38	25.58	< 0.05
Presence of mandibular tori		0.52	0.13	2.03	>0.05

Table 1 Results of statistical analysis of factors inhibiting mandibular denture suction

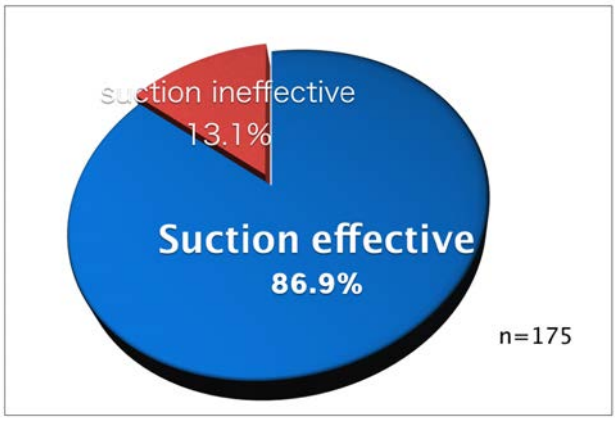

Fig. 3 Success rate of mandibular denture suction
Mandibular complete dentures fabricated according to the suction theory showed 86.9% of success rate.

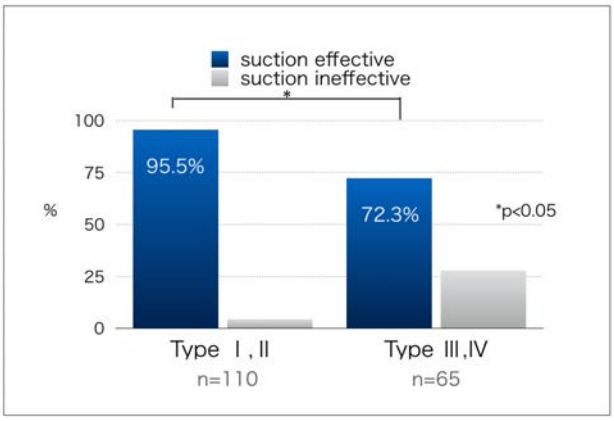

Fig. 4 Relationship between alveolar ridge resorption and success rate of mandibular denture suction
The success rate was significantly (*) lower with more extensive alveolar ridge resorption.

I.Overall success rate of mandibular denture suction (Fig. 3)

Of 175 cases included in this study, 152 cases or 86.9% showed effective suction of their mandibular complete dentures.

II. Relationships between the risk factors and success rates of mandibular denture suction

(success rate under each condition shown in percent)

1.Amount of alveolar ridge resorption (Fig. 4)
(1) Type I & II: 95.5% (105/110 cases)
(2) Type III & IV: 72.3% (47/65 cases)

2.Amount of spongy tissue in the sublingual fold region(Fig. 5)
(1) Sufficient spongy tissue: 97.6% (80/82 cases)
(2) Insufficient spongy tissue: 77.4% (72/93 cases)

3.Amount of space in the retromylohyoid fossa region (Fig. 6)
(1) Sufficient space: 93.1% (122/131 cases)
(2) Insufficient space: 68.2% (30/44 cases)

4.Shape of the retromolar pad (Fig. 7)
(1) Favorable: 92.7% (114/123 cases)
(2) Unfavorable: 73.1% (38/52 cases)

5.Distance of tongue retraction (Fig. 8)
(1) < 2 cm: 96.4% (81/84 cases)
(2) 2 cm to < 4 cm: 81.7% (67/82 cases)
(3) ≧4 cm: 44.4% (4/9 cases)

6.Occlusal stability (Fig. 9)
(1) Stable: 94.5% (121/128 cases)
(2) Unstable: 66.0% (31/47 cases)

7.Presence or absence of mandibular tori (Fig. 10)
(1) Absent: 87.6% (141/161 cases)
(2) Present: 78.6% (11/14 cases)

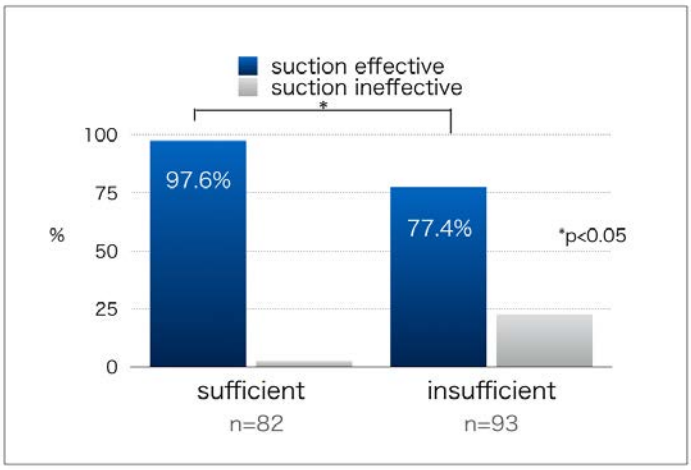

Fig. 5 Relationship between amount of spongy tissue in sublingual fold region and success rate of mandibular denture suction
The success rate was significantly (*) lower with insufficient spongy tissue.

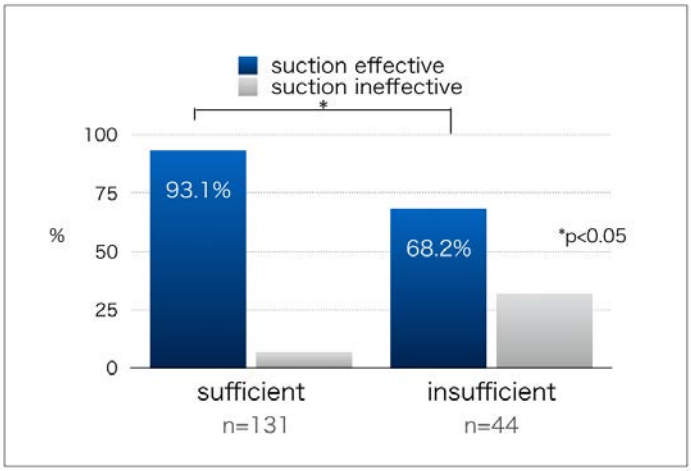

Fig. 6 Relationship between amount of space in retromylohyoid region and success rate of mandibular denture suction
The success rate was significantly (*) lower with insufficient space.

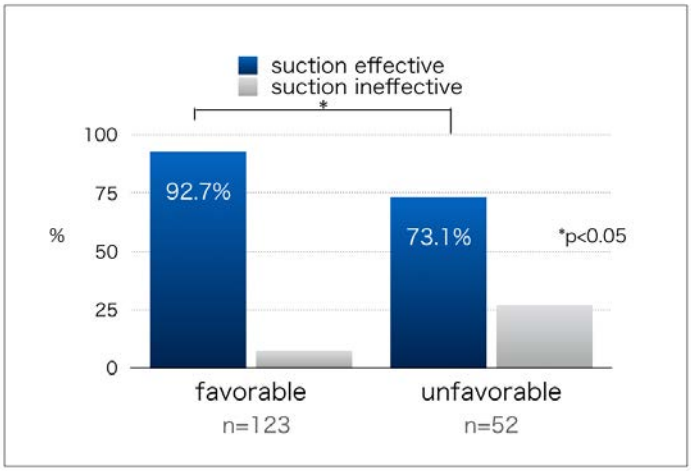

Fig. 7 Relationship between shape of retromolar pad and success rate of mandibular denture suction
The success rate was significantly (*) lower with unfavorable shape.

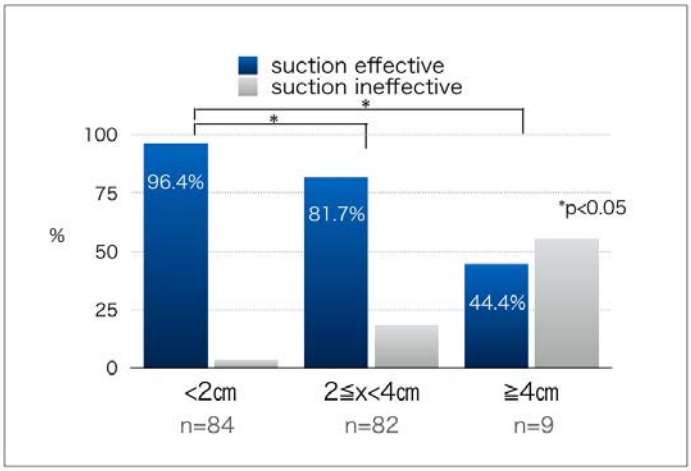

Fig. 8 Relationship between distance of tongue retraction and success rate of mandibular denture suction The success rate was significantly (*) lower with greater distances of tongue retraction.

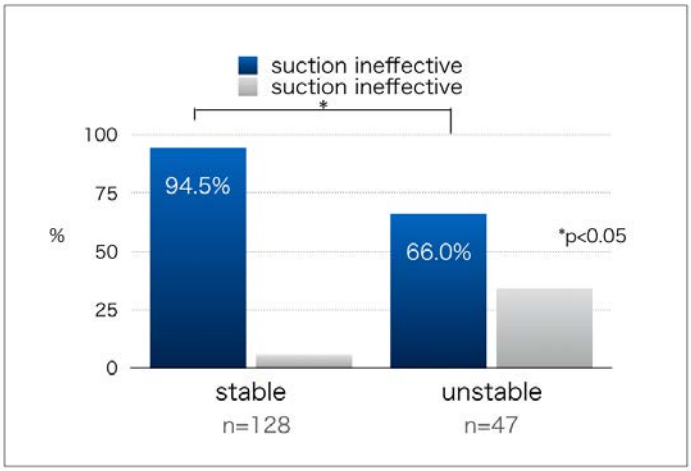

Fig. 9 Relationship between occlusal instability and success rate of mandibular denture suction
The success rate was significantly (*) lower with unstable occclusion.

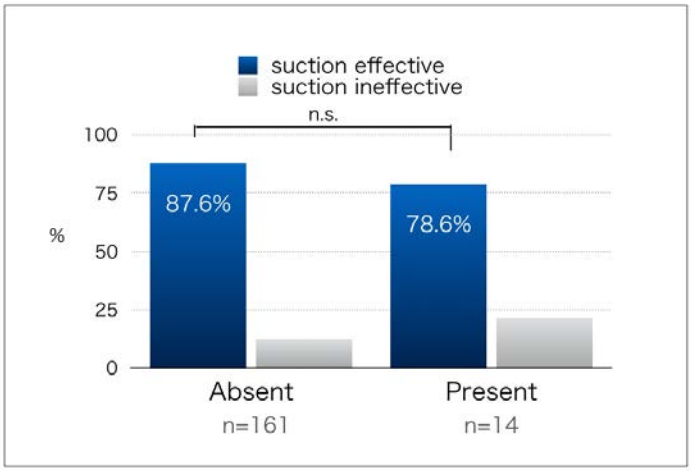

Fig. 10 Relationship between mandibular tori and success rate of mandibular denture suction
There was no significant difference with or without mandibular tori.

DISCUSSION

This study aimed to investigate the success rate in obtaining effective suction of mandibular complete dentures fabricated based on the suction concept and to identify factors inhibiting effective suction.

Knowing these factors is extremely important to increase the probability of achieving effective suction. Careful intraoral examination with attention to risk factors in each case would enable the clinician to determine the degree of difficulty in treating the case and plan treatment accordingly. If the possibility of achieving effective suction or improvement with therapeutic dentures is ruled out, alternatives treatment options such as implant overdentures could be proposed to ensure denture stability depending on the difficulty of the case.

Therefore, it is of utmost importance to examine the 6 risk factors identified in this study in order to determine the difficulty of achieving effective suction of mandibular complete dentures.

I.Overall success rate of mandibular denture suction

The overall success rate of mandibular denture suction in this study was 86.9%.
This high success rate indicates that mandibular complete dentures fabricated according to the suction concept have a high probability of remaining stable under negative pressure without lifting during mouth opening. This seems to greatly reduce dentists' and patients' stress due to denture instability.

Furthermore, there is a report that chewing movements are smoother in patients wearing suction-effective mandibular complete dentures than those wearing suction-ineffective ones[6]. It is conceivable that enhanced chewing function with suction-effective dentures will make denture wear more comfortable.

II. Relationships between the risk factors and success rates of mandibular denture suction(Table 1)

1. Extent of alveolar ridge resorption
The odds of mandibular denture suction decreased significantly with more extensive alveolar ridge resorption (odds ratio 8.04, 95% CI 2.82-22.96, $p<0.05$).

The mobility of buccal alveolar mucosa at the mucobuccal fold has been reported to be 2-3 times greater in the mandible than in the maxilla[7-9]. It is also known that a larger proportion of the alveolar mucosa, which is required for denture stability, is mobile in more difficult cases. These factors increase the difficulty of denture fabrication.

Dentures sitting on highly resorbed ridges tend to be more unstable and therefore more susceptible to peripheral air leakage and broken border seal, which may have contributed to the lower success rate observed in this study.

2. Amount of spongy tissue in the sublingual fold region
The success rate was significantly lower in patients with insufficient spongy tissue in the sublingual fold region (odds ratio 11.67, 95% CI 2.64-51.51, $p<0.05$). The sublingual folds are elongate crests elevated by the sublingual glands, lying between the underside of the tongue and gingiva[10]. Abe focused on spongy tissue present in the sublingual fold region. The lingual border of the custom tray stretches the mucosa in the sublingual fold region rich in soft spongy tissue during final impression, so that a thick imprint of the denture border area can be captured. This provides an extended area of contact between the denture base and the sublingual folds, which serves as the driving force for generation of negative pressure. This contact remains almost unchanged throughout tongue function, contributing to stable border seal.

In contrast, it is difficult to obtain a deep and wide imprint of the denture border area in the sublingual region without sufficient spongy tissue. Particularly in patients with excessive tongue retraction during mouth opening, border seal is easily broken due to air leakage in the sublingual fold region. This may explain the lower suction rate seen in the subgroup with insufficient spongy tissue in this region.

3. Amount of space in the retromylohyoid fossa region
The success rate was significantly lower with insufficient space in the retromylohyoid fossa region (odds ratio 6.33, 95% CI 2.50-16.00, $p<0.05$).
Sealing mechanism in this region is different from the contact closure found in other regions according to the suction

theory. Border seal in this area is called 'compensatory closure', which is obtained by extending the denture border 2 to 3 mm beyond the mylohyoid ridge to create a wall that resist tongue pressure when the tongue root presses against the lingual polished surface of the denture[3,11].

There seem to be two factors making it difficult to create this compensatory closure. One is 'horizontal

constriction' of this space due to excessive tongue strain or retraction and a resultant increase in lateral tongue pressure. The other factor is 'vertical constriction' of the space due to high position of the mylohyoid muscle attachment or excessive strain of this muscle, precluding extension of the denture border deep into the retromylohyoid fossa region.

4. Shape of the retromolar pad
The success rate was significantly lower with unfavorable shapes of the retromolar pad (odds ratio 4.67, 95% CI 1.87-11.84, $p<0.05$).

According to the suction theory, border seal in this region consists of the primary 'close contact closure of the interior side of the denture base and retromolar pad tissue' and the secondary 'close contact closure formed between the side of the tongue and buccal mucosa over the polished denture base surface in the retromolar pad'[3,11]. Regarding how much of the retromolar pad should be covered with the denture base, Abe considers it necessary to seal all denture borders, and recommends that the entire retromolar pad be covered to reliably seal all denture borders. Ichikawa reports that at least 2/3 of the retromolar pad should be covered for stable denture retention in the retromolar pad region[12].

Possible factors affecting mandibular denture suction in the retromolar pad region include the size of the retromolar pad, presence of fibrous tissue in its anterior 1/3, degree of its anterior inclination, and amount of its morphological change during opening and closing movements. Particularly when the retromolar pad is steeply inclined and as thin as a string, the denture becomes unstable due to a decreased area of contact between the mucosa in the retromolar pad region and the interior surface of the denture base, and increased tendency of the denture to slip forward. This may result in air leakage, broken seal, and loss of suction.

5. Distance of tongue retraction
The success rate was significantly lower with greater distances of tongue retraction (2-4 cm: odds ratio 6.04, 95% CI 1.68-21.77, $p<0.05$) (≧4 cm: odds ratio 33.75, 95% CI 5.87-194.00, $p<0.05$).

Wright et al. have shown that 25% of dentate individuals retract the tongue during mouth opening. In the present study, 48% (84/175 cases) had the habit of tongue retraction, suggesting that the incidence of tongue retraction may be higher in edentulous elderly than dentate individuals. This study also revealed that the larger the distance of tongue retraction, the greater the chance of broken seal in the lingual denture border area and the lower the probability of achieving mandibular denture suction. Particularly when the distance of tongue retraction is 4 cm or larger, the floor of the mouth is severely strained and spongy tissue in the sublingual fold region is tightly stretched. This may lead to air leakage and broken seal in the anterior lingual area.

6. Occlusal stability
The success rate was significantly lower when the occlusion was unstable (odds ratio 8.92, 95% CI 3.38-25.58, $p<0.05$). Abe, an anatomist, and others report that the temporomandibular joint (TMJ) structures are severely damaged in edentulous people compared with dentate people[14]. Tanaka and others have shown that 68.6% of patients wearing complete dentures have internal derangement of the TMJ[15]. These findings indicate that edentulous people may be more prone to occlusal instability.

The sole reason why occlusal instability lowers the probability of achieving effective suction is because the denture is mobile when the occlusion is unstable. Premature occlusal contacts will induce excessive denture mobility, causing air leakage and broken seal in denture border areas.

7. Presence or absence of mandibular tori
No significant difference was observed in success rate with or without mandibular tori. It is often difficult to provide adequate relief to prevent pain from excess pressure exerted by the denture on the mucosa over tori. Generally, those with tori have favorable ridge morphology and may not require suction mechanism for denture stability.

Conclusions

A questionnaire was sent to 11 dentists and 2 dental technicians with 10 or more years of clinical experience who are familiar with the suction theory to examine factors inhibiting mandibular denture suction. This study included 175 cases with mandibular or bimaxillary edentulism wearing mandibular complete dentures fabricated according to the suction theory. The following results were obtained:

. 1) The overall success rate of achieving effective suction was 86.9% for the mandibular complete dentures fabricated according to the suction theory.

. 2) The success rate was significantly lower when the following risk factors were present: more extensive alveolar ridge resorption, insufficient spongy tissue in the sublingual fold region, insufficient space in the retromylohyoid fossa region, unfavorable shape of the retromolar

pad, excessive tongue retraction, and occlusal instability. There was no difference in the success rate with or without mandibular tori. These results suggest that it is important to pay attention to 6 of the 7 factors investigated in this study, excluding mandibular tori, in the examination and diagnosis of edentulous mandibles in order to achieve a high success rate of mandibular denture suction.

The results also indicate that a high success rate can be achieved when mandibular complete dentures are fabricated according to the suction theory.

The author declares that there is no conflict of interest regarding the publication of this paper.

Acknowledgement

I would like to express my heartfelt gratitude to Dr. Jiro Abe for his guidance from the stage of study design. My deep appreciation also goes to 13 dentist and dental technician members of the Japan Plate Denture Association for their cooperation.

References

1. Abe J. Clinical practice of complete denture: to attain the lower complete denture suction [in Japanese]. J Nippon Dental Review 1999;679:159-174;680:125-139;681:141-157.
2. Abe J. Lower Complete Denture Suction That Everyone Can Achieve.Tokyo:Hyoron Publishers, 2004.
3. Abe J, Kyoko Kokubo, Koji Sato. 4 Steps from Start to Finish. Mandibular Suction Denture and BPS:A Complete Guide.Tokyo:Quintesence Publishing Co Inc,1981:51-78.
4. McGarry TJ, et al: Parameters of care for the American College of Prosthodontists. POC version 1,March 1996:J prosthodont,5(1):3-70.
5. Nimmo A, et al:Defining predoctoral prosthodontic curriculum: a workshop sponsored by the American College of Prosthodontists and the prosthodontic forum.J Prosthodont 1998; 7(1):30-34.
6. Sato K. Comparison of matiscatory movements while wearing complete mandibular dentures with and without suction in a totally edentulous subject.J Acad Clin Dentistry 2008;28(04)166-173.
7. Omori A, Kamijo Wakatuki E, et la. A study on chewing cycle with X-ray TV cinematography. J Tokyo Dental College Society 1975;75:87.
8. Takano K.A study on changes in the buccal mucosa during chewing movement with X-ray TV cinematography.J Tokyo Dental College Society 1979;79(9):1361-1453.
9. Omori A.A study on changes in the buccal mucosa with movement using X-ray TV cinematography. J Tokyo Dental College Society 1979;79(9):1757-1813.
10. Fujita K. Human Anatomy(35th edition).Tokyo:Nanko-sha Co Inc,1987;184.
11. Abe J. Clinical Denture Fabrication to Achieve an Effective Suction of the Mandibular Complete Denture:Enhancement of the Posterior End Border Seal around the Retromolar Pad:Ann Jpn Prothodont Soc 2011;3:220-230.
12. Masato Ichikawa.Report on establishing the base outline of mandibular complete denture obtained from measurements of denture base dislodging and retraction force (1st report): Discussion on retentive force from coverage difference with adenture base over the retromolar pad.J Acad Clin Dentistry 2012;32:57-64.
13. Wright CR,Muyskens,JH:A study of the tongue and its relation to denture stability;J Am Dent Assoc 1949;,39(3):269-275.
14. Abe S,Ide Y：Department of Clinical Anatomy.J Nippon Dental Review 2001;61(4):97-100,2001.
15. Tanaka H, Mushimoto E, Chiba M,et al:Characteristics of Temporomandibular Disorders in Complete Denture WearersPrevalence of Internal Derangement of the Temporomandibular Joint:Ann Jpn Prothodont Soc 1995;39(2):396-405.