The increasing risk of temporomandibular disorder and articular eminence inclination due to tooth loss

Rahmadhani Harahap[1], Ricca Chairunnisa[1*]

[1]**Department of Prosthodontic, Faculty of Dentistry Universitas Sumatera Utara, Indonesia**

ABSTRACT

Introduction: Tooth loss leads to increased biomechanical pressure in the temporomandibular joint due to changes in the functional movement pattern of the jaw, resulting in joint structure damage specifically change of the articular eminence inclination (AEI) angle, which is one of the increased risks of the temporomandibular disorder (TMD). This study aimed to analyze the relationship between the number and quadrants of tooth loss on TMD and the AEI. **Methods:** It was descriptive-analytic study using a cross-sectional design. The study was done in Universitas Sumatera Utara (USU) Dental hospital, conducted questionnaires and panoramic radiographic on 42 subjects aged over 18-64 years with tooth loss. Data analyzed used Chi-square analysis. **Results:** The prevalence of TMD on the ≥3 tooth loss group by 82.6% and the four-quadrant group by 93.8%. The prevalence of change in the AEI on the ≥3 tooth loss group was 34.8% on the flat right side, while on the left side of 26.1% was flat, and 13% was steep. Based on the number of quadrants tooth loss, the highest was on the four-quadrant group by 50% on flat right side, and on the three-quadrant group was 25% flat, 25% steep on the left side. There was a significant relationship between the number of tooth loss (p=0.023), the number of tooth loss quadrants, and TMD (p=0.016). There was no relationship between the number of tooth loss and the AEI, except for the number of tooth loss quadrants and the AEI on the right side with a significant result (p=0.017). **Conclusion:** There was relationship between the number of tooth loss, the number of tooth loss quadrants, and TMD and there was no relationship between the number of tooth loss and the AEI, except for the number of tooth loss quadrants and the AEI on the right side.

Keywords: Edentulous; tooth loss; temporomandibular disorder; inclination of articular eminence.

p-ISSN: 1979-0201; e-ISSN: 2549-6212; Available from: http://jurnal.unpad.ac.id/pjd/article/view/33067
DOI: 10.24198/pjd.vol34no2.33067
Submission: Apr 13, 2021; Accepted: Jul 31, 2022; Published online: Jul 31, 2022

INTRODUCTION

The stomatognathic system is a very complex interaction. The components consist of joints, ligaments, tooth, and muscles. Also, some nerves govern and coordinate this entire system. Its functions include chewing, speaking, and swallowing. Any disturbance in one of these components will cause an imbalance of function so that it impacts the other components.[1] Loss of tooth can interfere with occlusion, have consequently to the temporomandibular joint. Temporomandibular disorders are structural and functional disorders related to the temporomandibular joint,

**Corresponding author: Ricca Chairunnisa, Department of Prosthodontic, Faculty of Dentistry Universitas Sumatera Utara, Indonesia. Jalan Alumni No 2, North Sumatera, Indonesia, 20155. Phone: +628126445204; Email: ricca@usu.ac.id*

masticatory muscles, or both. Loss of tooth that is not immediately replaced by dentures can lead to changes in the occlusion pattern, leading to occlusion disharmony. Good occlusion should allow the mandible to translation without obstacles during functional movements, especially in the posterior segment; hence, the distribution of axial loads is more even and can avoid overloading the temporomandibular joint.

Research conducted by Shet RKG et al[4], in North Gujarat on 250 patients showed a decrease in temporomandibular joint function along with an increase in the number of tooth loss and the number of quadrants of tooth loss.[2,3,4] Diagnosis of temporomandibular disorders is obtained from examining the patient's history, clinical examination, and radiographic examination. Radiographs are required to make the diagnosis. Radiographs that can be done are panoramic, bilateral TMJ, MRI, and CT.[5]

Panoramic radiographs can show a picture of the facial structure including the arch of the maxillary tooth, mandible, temporomandibular joints, maxillary sinus, the nasal cavity.[6] Outline of the articular eminence and glenoid fossa can be seen from panoramic radiographs to be a guide in determining sagittal condylar guidance.[7] The development of the articular eminence depends on the functional stimulus of the condyles. Factors such as age, length of tooth loss, chewing load, and the type of prosthodontic restoration used can influence the leveling of the articular eminence slope.[8,9]

The inclination angle of the articular eminence can be measured in degrees with a normal value of 30^o-60^o. An articular eminence angle below 30^o is said to be flat and above 60^o is said to be steep. Both disorders are articulation disorders.[10] Based on Chiang MT's et al[11], study, it was reported that there was no significant difference between partial tooth loss and the inclination angle of the articular eminence. Erzurumlu ZU et al[12], study showed that patients with missing teeth had lower eminence inclination angle values than patients with complete teeth.

Study conducted by Modgi C et al[12], reported that the angle of inclination of the articular eminence was slightly higher in the group with missing teeth. Based on the description of previous studies, it can be seen that the relationship between the tooth loss factor on temporomandibular disorders and the angle of inclination of the articular eminence is a matter of debate in the field of dentistry. Therefore, the aim of this research is to analyzed relationship between the number of tooth lost and the number of quadrants of tooth loss with temporomandibular disorders and the angle of inclination of the eminence articular in panoramic radiographs.

METHODS

This study is descriptive-analytic with a cross-sectional design. In this study, respondents were interviewed directly by using Fonseca's questionnaire and panoramic radiographic. The questionnaire used was Fonseca's questionnaire consisting of ten questions that can be answered with yes, no or sometimes about sound in TMJ, pain in TMJ, fatigue in TMJ.

The sample was 42 patients USU Dental hospital. The sampling is done using the purposive sampling technique using the following criteria: aged over 18-64 years; missing tooth; a female who has requested his consent through informed consent. The samples were grouped into two characteristics, namely the number of missing tooth, the number of dental quadrants with missing tooth. data were analyzed with Chi-square and Fisher's exact test.

The instruments and materials for this study were stationary, gloves, mask, laptop, orthopantomograph OP 200 D, software Cliniview 10.12, informed consent form, and examination form. The study method used for measurement of the angle of inclination of the articular eminence is as follows : (1) The most superior point on the roof of the glenoid fossa i.e. point *g* is identified geometrically as the thinnest part of the base of the fossa and the innermost part of the basin of the glenoid fossa; (2) The *h* horizontal axis is defined as the horizontal plane, identified by connecting the most inferior point in the orbital cavity, with the point most superior to the external acoustic meatus; (3) The inflection point that is point *e* is the point where the basin of the glenoid fossa and the slope of the articular eminence meet and form a sigmoid curve.

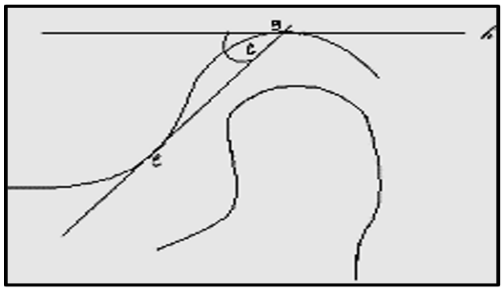

Figure 1. The reference point on the articular eminence.[4]

Measurement of the inclination angle of the articular eminence using software cliniview 10.12. Point e and g were connected , creating a line connected to the h horizontal axis. The angle created between the intersection of both lines is the angle of inclination of the articular eminence. The research acquired a permission from the Ethics Commission of the University of North Sumatra with letter number No: 290/KEP/USU/2020.

Table 1. Prevalence of USU Dental hospital patients with temporomandibular disorders based on the number of tooth loss and the number of quadrants of tooth loss

Variable	Temporomandibular disorder		
	Yes	No	Total
The number of tooth loss	**n (%)**	**n (%)**	**n (%)**
a. <3	9 (47.4%)	10 (52.6%)	19 (100%)
b. ≥3	19 (82.6%)	4 (17.4%)	23 (100%)
Total	28 (66.7%)	14 (33.3%)	42 (100%)
The number of tooth loss quadrant			
a. 1	5 (50%)	5 (50%)	10 (100%)
b. 2	3 (37.5%)	5 (62.5%)	8 (100%)
c. 3	5 (62.5%)	3 (37.5%)	8 (100%)
d. 4	15 (93.8%)	1 (6.2%)	16 (100%)
Total	**28 (66.7%)**	**14 (33.3%)**	**42 (100%)**

Table 2. Prevalence of USU Dental hospital patients with changes in the inclination angle of articular eminence based on the number of tooth loss and the number of quadrants of tooth loss

Variables	Articular Eminence Inclination							
	Right				Left			
	Normal	Flat	Steep	Total	Normal	Flat	Steep	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
The number of tooth loss								
a. <3	17 (89.5%)	2 (10.5%)	0	19 (100%)	15(78.9%)	4 (21.1%)	0	19 (100%)
b. ≥3	15 (65.2%)	8 (34.8%)	0	23 (100%)	14 (60.9%)	6 (26.1%)	3 (13%)	23 (100%)
The number of tooth loss quadrant			0					
a. 1	9 (90%)	1 (10%)	0	10 (100%)	7 (70%)	3 (30%)	0	0
b. 2	7 (87.5%)	1 (12.5%)	0	8 (100%)	7 (87.5%)	1 (12.5%)	0	8 (100%)
c. 3	8 (100%)	0	0	8 (100%)	4 (50%)	2 (25 %)	2 (25 %)	8 (100%)
d. 4	8 (100%)	8 (100%)	0	16 (100%)	11 (68.8%)	4 (25%)	1 (6,2%)	16 (100%)
Total	**32 (76.1%)**	**10(23,8%)**	**0**	**42 (100%)**	**29 (69%)**	**4 (25%)**	**3 (7,1%)**	**42(100%)**

Table 3. The association between the number of tooth loss with temporomandibular disorders

Variables	Temporomandibular disorder			P
	Yes	No	Total	
	n (%)	n (%)	n (%)	
The number of tooth loss			19 (100%)	
a. <3	9 (47.4%)	10 (52.6%)		0.023*
b. ≥3	19 (82.6%)	4 (17.4%)	23 (100%)	

Table 4. The association between the number of tooth loss quadrant with temporomandibular disorders

Variables	Temporomandibular disorder			P
	Yes	No	Total	
	n(%)	n(%)	n(%)	
The number of tooth loss quadrant				
a. 1	5 (50%)	5 (50%)	10 (100%)	
b. 2	3 (37.5%)	5 (62.5%)	8 (100%)	0.016*
c. 3	5 (62.5%)	3 (37.5%)	8 (100%)	
d. 4	15 (93.8%)	1 (6.2%)	16 (100%)	

Table 5. The association between the number of tooth loss with the articular eminence inclination

Variables	The number of tooth loss					
	Right			Left		
	< 3	≥3	P	<3	≥3	P
	n (%)	n (%)		n (%)	n (%)	
Normal	17 (89.5%)	15 (62.5%)	0,083	15 (78.9%)	14 (60.9%)	0,302
Flat	2 (10.5%)	8 (34.8%)		4 (21.1%)	6 (26.1%)	
Steep	0	0		0	3 (1.3 %)	
Total	**19 (100%)**	**23 (100%)**		**19 (100%)**	**23 (100%)**	

Table 6. The association between the number of tooth loss quadrant with the articular eminence inclination

Variables	The number of tooth loss quadrant								
	Right					Left				
	1	2	3	4	P	1	2	3	4	P
	n (%)	n (%)	n (%)	n (%)		n (%)	n (%)	n (%)	n (%)	
Normal	9 (90%)	7 (87.5%)	8 (100%)	8 (50%)	0.023*	7 (70%)	7 (87.5%)	4 (50%)	11 (68.8%)	0.577
Flat	1 (10%)	1 (12.5%)	0	8 (50%)		3 (30%)	1 (12.5%)	2 (25%)	4 (25%)	
Steep	0	0	0	0		0	0	2 (25%)	1 (6.2 %)	
Total	**10 (100%)**	**8 (100%)**	**8 (100%)**	**16 (100%)**		**10 (100%)**	**8 (100%)**	**8 (100%)**	**100%**	

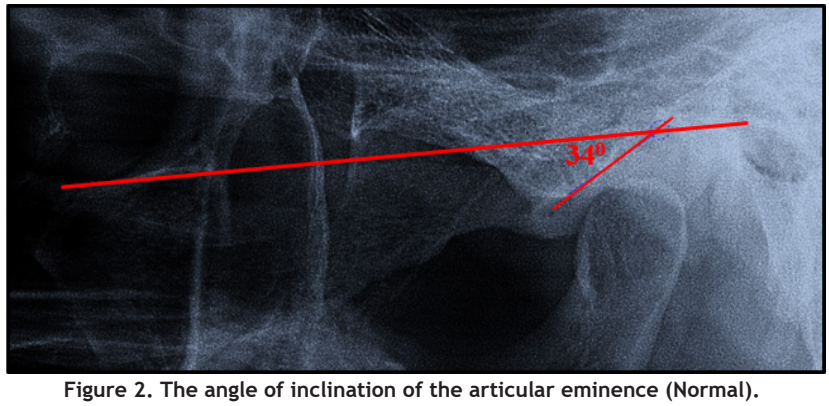

Figure 2. The angle of inclination of the articular eminence (Normal).

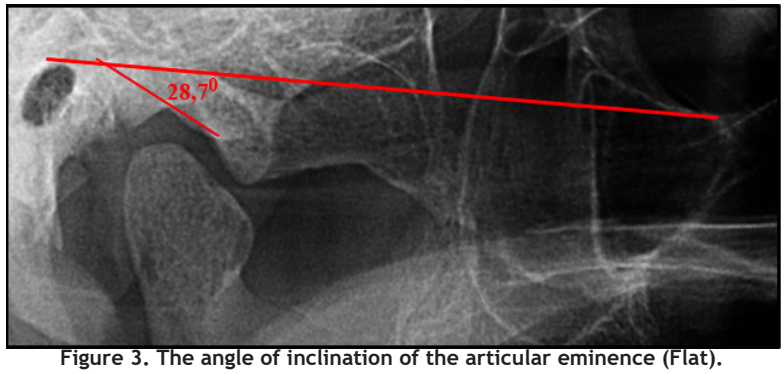

Figure 3. The angle of inclination of the articular eminence (Flat).

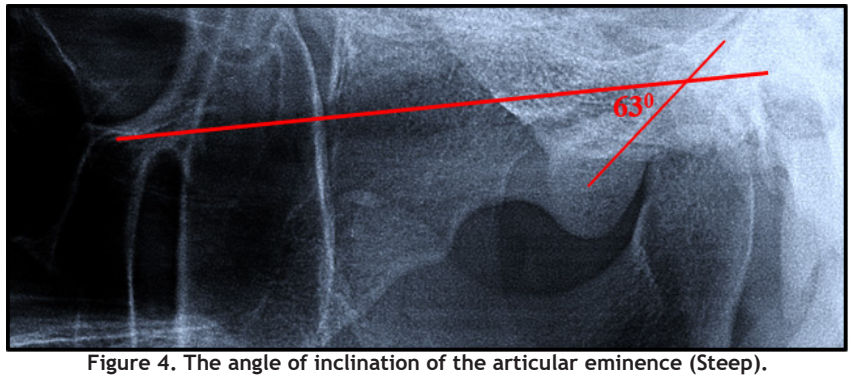

Figure 4. The angle of inclination of the articular eminence (Steep).

RESULTS

The prevalence of USU Dental hospital patients experiencing temporomandibular disorders based on the largest number of tooth loss in the ≥3 tooth loss group was 82.6% and based on the largest number of quadrants of tooth loss in the tooth loss group in the four quadrants of 93.8% (Table 1). The prevalence of USU Dental hospital patients who experienced changes in the inclination angle of the articular eminence based on the largest number of tooth loss in the group ≥3 tooth loss was 34.8% which was flat on the right side and the left side was 26.1% which was flat, and 13% was steep.

Based on the number of quadrants, the largest tooth loss was in the tooth loss group in the four quadrants, 50% were flat on the right side and the tooth lost in the three quadrants were 25% flat and 25% were steep on the left (Table 2). The chi-square test was significant p = 0.023 (p<0.05). Table 3 shows the association between the number of tooth loss with temporomandibular disorders. Table 4 shows the association of the number of tooth loss quadrants with temporomandibular disorders p = 0,016 (p<0.05). There was no association between the number of tooth loss and the articular eminence inclination (p=0.083) on the right side and p=0,302 on the left side with fisher's exact test (Table 5), except for the number of tooth loss quadrants to the articular eminence inclination in the right side was significant p=0.017, while analysis data in the left side was not significant p=0.577 (Table 6).

DISCUSSION

In this study, the highest subject percentage experiencing temporomandibular disorder was the ≥3 tooth loss group by 82.6% (Table 1). The study results are consistent with the research of Fallahi et al[14] which was conducted on 100 people with missing tooth and 100 people with complete tooth as controls.This study showed that the highest prevalence of temporomandibular disorders was found in subjects who lost their tooth by 58% compared to the control group at 43%. This research is also following research conducted by Sihombing et al[15], which shows that the largest percentage of subjects who experience temporomandibular disorders are in the four-quadrant group (95.7%). In table 1, many in the four-quadrant group were found 15 people (93.8%) and 1 people did not experience it (6.2%).[15] This situation is due to the loss of teeth will disrupt the stability of the occlusion

thereby increasing susceptibility to changes in the functional load of the temporomandibular joint which over time can trigger damage to the joints, teeth, and supporting structures.[4] In the two-quadrant group, subjects who did not experience temporomandibular joint disorders were greater than those with temporomandibular joint disorders. This is because each individual has a biological system that can tolerate certain conditions called adaptive abilities. The human musculoskeletal system can adapt and tolerate certain conditions without showing signs and symptoms of temporomandibular joint disorders. Therefore, individuals who have several factors such as tooth loss, trauma, parafunctional habits, and others do not always show signs and symptoms of temporomandibular joint disorders.[1]

The prevalence of patients with changes in the angle of the articular eminence were in the group of 3 tooth loss as many as 8 people (34.8%) who experienced flattening on the right side of the articular eminence. While on the left side as many as 6 people (26.1%) experienced flattening of the articular eminence and 3 people (13%) experienced steepness of the articular eminence (Table 2). This study is accordance with the study of Erzurumlu ZU et al[12], which showed that patients with tooth loss had a lower eminence inclination angle than patients with complete teeth. Based on the number of quadrants of tooth loss, the largest percentage of subjects who experienced changes in the angle of inclination of the articular eminence was in the group of four quadrants as many as 8 people (50%) who experienced flattening at the angle of inclination of the articular eminence on the right side. But on the left side, the largest percentage of articular eminence angle flattening was in the one quadrant group of 3 people (70%) out of 10 subjects while in the four quadrant group as many as 4 people (25%) out of 16 subjects. The percentage of changes in the articular eminence that experienced the greatest steepness in the three quadrant group was 2 people (25%) of the 8 subjects in that group (Table 2).

The results of this study are in accordance with Chiang MT's et al[11], study conducted on 53 patients who had unilateral tooth loss. This study reported that the inclination of the articular eminence was slightly steeper in the complete dentition group than in the tooth loss group. This can happen because the population in each quadrant group has an uneven distribution based on the number of quadrants of teeth and the masticatory load in each person is different.

The Chi-square analysis test show a significant relationship between the amount of tooth loss and temporomandibular disorders with a value of p=0.023 (p <0.05) (Table 3). This is because the loss of tooth will result in an occlusion disharmony that will disturb the dental arch stability, and this situation can cause excessive pressure on the temporomandibular joint.[15] The results of this study are in line with the research of Al-Shulaiman Y et al[16] which showed the same results with this study that there is a significant relationship between tooth loss and signs and symptoms of temporomandibulardisorders. The study result by Malherios AS et al[17] also stated a strong correlation between tooth loss and temporomandibular disorders.

Temporomandibular disorders are structural and functional disorders related to the temporomandibular joint, masticatory muscles, or both. Tooth loss can lead to neuromuscular changes such as muscle hyperactivity due to excessive loads that affect lateral movement.[3] The loss of tooth in the anterior part will have an impact on the posterior part. The mandibular anterior tooth incisal margin is retained against the lingual surfaces of the anterior maxillary teeth. This lingual surface determines the amount of vertical movement of the mandible. Loss of anterior tooth can cause disturbance in the posterior part with a long time of disoclusion.[18] Loss of posterior tooth can cause changes in the vertical dimension of the occlusion. Posterior tooth, namely molar and premolar tooth, are the occlusal support areas and have an important role in determining the position of the lower jaw to the upper jaw and will have an impact on the temporomandibular joint relationship allows receiving heavy loads.[1] The loss of posterior tooth will result in excessive load on the temporomandibular joint to trigger temporomandibular disorders.[4]

Based on the Chi-square test, it was found that there was a significant relationship between the number of quadrants of tooth loss and temporomandibular disorders with a value of p = 0.016 (p <0.05) (Table 4). It has also been reported by Shet et al[4], showed that there is a

significant relationship between the number of quadrants of tooth loss and temporomandibular joint disorders. This study also showed a decrease in temporomandibular joint function along with an increase in the number of quadrants of tooth loss.

This situation is due to the loss of tooth in many quadrants which will result in the loss of contact with the dental occlusion. It can lead to changes in occlusion patterns and loss of occlusal support. Contact occlusion serves to maintain mandibular stability. Good occlusion allows the mandible to translate without occlusal hindrance during functional movement so that mastication efficiency on the work side is not lost, distribution of axial loads is more even and can avoid overloading the temporomandibular joint. The loss of occlusion contacts causes the patient to try to get a new occlusion contact so that there is a change in the occlusion pattern. Therefore, tooth loss will affect the balance of occlusion which will disturb the stability of the dental arch. This situation causes increased biomechanical stress on the structure of the temporomandibular joint. The number of tooth loss in some quadrants, especially in the posterior part, can also cause a decrease in the vertical dimension. This reduction in vertical dimension may result in dislocation of the disc anteriorly. So that when opening the mouth, the condyle moves forward pushing the disc anteriorly so that there is a fold of the disc. When the disc can no longer be pushed, the condyle will jump over the fold causing a clicking sound, which is a sign and symptom of temporomandibular disorder.[1,3,5]

The articular eminence is a small bone located anterior to the glenoid fossa. Articular eminence varies from person to person. The development of the articular eminence depends on the functional stimulus of the condyles. Accepting functional loads arising from the chewing process can affect the morphology and angle of inclination of the articular eminence. This leveling of the articular eminence slope is associated with a decrease in condyle height due to too much weight on the temporomandibular joint. Tooth loss will result in overclosure of the mandible, causing the condyles to deviate from a normal centric position causing bone resorption from the fossa to the articular eminence so that the posterior part of the articular eminence becomes flat. Further bone resorption can cause articular eminence to go from a convex to a concave shape. The absorption of the articular eminence can be observed from changes in the inclination of the articular eminence angle. The articular eminence serves as the condyle pathway to slide when opening the mouth. The alignment of the articular eminence is thought to be because the disc is displaced to a lateral position from the disc position, and the eminence is normal. It is due to the large joint load so that the condyle position changes.[9,11]

The current study discovered no relationship between the number of tooth loss and the angle of inclination of the articular eminence on the right side with a value of p=0.083 and the left side with a value of p=0.302 (p>0.05) (Table 5). The results of this study are accordance with Chiang et al[11], which shows that there is no significant result between partial tooth loss and the inclination angle of the articular eminence. It occurs because of changes in the structure of the articular eminence depending on the functional stimulus of the condyle. Factors such as age, length of tooth loss, chewing load, and the type of prosthodontic restoration used have the potential to influence structural changes in the articular eminence.[8] This is also supported by the age range large. A study by Chiang et al[11], reveals no significant relationship between increasing age and changes in articular eminence. However, the morphology of articular eminence may change its structure with age.

The results of this study indicated that there was a significant relationship between the number of quadrants of tooth loss and the angle of inclination of the articular eminence on the right side with a value of p = 0.023 (p <0.05), but there was no significant relationship between the number of quadrants of tooth loss and the angle of inclination of the articular eminence. on the left side with a p-value = 0.577 (p> 0.05) (Table 6). This study is in line with research conducted by Modgi et al [13], who reported that the angle of inclination of the articular eminence was slightly higher in the group with tooth loss. Differences on the two sides that can be caused by the use of tooth during the chewing process can affect the angle of inclination of the articular eminence. Conditions such as one-sided chewing, clenching, nail-biting, and the habit of resting on one side

of the chin can result in an excess distribution of biomechanical stress on one side only. If the biomechanical pressure is distributed equally on both sides of the jaw, the joint structure changes also coincide in both joints, this causes a large change in the angle of inclination of the articular eminence to occur in the same quantity. If the contact between the tooth on both sides of the jaw is not balanced, the position of the mandible becomes unstable, as a result, the biomechanical stress on one side will be excessive and damage to the joint structure can occur.[1,4,11]

In this study, there are limitations to the study, namely not paying attention to other risk factors that can cause temporomandibular disorders and changes in the angle of inclination of the articular eminence such as age, tooth loss, and other bad habits. Besides, when taking panoramic radiographs, there may be overlaps, distortion, and the possibility of the patient's position which could not be kept stable during photoshoot which may be a factor that causes differences in results with previous studies. This study was only conducted using interview result and did not include clinical examinations due to the pandemic Covid-19.

CONCLUSION

There is increasing risk of temporomandibular disorder and articular eminence inclination due to tooth loss. The amount tooth loss has significant relationship with temporomandibular disorder. The amount tooth loss is not associated with articular eminence inclination, while the number of tooth loss quadrant are associated with the articular eminence inclination in the right side.

REFERENCES

1. Okeson J. Management of temporomandibular Disorders and Occlusion. 8th Ed. Missouri: Elsevier Mosby. 2020: 3-63.
2. Bordin TB, Conci RA, Pezzini MMG, Pezzini RP, Mendonca MJ. Prevalence of sign and symtoms of temporomandibular disorders (TMD) in patient wearing bimaxillary complete denture, removable partial dentures and in students with natural dentition. Acta Odontol Latinoam. 2013; 26(3): 173-80
3. Alzarea BK. Temporomandibular disorders (tmd) in edentulous patients: a review and proposed classification (dr. Bader's classification). J Clin Diagn Res. 2015; 9(4): ZE06-9. DOI: 10.7860/JCDR/2015/13535.5826.
4. Shet RG, Rao S, Patel R, Suvvati P, Sadar LR, Yadav RD. Prevalence of temporomandibular joint dysfunction and its signs among the partially edentulous patients in a village of North Gujarat. J Contemp Dent Pract. 2013; 14(6): 1151-5. DOI: 10.5005/jp-journals-10024-1466.
5. Ferreira LA, Grossmann E, Januzzi E, de Paula MV, Carvalho AC. Diagnosis of temporomandibular joint disorders: indication of imaging exams. Braz J Otorhinolaryngol. 2016; 82(3): 341-52. DOI: 10.1016/j.bjorl.2015.06.010.
6. Im YG, Lee JS, Park JI, Lim HS, Kim BG, Kim JH. Diagnostic accuracy and reliability of panoramic temporomandibular joint (TMJ) radiography to detect bony lesions in patients with TMJ osteoarthritis. J Dent Sci. 2018; 13(4): 396-404. DOI: 10.1016/j.jds.2018.08.006.
7. Prasad KD, Shah N, Hegde C. A clinico-radiographic analysis of sagittal condylar guidance determined by protrusive interocclusal registration and panoramic radiographic images in humans. Contemp Clin Dent. 2012; 3(4): 383-7. DOI: 10.4103/0976-237X.107419.
8. Manja CD, Rajaduray D. Analysis of height and width of mandibular condyle and shape of the articular eminence with and without clicking using tmj radiography. Int J Dent Res. 2019; 4(3): 99-103.
9. Rabelo KA, Sousa Melo SL, Torres MGG, Campos PSF, Bento PM, Melo DP. Condyle excursion angle, articular eminence inclination, and temporomandibular joint morphologic relations with disc displacement. J Oral Maxillofac Surg. 2017; 75(5): 938. e1-938.e10. DOI: 10.1016/j.joms.2017.01.019.
10. Sa SC, Melo SL, Melo DP, Freitas DQ, Campos PS. Relationship between articular eminence inclination and alterations of the mandibular condyle: a CBCT study. Braz Oral Res. 2017 Mar 30;31:e25. DOI: 10.1590/1807-3107BOR-2017.vol31.0025.
11. Chiang MT, Li TI, Yeh HW, Su CC, Chiu KC,

Chung MP, Shieh YS. Evaluation of missing-tooth effect on articular eminence inclination of temporomandibular joint. J Dent Sci. 2015; 10(4): 383–7. DOI: 10.1016/j.jds.2015.02.001

12. Chairunnisa R, Sihombing RJ. The association between of tooth loss, tooth loss quadrants, and occlusal support with temporomandibular disorders in partially edentuluous patients. Adv in Heal Sci Res. 2018; 8: 255-7. DOI: 10.2991/idcsu-17.2018.65
13. Fallahi HR. Evaluation of the Relationship Between Partial Edentulism and TMJ Disorders. Biosci Biotech Res Asia. 2016; 13(3): 1726-9. DOI: 10.13005/bbra/2323
14. Al-Shumailan Y. The prevalence and association of sign and symptoms of temporomandibular disorder with missing posterior tooth in adult jordania subject. JRMS. 2015; 22(2): 23-4. DOI: 10.12816/0011360
15. Malheiros AS, Carvalhal ST, Pereira TL, Filho EM, Tonetto MR, Gonçalves LM, Bandeca MC, De Jesus Tavarez RR. Association between tooth loss and degree of temporomandibular disorders: a comparative study. J Contemp Dent Pract. 2016; 17(3): 235-9. DOI: 10.5005/jp-journals-10024-1833.
16. Gupta S, Gupta R, Garg R. Partial Edentulous and Temporomandibular Disorder. J Dent And Med Sciences. 2014; 13(12): 60-3. DOI: 10.9790/0853-131246063