

---

# Variability of the styloid process and stylohyoid ligament in panoramic radiographs

Paul A. Monsour and William G. Young, Brisbane, Australia

DEPARTMENT OF ORAL BIOLOGY AND ORAL SURGERY, UNIVERSITY OF QUEENSLAND DENTAL SCHOOL

This article deals with the incidence of anatomic variations in the styloid process and stylohyoid ligament as found in panoramic radiographs. Also, the accuracy was determined for measuring the length of styloid processes from panoramic radiographs, the variation in length of the styloid process with age, and the relationship of elongated styloid processes and ossified stylohyoid ligaments to symptoms of styloid-stylohyoid syndrome. Variations in styloid process and stylohyoid ligaments are not uncommon, especially segmentation of the process in young subjects. The apparent length of the styloid process was magnified approximately 1.37 times and was never diminished by panoramic radiographs. A steady increase in styloid process length was observed to age 30 years, with another slight increase starting at age 60 years. Subjects with elongated styloid processes (>40 mm) had the highest incidence of discomfort on swallowing, whereas subjects with ossification of the stylohyoid ligament had the highest incidence of discomfort on turning the head from side to side.

(ORAL SURG. ORAL MED. ORAL PATHOL. 61:522-526, 1986)

With the increasingly widespread use of panoramic radiographs in dental practice, dentists have become more aware of the variations in the styloid process and the stylohyoid ligament. When an apparent enlargement of the process or ossification of the ligament is detected, the clinician may be at a loss to know whether this is normal for the patient's age and sex and whether it is related to symptoms expressed by the patient.

Elongation of the styloid process and ossification of the stylohyoid ligament were reported as early as 1870.<sup>1</sup> Eagle<sup>2</sup> reported 4% incidence of styloid elongation; however, Kaufman et al.,<sup>3</sup> in a study of 484 patients, found that the incidence of elongation and calcification was 28%. Barclay and Donaldson<sup>4</sup> reported ossification of the stylohyoid ligament in fewer than 1% of 100 edentulous patients surveyed radiographically.

The styloid process and the stylohyoid ligament are derived from the second branchial arch (Reichert's cartilage) and form part of a chain that connects the temporal bone to the hyoid bone.<sup>1</sup> In the adult the stylohyoid ligament, which is normally composed of dense fibrous connective tissue, may retain some of its embryonic cartilage and thus have the potential to become partially or completely ossified.

The styloid process is normally a slender, cylindrical bone located immediately in front of the stylo-mastoid foramen and fused to the inferior aspect of the temporal bone. It normally lies between the internal and external carotid arteries and has three muscles and two ligaments attached to it. The tip of the styloid process is continuous with the stylohyoid ligament, which extends to the lesser cornu of the hyoid bone.<sup>5</sup> The mean radiographic length of the styloid process has been reported to be between 20 and 30 mm.<sup>1, 3, 5-7</sup>

Elongated styloid processes and/or ossification of the stylohyoid ligament may result in styloid-stylohyoid syndrome, that is, vague facial pain, throat discomfort, otalgia, dysphagia, and pain along the distribution of the internal and external carotid arteries.<sup>6, 8-12</sup> Ettinger and Hanson<sup>13</sup> have reported emotional distress and cancerophobia in a patient in whom the syndrome had not been diagnosed. Abnormal variations in the styloid process and/or stylohyoid ligament may present anatomic obstacles in tonsillectomy and orthognathic surgery.<sup>14</sup>

Although variations of the styloid process and the stylohyoid ligament have been observed and measured on panoramic radiographs,<sup>3, 4, 13, 15</sup> the dimensions of these images may be subject to distortion from panoramic radiographic techniques. The pan-

oramic radiograph is designed primarily to display the dentition and the maxilla and mandible; the styloid process is demonstrated only fortuitously. Because the angulation and length of the process may vary with patients and with the panoramic unit in use, the apparent length of the process may also vary on the radiograph.

The purposes of this study were to (1) record the incidence of anatomic variations in the styloid process and stylohyoid ligament as found on panoramic radiographs, (2) determine the accuracy of measurements of styloid processes from such radiographs, (3) measure the lengths of styloid processes to determine their normal variation with age and sex, and (4) relate processes of abnormal length and ossifications of the ligament to symptoms of the styloid-stylohyoid syndrome.

### MATERIALS AND METHODS

To determine the accuracy of length measurements of styloid processes in panoramic radiographs, a wire of known length was attached with radiolucent material to the lateral aspect in the long axis of six styloid processes on three dried skulls.

The skulls were mounted in the Orthopantomograph (Palomex/Instrumentarium OY, Hyryla, Finland, distributed by Siemens Corp., Iselin, N.J.), with the Frankfort plane horizontal, in the manner described by the manufacturer for the live patient. To allow for the clinical variables of patient positioning by different radiographers, the skulls were positioned three times for each styloid process by three different radiographers, and radiographs were taken on each occasion. Radiographs were exposed for 15 seconds at 55 kV. The radiographs were developed and dried in the same manner by automatic processing. The three apparent lengths of the wire were measured from the radiograph with the same steel metric rule graduated in millimeters. The mean apparent length of the wire was calculated to determine whether the real length was magnified or reduced.

To study variations of the styloid process and stylohyoid ligament in patients of known age and sex, more than 1200 panoramic radiographs from patient records at the University of Queensland Dental School, which had been taken with the same x-ray unit as above, were examined. In 549 of these, at least one complete styloid process was measurable, and a total of 670 processes were measured. The presence of anatomic variations of the styloid process and of ossification of the stylohyoid ligament were recorded by the classification illustrated in Fig. 1. The apparent lengths of 670 styloid processes were measured with the same steel metric rule as above,



**Fig. 1.** Tracings taken from panoramic radiographs illustrating classification and frequency of styloid processes and stylohyoid ligament variations. Normal appearance of the styloid process (a), forms of segmented styloid processes (35%, b, c, and d), elongated styloid processes (>40 mm, 21.1%, e), bent styloid processes (4.5%, f), partial ossification of the stylohyoid ligament (9.4%, g), prominent lesser cornu of the hyoid bone (3.0%, h). Relationship of stylohyoid chain to dental landmarks as seen in panoramic radiographs is also shown.

from the point of emergence of the process from the temporal bone to their tips as recorded on the radiograph, regardless of whether or not they were segmented. These data were then subjected to a regression analysis, and a correlation coefficient between length and age was calculated. Means and standard errors of measurements of styloid process length were calculated for seventeen groups of subjects ranging from 8 to 76 years of age in consecutive 4-year age-group intervals.

Twenty subjects of either sex with styloid processes less than 30 mm long on the radiograph, twenty subjects with styloid processes greater than 40 mm, and twenty subjects with partial ossification of the stylohyoid ligament were interviewed concerning symptoms of styloid-stylohyoid syndrome. The interviews were conducted by telephone, and the subjects were asked a series of questions detailed in Table I. The answers were recorded as positive, negative, or uncertain. Only positive responses were used as the data. Three subjects who wore dentures and were unhappy with them and one subject with multiple sclerosis were excluded and replaced in the sample by four subjects with processes of equivalent

**Table I.** The number of positive responses to twelve questions concerning styloid-stylohyoid syndrome from three groups of twenty subjects, with or without elongated styloid processes or with ossification of the stylohyoid ligament

Question	Styloid processes <30 mm	Styloid processes >40 mm	Ossified stylohyoid ligament
Have you had your tonsils removed?	8	13	7
If so, have you had discomfort in your tonsillar region since their removal?	2	6	3
Do you experience discomfort in the back of your mouth when swallowing?	0	4	1
Do you ever get the feeling that a sharp object is caught in your throat?	0	5	2
Do you suffer discomfort in your throat after prolonged speaking?	0	7	2
Do you suffer from frequent headaches?	2	8	3
Do you suffer from arthritis?	1	8	2
Do you suffer discomfort in your throat or the front of your neck when turning your head from left to right?	1	4	7
Do you suffer from frequent earaches?	1	4	5
Do you suffer from pain in the jaw joint?	1	2	4
Do you suffer from vague facial pain?	0	1	1
Have you ever sought medical advice for any of your complaints?	0	2	2

length. Because of the small number of subjects in the group, no statistical analysis was performed, and no attempt was made to correlate frequency of symptoms with the sex of the subjects.

## RESULTS

Anatomic variations of the ossified components of the styloid process and stylohyoid ligament occurred with equal frequency in both male and female subjects. The most common variation (37%) was segmentation of the styloid process (Fig. 1, *b*, *c*, and *d*). With increasing age, the percentage of segmented styloid processes diminished. Segmentation was present in 41.5% of subjects under 21 years of age and in 24.5% of subjects over 20 years of age (Fig. 2). The next most common variation was elongation of the styloid process, which occurred in 21.1% of the subjects (Fig. 1, *e*). Partial ossification of the stylohyoid ligament was observed in 9.4% of the subjects (Fig. 1, *g*). Bent styloid processes (Fig. 1, *f*) were less commonly observed (4.5%), and few enlargements of the lesser cornu of the hyoid bone (Fig. 1, *h*) were found (3%).

The apparent length of the wire on any one process was not affected by changing radiographers, since no significant differences were found between the three measurements. The apparent length of the wire was moderately affected by changing it onto different processes as the mean magnifications of the wire on

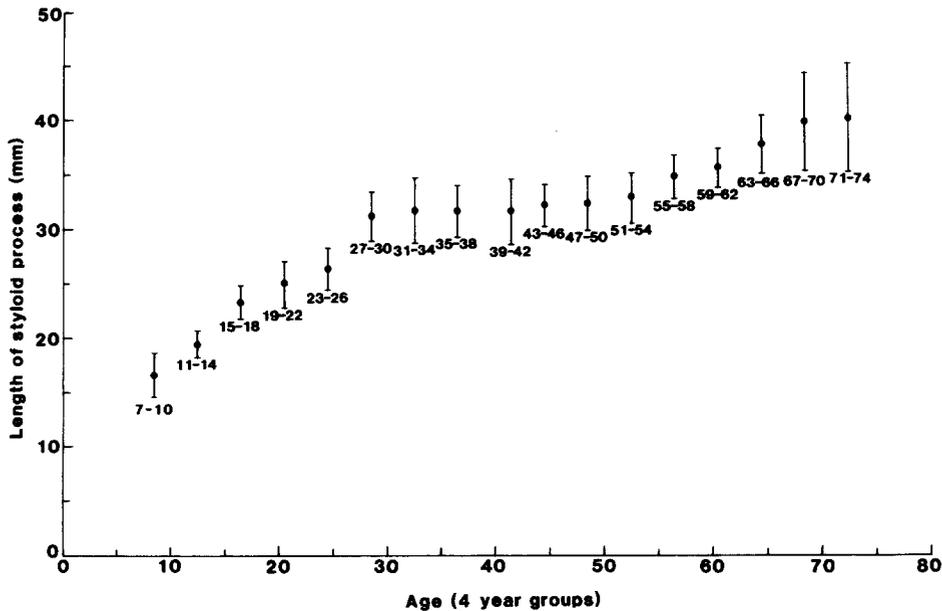
different processes ranged from  $\times 1.3$  to  $\times 1.49$ . The overall mean magnification was  $\times 1.37$  (standard error,  $\times 0.11$ ).

The apparent lengths of the 670 styloid processes measured ranged from 6 to 71 mm, mean 29.20 (standard error, 4.85 mm). The regression analysis showed that the processes increased in length with age. The coefficient of correlation was 0.6257. The means and standard errors for the 4-year age group are shown in Fig. 3, which illustrates that the apparent length of processes increased gradually to age 30 years and then leveled; another small rise followed, starting at age 60 years (Fig. 3). No statistically significant difference in length was found between male and female subjects.

The responses of the subjects surveyed showed that 86% of the positive responses regarding symptoms were from patients who had processes greater than 40 mm, partial ossification of the stylohyoid ligament, or both. Subjects with processes greater than 40 mm also had the highest incidence of arthritis, headaches, and discomfort following prolonged speaking (Table I). Patients with partial ossification of the stylohyoid ligament gave more positive responses about discomfort on turning their heads (Table I). Of subjects with styloid processes greater than 40 mm, 27% were symptom free, 25% of subjects with partial ossification of the stylohyoid ligament were symptom free, and 83% of subjects



**Fig. 2.** Histogram showing that percentage of subjects with segmented styloid processes decreased with increasing age.



**Fig. 3.** Comparison between age of subject and length of styloid process. Mean length of styloid process for 4-year age groups is plotted with  $\pm 2$  standard error bars. With increasing age, the length of the styloid process increased and plateaued at age 30 years. A minor increase in length was apparent at 65 years.

with processes less than 30 mm on radiographs were symptom free.

**DISCUSSION**

Segmentation of the styloid process is a variation of normal and should not be mistaken for a fracture of the process, as mentioned by Manson-Hing.<sup>16</sup> It probably represents one pattern of progressive ossification, because approximately 40% of subjects younger than 20 years of age had segmentation and its incidence diminished with age (Fig. 2). Segmenta-

tion has not been previously reported in subjects younger than 20 years of age. Kaufman et al.<sup>3</sup> reported segmentation present in 12.9% of adults. Partial ossification of the stylohyoid ligament was moderately common in adults (9.4% of subjects). It is interesting that no examples were found in subjects younger than 18 years of age, since this further suggests that ossification progresses with age. However, Barclay and Donaldson<sup>4</sup> reported only a 7% incidence of ossification in the stylohyoid ligament in 100 edentulous subjects.

As radiographs of the dried skulls magnified the wire attached to the styloid processes, it was necessary to correct measurements from panoramic radiographs by a reduction of approximately 37% to obtain the actual length of the process. Thus, the mean radiographic length of styloid processes measured (29.20 mm) converts to 18.47 mm. It can be said that panoramic radiographs do not accurately reproduce the length of the styloid process. However, they can indicate when the styloid process is elongated. Panoramic radiographs do show qualitative variations in the stylohyoid chain as well.

The moderately high incidence of elongated styloid processes found in our study (21.1%) is not in agreement with the findings of Eagle<sup>2</sup> (incidence of only 4%). Kaufman et al<sup>3</sup> found that approximately 25% of adults had elongation of the styloid process (>30 mm on panoramic radiograph), which is more in agreement with the findings in this study.

The increasing length of the styloid process with age does indicate a process of continuing growth with age, which slows down between the ages of 30 and 50 years. An apparent increase in length after 50 years of age may reflect an aging change. These findings do not agree with the conclusions of Bernfeld,<sup>17</sup> who reported that by age 5 to 8 years the process of continuing ossification is normally quite advanced and often concluded.

The data presented in Fig. 3 should be clinically useful in determining when a process, measured from a radiograph, falls into the normal range for that age group. The finding that processes in children are smaller than the mean that is usually quoted for adults may allow young patients with abnormally long processes to be identified before the onset of symptoms of the styloid-stylohyoid syndrome.

The main finding from the survey was that subjects with elongated styloid processes, partial ossification of the stylohyoid ligament, or both had a greater chance of having the symptoms of styloid-stylohyoid syndrome. The findings also support separation of the styloid-stylohyoid syndrome into two forms: elongation of the process and ossification of the ligament.<sup>11,12</sup> The group in which the styloid processes were greater than 40 mm had the highest incidence of discomfort on swallowing, throat discomfort, discomfort following prolonged speaking, headaches, and pain in the side of the neck. These findings are consistent with the concept that the elongated styloid process impinges either on nerves in the tonsillar fossa<sup>12</sup> or on tonsillectomy scarring.<sup>11</sup> Subjects with partial ossification of the ligament had the highest incidence of discomfort in the side of the neck. These subjects commonly complained that they felt as if a nerve were being pinched in the neck when

they turned their heads. This group also had the highest incidence of temporomandibular joint discomfort and a relatively high incidence of ear tenderness. Such symptoms have been ascribed to pressure from the ossified ligament on the internal or external carotid artery.<sup>11</sup> The higher incidence of arthritis in patients with elongated styloid processes probably reflects the coincidental finding of arthritis and longer processes in older subjects, rather than an association between arthritis and elongation. Elongation of the styloid process or partial ossification of the stylohyoid ligament does not necessarily result in symptoms, since 27% of subjects with elongated processes and 25% with ossification of the ligament were symptom free.

#### REFERENCES

1. Dwight T: Stylohyoid ossification. *Am Surg* **46**: 721, 1907.
2. Eagle WW: Symptomatic elongated styloid process. *Arch Otolaryngol* **49**: 490-503, 1949.
3. Kaufman SM, Elzay RP, Irish EF: Styloid process variation radiologic and clinical study. *Arch Otolaryngol* **91**: 460-463, 1970.
4. Barclay JK, Donaldson KI: Panoramic radiography of the edentulous jaws—a survey of 100 patients. *NZ Dent J* **66**: 53-60, 1970.
5. Gray H: *Anatomy of the human body*, ed. 35, Edinburgh, Scotland, 1973, Longman Group Ltd., p. 507.
6. Donohue WB: Styloid syndrome. *J Can Dent Assoc* **25**: 283-286, 1959.
7. Stafne EC, Hollinshead WH: Roentgenographic observations on the stylohyoid chain. *ORAL SURG ORAL MED ORAL PATHOL* **15**: 1195-1200, 1962.
8. Balasubramanian S: The ossification of the stylohyoid ligament and its relation to facial pain. *Br Dent J* **114**: 108-111, 1964.
9. Steinmann EP: A new light on the pathogenesis of the styloid syndrome. *Arch Otolaryngol* **91**: 171-174, 1970.
10. Dayal US, Morrison MO, Dickson TGM: Elongated styloid process. *Arch Otolaryngol* **94**: 174-179, 1971.
11. Messer EJ, Abramson AM: The stylohyoid syndrome. *J Oral Surg* **33**: 664-667, 1975.
12. Gossman JR, Tarsitano JJ: The styloid-stylohyoid syndrome. *J Oral Surg* **35**: 555-560, 1977.
13. Ettinger RL, Hanson JG: The styloid or "Eagle" syndrome: an unexpected consequence. *ORAL SURG ORAL MED ORAL PATHOL* **336-339**, 1975.
14. Braun TW, Sotereanos GC: The styloid process as an anatomic hindrance in orthognathic surgery. *J Oral Maxillofac Surg* **41**: 676-679, 1983.
15. Marano PO, Fenster GF, Gosselin CF: Eagle's syndrome necessitating bilateral styloid amputation. *ORAL SURG ORAL MED ORAL PATHOL* **33**: 874-878, 1972.
16. Manson-Hing LR: The stylohyoid chain. *ORAL SURG ORAL MED ORAL PATHOL* **27**: 338-343, 1969.
17. Bernfeld K: Zur Begriffsleestimmung und Pathogenese eines neuem Krankheitsbildes, des sog: Styloideus-Symptomenkomplexes. *Z Laryngol Rhinol* **23**: 107-114, 1982.

#### Reprint requests to:

Dr. P. A. Monsour  
Department of Oral Biology and Oral Surgery  
Physiology Building  
University of Queensland  
St. Lucia 4067, Brisbane, Australia