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Research Article

Possible Association of Styloid Process Calcification in TMD Subjects-A Cross-Sectional CBCT Analysis

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Abstract

Objective: To evaluate possible associations between types of calcification of the styloid process and temporomandibular joint disorder (TMD).

Study design: A cross-sectional study

Materials and Methods: An analysis of available CBCT images of patients in the age group of 18–70 years diagnosed with TMD and patients subjected to radiographic evaluation for other reasons has been evaluated. Images that are clear, symmetrical, and undistorted were evaluated.

Images were evaluated for length of styloid process linearly on reconstructed sagittal slices of CBCT (from the inferior most part of the external auditory meatus to the inferior most calcified portion), and for calcification patterns such as elongated, pseudo-segmented, and segmented types.

CBCT images of patients with a history of trauma, radiation therapy, and TMJ surgery, having collagen, vascular, or neurological disorders, or distorted images has been excluded.

CBCT radiographs in each group were evaluated by two experienced maxillofacial radiologists.

The comparisons of the types of styloid process calcification between TMD and non-TMD patients were analyzed using the chi-square test.

The current study's findings are similar to those of a study conducted on the Brazilian population by Kelly Machado de Andrade., et al. There was a statistically significant percentage of people in group B (non-TMD) who had less than 30 mm of styloid process, with a mean value of 38.3%.

According to Merve Donmez., et al., among the elongated styloid processes, the type I pattern of calcification was the most frequent type on both sides, but in the present study, type 3 pattern (segmented) was more frequently observed in TMD patients. The reliability kappa value was 0.599, suggesting average reliability.

The limitations of the present study are the smaller sample size and lack of clinical symptoms. Further studies need to be done to correlate the clinical symptoms and radiographic findings of the styloid process in both groups with a larger sample size.

Keywords: Styloid Process; Temporomandibular Joint Disorder; TMD; CBCT; Eagle's Syndrome

Introduction

The styloid process (SP) of the temporal bone is a long conical cartilaginous projection that lies anterior to the mastoid process. The SP is located in the anterior, lateropharyngeal space, between the external carotid artery, palatine tonsil, styloglossus, and stylopharyngeal muscles. The stylohyoid chain is composed of the styloid process, the stylohyoid ligament, and the cornuminus of the hyoid bone [1]. The structures surrounding the styloid process are the internal jugular vein, internal carotid artery, and glossopharyngeal nerve (CN IX), vagus nerve (CN X), and accessory nerve (CN XI) lying medial to the styloid process. And the occipital artery and hypoglossal nerve (CN XII) run along its lateral side. The styloid process facilitates the movement of the tongue, pharynx, larynx, hyoid bone, and mandible by offering attachment to the stylohyoid ligament, stylopharyngeus, and styloglossus muscles.

Embryologically, the stylohyoid chain originates from the second brachial arch (Reichert's cartilage). The styloid process develops from the first two segments of the cartilage; those are the tympanohyal and stylohyal. Tympanohyal gets calcified at birth, but attachment to the temporal bone is believed to take place during the first year of life. Stylohyal appears after birth and slowly calcifies. These two segments fuse at puberty, but in some cases, fusion is delayed or does not occur at all. The average length of the styloid process is 30 mm [2].

Eagle has described syndromes known popularly as Eagle's Syndrome, also known as Elongated styloid process syndrome, styloid process carotid artery syndrome, stylohyoid syndrome, or styloid process neuralgia. The symptoms include pain in the pharynx and hypopharynx and throughout the distribution of the internal or external carotid artery [3].

He reports relief of symptoms after removal of the calcified ligament and/or shortening of the process where these structures impinge on the tonsils or carotid artery [4]. Although the aetiology of the styloid chain calcification or elongation of the styloid process (ESP) is unclear, some authors claim that the increased tensile stress in the stylohyoid ligament might be responsible for this clinical condition. But, as not all morphological changes in the styloid process produce painful symptoms that is the reason the diagnosis of Eagle's Syndrome, resulting in elongation of the styloid apophysis, is quite difficult. Most authors agree that few of these processes become symptomatic, with the reported prevalence ranging from 1% to 5% [5].

Temporomandibular disorder (TMD) is a term given to a heterogeneous group of pathologies affecting the temporomandibular joints, the masticatory muscles, or both. It is the most commonly occurring jaw disorder, with a prevalence rate of 28% to 86% of adults and adolescents showing one or more clinical signs and symptoms similar to Eagle's syndrome [6].

Finding the correct diagnosis is crucial for the development of an optimal treatment strategy as well as the application of appropriate treatment. The present study is aimed at establishing any relation between elongation and type of calcification of the styloid process and temporomandibular disorder.

Materials and Method

Institutional ethical committee approval was obtained (IRB) for this cross-sectional study. Sample size estimation was done depending on the pilot study. 30 CBCT images were obtained from the archives of the radiology department database in each group.

All the images were obtained from the KODAK 9600CS 3D extraoral Imaging System (Carestream Health, Inc., 150 Verona Street, Rochester, NY 14608).

Inclusion criteria

Group A

- Bilateral CBCT of patients aged between 18 and 70 years who have been diagnosed with TM disorder according to DC-TMD.

Group B

- Bilateral CBCT of patients aged between 18 and 70 years old who underwent CBCT evaluation for other reasons (implantation, extraction)

Exclusion criteria

- A radiograph of the patient with trauma and sub-condylar fractures
- Radiograph of the patient with any systemic collagen, vascular, or neurologic disorder.
- Radiograph of the patient with a previous history of radiation treatment to the head and neck or a previous history of TMJ surgery and treatment for TMJ disorder.

Image analysis

The radiological assessment was done by two experienced radiologists who have been trained to identify the structures and to

undertake the measurement. Only images that were clear, symmetrical, and undistorted were included. All the images that met inclusion criteria were evaluated for length of styloid process linearly on reconstructed sagittal slices of CBCT (from the inferior most part of the external auditory meatus to the inferior most calcified portion) figure 2. And for calcification patterns, they were classified as elongated, pseudo-segmented, and segmented according to Langlais., *et al*. [5]. Type I-Elongated: SP is characterised by the uninterrupted integrity of the image. Type II - Pseudoarticulated: the SP portions appear to be joined together by a pseudoarticulation.Type III - Segmented: This type is formed by discontinuous SP segments. Figure 1.

Statistical analysis

The mean length of the styloid process was compared between the groups by an unpaired t test.

The chi-square test was used to compare the relationship between the type of calcification and the groups.

Intraobserver reliability was analysed by the kappa measure of agreement. A P value of <0.05 was considered statistically significant.

Results

There was no statistically significant difference in length found between subjects with TMD and non-TMD patients, with the mean value of length being 34.8mm and 32.11mm, respectively, with a standard deviation of 7.8 in each group, and a p value of 0.05.(Graph 6 and table 1).

In the non-TMD group, a statistically significant number of samples showed less than 30 mm of styloid process, with a value of 38.3%. In the TMD group, only 12.1% of samples had less than 30 mm of styloid process.

In TMD patients, the segmented type of calcification was found in 36% of samples, followed by elongated and partially segmented types, respectively, at 29.3% and 22.4%. The inter-operator reliability kappa value was 0.599, suggestive of average reliability. (Table 4).a

Discussion

The aim of the present study was to assess the occurrence of radiological alterations in the length of the styloid process and pattern of calcification in patients with TMD.

In the year of 1948, Eagle first described the elongated styloid process syndrome, which is popularly known as Eagle's syndrome. An elongated styloid process can be palpable intraorally in the tonsilar region.

This is most commonly seen after the tonsillectomy procedure. Tightening of the mucosa around the styloid process due to scar formation results in symptoms like dysphagia, pain referred to the ear, dysphonia, and a sensation of a foreign body in the pharynx.

Owing to its proximity to crucial anatomic structures, changes in the angulation of the styloid process may impinge on the carotid artery, causing neck pain and pain when turning the head; this condition is also referred to as carotid artery syndrome or carotidynia.

The styloid process is an injury prone site irrespective of its length. Ligaments attached to the styloid process can stretch in whiplash-injuries when acute force excides the physiological limits and the tendon attachment sites are considered to be vulnerable to injury from trauma.

Any variation in the length and angulation of the styloid process causes irritation to its surrounding vital structures, mainly to the carotid arteries, accessory, hypoglossal, vagus or glossopharyngeal nerve [7], which are clinically present with symptoms like dysphagia, recurrent headaches, otalgia, orofacial pain, and pain in the TMJ [8,9]. similar symptoms can be manifested by temporomandibular joint disorders (TMD) as well. TMDs are a result of alteration in the temporomandibular joint and/or masticatory muscles, and can be conservatively managed by administering a splint. The symptoms can also overlap with facial neuralgias.

In a study conducted by Anbiaee., *et al*. in the Iranian population, 207 styloid complexes on OPG and co-related clinical symptoms were evaluated. It was concluded that elongation of the styloid complex can be considered as a physiological phenomenon [10].

In a study by Mun Bhawni Bagga., *et al*. where OPGs of 2,706 adults from the Indian population were analysed, it was concluded that the prevalence of elongated styloid process is more common in the regional population of Mathura compared to other regions of India. This observation was more evident in the older age groups, and there was no gender predilection. An additional finding of this study was a partially calcified pattern more common in this population [11].

A study done in Brazil by Kelly Machado de Andrade (2012) was suggestive of no significant difference in morphological length between the TMD and non TMD groups, and the mean lengths of the right and left styloid processes were 33.50 mm and 32.98 mm, which are similar to the present study [5].

A retrospective study by Turkiye., *et al*. on 1000 patients evaluated the styloid process on computed tomographic images. It was observed that 76% of the individuals showed elongation of at least one of the styloid processes in TMD patients. Among the ESPs, Type I was the most frequent type of SP on both sides, whereas Type II was the least common type on both sides. In contrast to these findings, the present study reports type 3 to be the most commonly found [2].

Hatice Cansu Kış, conducted a retrospective cohort study suggesting a statistically significant difference between the TMD and the non-TMD groups in terms of the mean styloid process lengths. The mean styloid process length of men is higher compared to women. In the non-TMD group, a statistically significant number of samples showed less than 30 mm of styloid process, with a value of 38.3%. In the TMD group, only 12.1% of samples had less than 30 mm of styloid process. In TMD patients, the segmented type of calcification was found in 36% of samples, followed by elongated and partially segmented types [1].

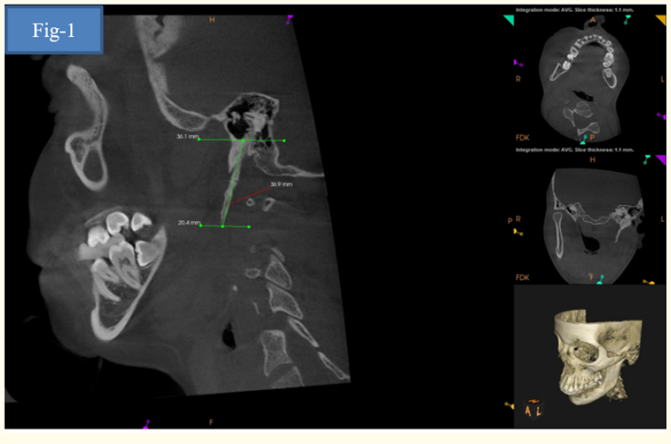

Figure 1: CBCT Images showing measurement of length of styloid process linearly on reconstructed sagittal slices (from inferior most part of external auditory meatus to the inferior most calcified portion).

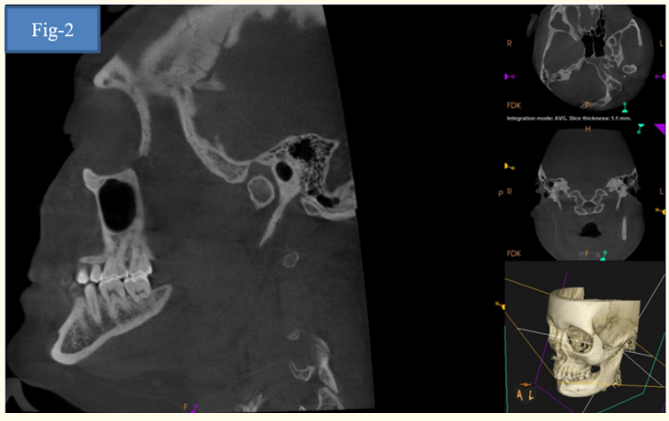

Figure 2: CBCT reconstructed sagittal slices showing Type I – Elongated styloid process.

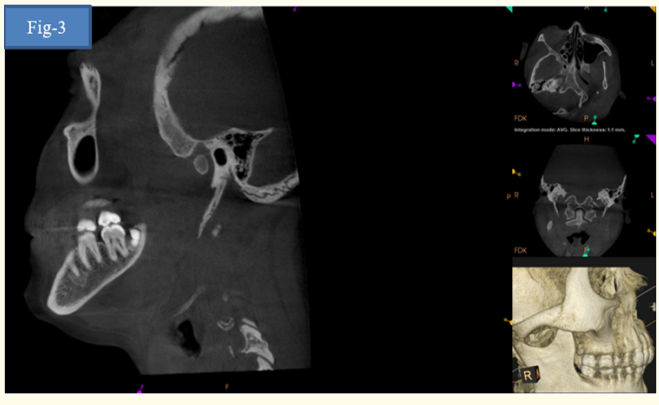

Figure 3: CBCT reconstructed sagittal slices showing Type II – Pseudoarticulated styloid process.

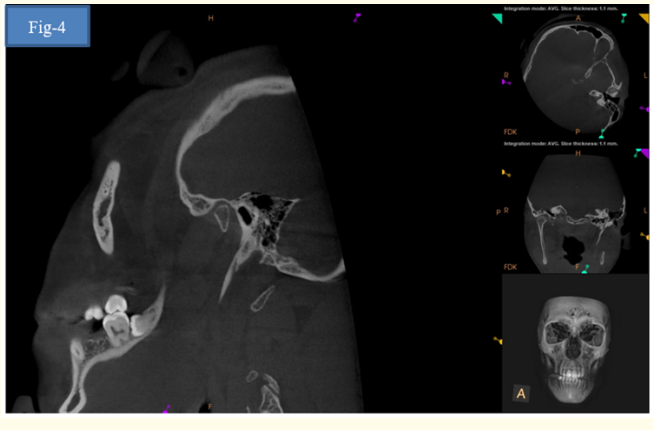

Figure 4: CBCT reconstructed sagittal slices showing Type III – Segmented styloid process

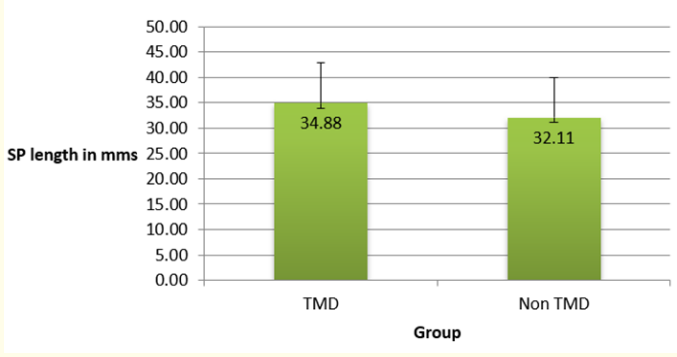

Figure 5: Bar diagram showing length of stloid process in both the groups.

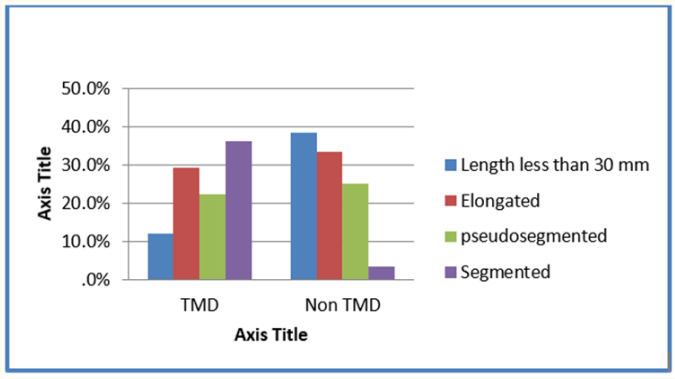

Figure 7: Bar diagram showing type of styloid process in both the groups.

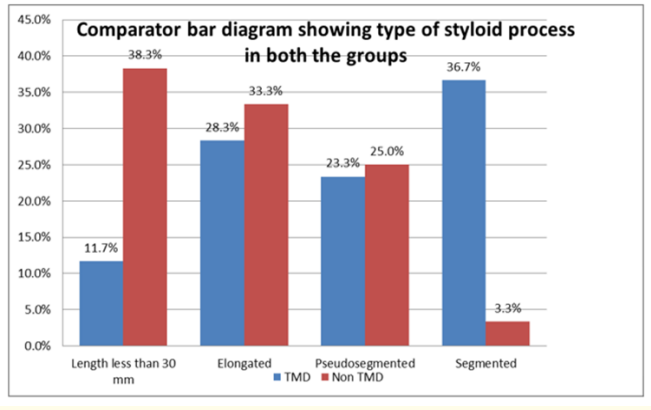

Figure 6: Comparator bar diagram showing type of styloid Process in both the groups.

Limitations and Conclusions

Although the elongated styloid process has been postulated to be one of the causes of symptoms in subjects with TMDs, the varied results in different populations do not substantiate the idea completely.

The present study was carried out on a smaller set of samples, owing to the fact that obtaining CBCT images of TMJs of normal subjects is practically not feasible.

	Group	N	Mean	Std. Deviation	t	df	p-value	Mean Difference	Std. Error Difference
Length of SP	TMD	60	34.880	7.80367	1.940	118	0.055	2.77000	1.42776
	Non TMD	60	32.110	7.83667					

Table 1: Group Statistics.

	Length less than 30 mm	Elongated	Partially segmented	Segmented
TMD	12.1%	29.3%	22.4%	36.2%
Non TMD	38.3%	33.3%	25.0%	3.3%

Table 2

	Value	df	p-value	
Pearson Chi-Square	24.588[a]	3	.000	Significant

Table 3: Chi-Square Tests.

	Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.	
Measure of Agreement Kappa	.599	.086	7.468	.000	Weak to average reliability
N of Valid Cases	56				

Table 4: Symmetric Measures.

Further studies on larger sample sizes would probably suffice the findings of the elongated styloid process as a causative factor in TMDs. The findings from a larger sample size may justify including styloid process radiographic findings as one of the diagnostic investigations in the diagnosis and management of TMDs.

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