II. Stylohyoid chain ossification: A discussion of etiology

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It has been estimated that between 2% and 4% of the general adult population has radiographic evidence of an ossification of the stylohyoid chain. In an effort to prove that this is also the case in children and adolescents, 150 panoramic radiographs were examined at the Department of Pedodontics of St Justine's Hospital in Montreal, Quebec, Canada. A total of 300 styloid processes and stylohyoid chains were evaluated and measured radiographically. The patients' mean age was 11 years. The mean length of the styloid processes was 10 mm. Forty percent of the population without symptoms studied showed some evidence of stylohyoid ligament ossification. Sixty percent of these were males; 40% were females. It was also found that 65.6% had no history of cervicopharyngeal trauma on review of the medical and dental histories.

In the first article of this series, we presented a literature review pertaining to the etiology of cervicopharyngeal symptomatology as it relates to the stylohyoid chain. Four interesting findings were reported. First, the vast majority of patients with symptoms who had a true stylohyoid chain ossification are 40 years of age and older. Second, very few of these patients give detailed histories of tonsillectomy or other recent neck trauma. Third, the majority of patients without symptoms with radiographic evidence of stylohyoid chain ossification are young. Fourth, some older patients with symptoms may tolerate their symptoms well in spite of not having had surgery performed for removal of the ossification. As a result of this literature review and the confusion with respect to the many associated syndromes, we proposed a simplified classification of such patients according to etiologic factors. A diagnosis of Eagle's syndrome is applied only when patients have no history of such ossification before trauma; such ossification develops in patients within a period of time after trauma, with accompanying symptoms; patients demonstrate such ossification clinically (on palpation) and radiographically (after trauma) as a result of either the Theory of Reactive Hyperplasia or the Theory of Reactive Metaplasia.

A diagnosis of stylohyoid syndrome is applied only when patients have possible clinical (on palpation) evidence and definite radiographic evidence of stylohyoid chain ossification and/or styloid process elongation; there is no history of previous cervicopharyngeal trauma; such ossification has occurred during childhood or early adolescence without initial symptoms, according to the Theory of Developmental Anomaly.

A diagnosis of pseudo-stylohyoid syndrome is applied only when there is no clinical palpation or radiographic evidence of stylohyoid ligament ossification; there is no history of previous cervicopharyngeal trauma; patients have symptoms typical of the patients with stylohyoid syndrome.

The evidence presented would seem to indicate that anatomically abnormal and ossified stylohyoid ligaments develop in a significant number of young healthy persons during their early formative years, and that many years may pass before symptoms possibly occur. Such symptoms may occur as a result of loss of surrounding soft tissue elasticity about the possibly slowly and continuously ossifying stylohyoid.
Table I. Stylohyoid syndrome subjective symptomatology

<table>
<thead>
<tr>
<th>Primary Complaints</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysphagia</td>
<td>80%</td>
</tr>
<tr>
<td>Sensation of foreign body in throat</td>
<td>55%</td>
</tr>
<tr>
<td>Constant dull ache in throat</td>
<td>40%</td>
</tr>
</tbody>
</table>

Secondary complaints

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Otalgia</td>
<td>40%</td>
</tr>
<tr>
<td>Headache</td>
<td>25%</td>
</tr>
<tr>
<td>Pain in distribution of carotid artery</td>
<td>20%</td>
</tr>
<tr>
<td>Pain in temporomandibular joint</td>
<td>10%</td>
</tr>
<tr>
<td>Glossopharyngeal neuralgia</td>
<td>10%</td>
</tr>
<tr>
<td>Generalized facial pain</td>
<td>5%</td>
</tr>
</tbody>
</table>


ANATOMY AND RADIOLOGY

The styloid process is normally a cylindrical spur of bone tapering as a pointed free end, the architecture of which may differ in human beings. Medially, the lingual, facial, superficial temporal, maxillary, and internal carotid arteries, as well as the internal jugular vein and sphenomandibular ligament, are found. Laterally, the facial and hypoglossal nerves, the occipital artery, and the posterior belly of the digastric muscle are found. Also originating in the styloid process are the sphenomandibular ligament and the stylopharyngeus, styloglossus, and stylohyoid muscles. The stylomandibular ligament occurs as a thickening of the deep cervical fascia, extending from the styloid process to the posterior border of the mandibular angle. As mentioned previously, the stylohyoid chain consists of the styloid process of the temporal bone, the lesser cornu of the hyoid bone, and the stylohyoid ligament.

The radiographic studies most often used to diagnose an elongated and ossified styloid process and/or ossified stylohyoid chain are the panoramic view (most used), the lateral and lateral oblique mandibular and neck views, the anteroposterior view, and the submental vertical view. Ciné-barium studies may be of some benefit. Although very useful, very few computer axial tomography (CAT) scans or nuclear magnetic resonance (NMR) studies have been performed for these patients.

Radiographically, a bony enlargement may be seen close to the base of the styloid process. From this point, the remainder of the process is usually straight but there may at times be a marked curvature. The stylohyoid chain may consist of three unfused but ossified elements: tympanohyal, stylohyal, and epihyal. Interestingly, if complete ossification of all elements occurs, this condition is usually unilateral. However, the thickness, the length of the parts, and the relation of the parts to one another usually remain unsymmetrical. For example, at times, the tympanohyal and epihyal elements are
continuous as a single ossification. At other times, all elements are fused. Finally, but rarely, all elements may remain ossified but separate and held together by fibrous connective tissue continuous with the periosteum. The findings summarized in Table II reflect the variability observed in measuring the length of such ossification.

METHOD

One hundred fifty panoramic radiographs from the pedodontic files of the Department of Dentistry at St. Justine's Hospital were selected at random. The styloid processes were then measured from the cranial base up to the osseous tip of each process. Similarly, if ossification of the stylohyoid ligament in part or in whole was observed, its length was measured beginning, if possible, at the tip of the styloid process. If no distinction between the styloid process and the ossified stylohyoid ligament was possible, then the entire osseous length of the stylohyoid apparatus was measured as a unit. Whenever a ligament was seen as a segmental ossification along its length, these segments were individually measured to arrive at a total true osseous length. All measurements were made with the panoramic radiograph, a radiographic viewer, and a transparent millimeter radiology ruler. Results were tabulated and graphs were prepared with the use of a computer.

RESULTS

Patients varied in age from 2 years to 21 years. The mean age was 11 years (Figs. 1 and 2). Styloid process length varied from 1 mm to 30 mm, the mean length being 10 mm. Of the 150 panoramic radiographs examined (300 stylohyoid chains), 61 patients (40.7%) had definitive ossification of a part or all of the stylohyoid ligament (Fig. 3).

Whenever a distinction could be made between the tip of the styloid process and the initial ossification of the stylohyoid ligament, the ossified ligament was measured. Whenever the styloid process and stylohyoid ligament were seen to be a continuous ossification, the entire length was measured, from the base of the styloid process to the tip of the stylohyoid ligament ossification. With the use of these two methods, stylohyoid ligament ossification varied from 5 mm to 35 mm. Of the 61 patients, 37 (60.1%) were male and 24 (39.9%) were female.

To rule out preexisting cervicopharyngeal trauma as a possible cause, the medical and dental charts of these 61 patients were thoroughly reviewed. Moreover, any record of cervicopharyngeal symptoms possibly related to such ossification was evaluated (for example, pain on deglutition). Forty patients (65.6%) had no recorded history of tonsillectomy or other cervicopharyngeal trauma. Of the remaining 21 patients (34.5%), 13 (21.3%) had had cleft palate surgery, 4 (6.6%) had undergone tonsillectomies, 1 (1.6%) had undergone an adenoidectomy, 1 (1.6%) had had head trauma with subsequent complaints relating to the temporomandibular joint, 1 (1.6%) had had a cranial fracture, and 1 (1.6%) had undergone a tympanoplasty. There were no reported subjective symptoms in any of these 61 patients with partial or complete stylohyoid ligament ossification either at the time of or before the examination. Moreover, whenever an ossified stylohyoid ligament was noted radiographically, it was most always unilaterally observed in the same patient. In those
panoramic radiographs that demonstrated bilateral stylohyoid ligament ossification, such ossification was more marked (longer) on one side than on the other.

DISCUSSION

Before presenting our findings, we must state that radiographic measurements of ossified anatomic structures are as reliable as the controls that the operator accurately maintains on the procedure. Several studies have concluded that there is much variation in the length and shape (radiologically viewed) of the styloid process. In general, however, styloid processes greater than 25 mm in length, as measured on panoramic radiographs from the cranial base to the tips of the processes, are considered to be of abnormal length. Such elongated styloid processes are capable of causing symptoms related to the compression of the carotid arterial system on lateral head movement.

One must also state that when the two most commonly used radiographic modalities—the panoramic and cephalometric radiographs—are considered, the styloid processes and the stylohyoid ligaments (if ossified) appear shorter on the panoramic radiograph than on the cephalometric radiograph because of the lateral curvature distortion inherent in the former technique. Moreover, studies comparing anatomic and radiographic measurements of the processes and ossified ligaments seem to conclude that the processes measured are actually longer in vivo than they are on radiographic appearance. Results from our study seem to indicate that since the mean length of the 300 styloid processes measured (150 panoramic radiographs) is 10 mm, this is well within the acceptable “normal” length of at most 25 mm. Since this mean length is used as the standard reference point to determine abnormality in this study, we can conclude that a developing anatomic variant of the styloid process rarely occurs in childhood or adolescence. On the other hand, 40.7% of the population we studied did have radiographic evidence of a significant ossification of part or all of the stylohyoid ligament.

SUMMARY

One hundred fifty panoramic radiographs of different patients chosen at random at the pedodontic clinic of the Department of Dentistry at St. Justine’s Hospital were studied, and measurements were recorded of all elongated styloid processes and/or ossified stylohyoid ligaments. In general, it was found that the styloid process length does not vary proportionately with age, and that the mean length measured reflected the belief that an abnormally long styloid process rarely exists as an anatomic variant in childhood or adolescence.

On the other hand, a significant number of the patients studied (40.7%) did have radiographic evidence of partly or completely ossified stylohyoid ligaments. Moreover, a majority (65.6%) of these latter patients did not report a history of cervicopharyngeal trauma, such as tonsillectomy, during a review of the medical and dental histories. Nor was there a history of related symptoms such as, for example, pain on deglutition or on lateral movement of the head or neck. Of further interest was the observation that stylohyoid ligaments, if ossified, were almost always unilateral in the same patient.

These findings lead us to believe that in childhood...
and adolescence, a statistically significant number have radiographic evidence of an ossification of a part or all of the stylohyoid ligament on panoramic interpretation. We may also conclude that such abnormal anatomic development in length is not true of the styloid process alone. Because 65.6% of the patients with such ossification related no history of cervicopharyngeal trauma whatsoever, we may also conclude that such ossification is most probably and usually an anatomic developmental anomaly.

If 2% to 4% of the general adult population has such elongated ossification of the styloid process and/or stylohyoid ligament as a developmental anomaly on routine panoramic study,¹ then why should such a discrepancy in frequency of occurrence exist between these two studies? Does such abnormal ossification degenerate in time? Before adopting this philosophy, one must accept the fact that radiographic interpretation and measurements may be different from one study to the next. However, this being the case, the present study confirms that such a developmental abnormality exists in the general population, and more specifically, that such asymptomatic ossification of the stylohyoid ligament does exist in childhood and adolescence.

If such a finding can be further extrapolated to the general adult population, since these same patients will eventually become adults, the next question would involve symptoms. That is to say, although no symptoms were related to such abnormal ossification in this young population, there is a statistically significant incidence of such patients in the older age group with related symptoms. If one proposes that it is this same group that goes on to form the large majority of the older patients with stylohyoid syndrome who have symptoms, then we may propose that symptoms may develop slowly over years as a result of the gradual loss of surrounding soft tissue elasticity. Such soft tissues become less adaptable to the possible further ossification of the stylohyoid ligaments over the years, offering more resistance during movements of the head and neck during deglutition. The only obvious experimental protocol that could prove or disprove this hypothesis would involve the long-term study, both radiographically and clinically, of these 61 patients with symptoms who have ossifying stylohyoid ligaments. Such a follow-up would allow us to observe further ossification, as well as to evaluate developing symptoms. The evidence presented, however, does seem to indicate that stylohyoid syndrome may far surpass either Eagle's syndrome or the pseudo-stylohyoid syndrome as the potential principal diagnosis in such patients with symptoms.

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**Table III. Distribution of patients with ossification of the stylohyoid apparatus according to age category**

<table>
<thead>
<tr>
<th>Age category (yr)</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>1</td>
</tr>
<tr>
<td>4-6</td>
<td>3</td>
</tr>
<tr>
<td>7-9</td>
<td>10</td>
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<td>10-12</td>
<td>18</td>
</tr>
<tr>
<td>13-15</td>
<td>19</td>
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<tr>
<td>16-18</td>
<td>9</td>
</tr>
<tr>
<td>19-22</td>
<td>1</td>
</tr>
</tbody>
</table>

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**Fig. 3.** Distribution of patients with ossification of stylohyoid apparatus according to age category.
REFERENCES


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