A Post Mortem Study of Elongated Styloid Processes in a Jamaican Population

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Citation


Abstract

Autopsy studies in predominantly Caucasian populations have suggested that elongated styloid processes occur bilaterally in 75% of cases without a sex predilection. This is the first anthropometric study of elongated styloid processes in a Caribbean population. A retrospective observational study of all cadaver dissections at the University of the West Indies was performed over three years from January 2006 to January 2009. All dried skulls with styloid process lengths >30mm were studied in detail. Styloid process length and diameter were measured using a standardized caliper technique. There were 5 skulls with elongated styloid processes at a mean length of 4.58cm on the left side (SD +/-1.32; Range 3.2-6.3; Median 4.4; Mode -) and 3.58cm (SD +/-0.33; Range 3.2-4.0; Median 3.55; Mode -) on the right. The skulls were predominantly male (4:1 ratio) at a mean estimated specimen age of 60.4 years (SD +/-6.19; Range 50-65; Median 62; Mode 65). There were features of true elongation (uniformly contoured styloid processes with smooth, thick cortices and a rounded tip) in 4 male skulls while the sole female specimen had features suggestive of secondary ossification of the stylohyoid ligament (irregular surface with thickened segments extending toward the lesser horn of the hyoid bone with marked medial angulation). There may be an association between male sex, Afro-Caribbean descent and a genetic predisposition to true SP elongation. Continued evaluation of a larger study cohort is required before a definitive association can be ascertained.

INTRODUCTION

The styloid process (SP) is a slender projection of bone that arises from the inferior surface of the temporal bone just beneath the external auditory meatus (Fig. 1). The normal adult SP length is considered to be between 20mm [1] and 30mm [2].

Figure 1

Figure 1: A dried adult human skull demonstrating normal styloid processes (arrows) as seen from the postero-anterior (1a) and infero-lateral (1b) views. The SPs measure 1.2cm (right) and 1.45cm (left).

It has already been noted that there is a high incidence of elongated SPs during routine cadaver dissections at the University of the West Indies in Jamaica [3]. However, there has been no prior report on the anthropometric features of elongated SPs in this setting. To the best of our knowledge, this is the first anthropometric report of elongated SPs in a post mortem series of skulls from the Caribbean.

METHODS

The University Hospital of the West Indies in Jamaica is a teaching hospital that is responsible for undergraduate and postgraduate training in all medical science disciplines. In this setting, gross anatomy is demonstrated using cadavers that have been donated to the Faculty of Medical Sciences for this expressed purpose. During routine dissections, we have encountered several specimens with elongated SPs.

We performed a retrospective observational study of all head and neck cadaver dissections done at the University of the West Indies during teaching sessions from January 2006 to January 2009. The dried skulls of all specimens encountered with a SP >30mm in length were included in this study.

An independent investigator measured the length and diameter of each SP using 150mm dial calipers (General Tools, MFg Co., New York, USA). Standardized
measurements of length were taken from the base to the apex of each SP. The base of the SP was considered to be the inferior surface of the temporal bone at the junction of its petrous and tympanic portions while the apex was defined as the bony tip. Separate measurements of right and left SP were taken.

Cadaver sex was determined based on cranial and pelvic morphology, when available [5]. Cadaver age was estimated based on pubic symphysis morphology [6], iliac surface morphology [7], ectl-cranial suture closure [8] and sternal rib end changes [9,10], when available.

RESULTS

There were five skulls from cadavers that had preserved elongated SPs. The longest SP occurred in a 60 year old male skull, measuring 6.3cm in length (Specimen 1).

Figure 2

Specimen 1: An adult human skull (specimen 1) viewed from the postero-inferior and lateral aspects. Elongated SPs measure 63mm on the left and 45mm on the right.

The skull bones were intact, with exception to minor breakage of the small nasal bones. There were 2 cases in which one SP was broken and/or missing, thereby precluding accurate evaluation (Specimen 3 and 5). However it was clear on observation that these SPs were longer than 30mm when artificially re-approximated.

Figure 3

Specimen 3: An adult human skull from specimen 3 viewed from the postero-inferior and lateral aspects.

Figure 4

Specimen 5: An adult human skull viewed from the postero-inferior and lateral aspects.

There was a preponderance of male skulls with a 4:1 male to female ratio. The elongated SPs occurred in skulls at a mean estimated age of 60.4 years (SD +/-6.19; Range 50-65; Median 62; Mode 65).

Full ante-mortem dentition was preserved in one skull from a 50 year old male, with thickened well developed SPs bilaterally (Specimen 2). One skull from a 65 year old male still had remnant dentition: 1 left upper and 2 right upper molars (Specimen 4). The remaining four skulls were edentulous at the time of death, with relatively robust, thickened maxillae and mandibles.
Figure 5
Specimen 2: An adult human skull (specimen 2) viewed from the postero-inferior and lateral aspects.

Figure 6
Specimen 4: An adult human skull (specimen 4) viewed from the postero-inferior and lateral aspects.

The individual characteristics of the SPs are listed in Table 1. The mean SP length in skulls with intact SPs was 4.58 cm on the left side (SD +/-1.32; Range 3.2-6.3; Median 4.4; Mode -) and 3.58 cm (SD +/-0.33; Range 3.2-4.0; Median 3.55; Mode -) on the right.

Figure 7
Table 1: Styloid Process Morphology in a Series of Cadaver Skulls in a Jamaican Population

<table>
<thead>
<tr>
<th>No</th>
<th>Sex</th>
<th>Age (yr)</th>
<th>Antemortem condition</th>
<th>SP Side</th>
<th>SP Length</th>
<th>Thickened diameter</th>
<th>SP Angulation</th>
<th>Surgical scar</th>
<th>Morphological fracture of the SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>69</td>
<td>Edentulous</td>
<td>Lt</td>
<td>6.7 cm</td>
<td>6.8 cm of middle</td>
<td>Medial</td>
<td>16°</td>
<td>Smooth, angular process with thick cortex and rounded tip.</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>50</td>
<td>Full dentition</td>
<td>Lt</td>
<td>4.7 cm</td>
<td>7.1 cm of middle</td>
<td>Medial</td>
<td>16°</td>
<td>Smooth, angular process with thick cortex and rounded tip.</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>62</td>
<td>Edentulous</td>
<td>Lt</td>
<td>3.5 cm</td>
<td>3.5 cm of middle</td>
<td>Medial</td>
<td>20°</td>
<td>Smooth, angular process with thick cortex and rounded tip.</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>65</td>
<td>Edentulous</td>
<td>Lt</td>
<td>4.5 cm</td>
<td>6.2 cm of middle</td>
<td>Medial</td>
<td>20°</td>
<td>Smooth, angular process with thick cortex and rounded tip.</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>65</td>
<td>Mandibular osteotomy on left</td>
<td>Lt</td>
<td>3.5 cm</td>
<td>5°</td>
<td>Medial</td>
<td>20°</td>
<td>Smooth, angular process with thick cortex and rounded tip.</td>
</tr>
</tbody>
</table>

Abbreviations: M = Male, F = Female, * = Denture, Lt = Left, Rt = Right, J = Junction of proximal third and distal two thirds of process measured from AP view.

Only one specimen had a SP with a smooth uniform base and thick bony cortex that was replaced at the distal third of its length with an irregular nodular tip (Fig. 4). The tip was delicate and pointed with pronounced medial angulation.

DISCUSSION
The SP is a slender projection of bone that arises from the inferior surface of the temporal bone just beneath the external auditory meatus. The normal adult SP length is considered to be between 20 mm [1] and 30 mm [2].

The SP tip lies in the pharyngeal wall lateral to the tonsillar fossa [1,2,3,4] where it is flanked by several neurovascular structures: Internal Carotid Artery, Internal Jugular Vein and Cranial Nerves X, XI and XII lie on its medial side; Cranial Nerve VII lies antero-medially; Cranial nerve IX exits the jugular foramen and curves under the SP.

There are also ligaments (stylohyoid; stylomandibular) and muscles (styloglossus; stylohyoid; stylopharyngeus) arising from the SP that stabilize the hyoid bone during normal oropharyngeal functions. The stylohyoid ligament (SHL) arises from the SP tip and attaches to the lesser cornu of the hyoid bone. This anatomic complex, collectively termed the stylohyoid chain, is important in the aetiology of stylohyoid syndromes [1,2,3].

The stylohyoid chain components are derived embryologically from the first and second branchial arches in four distinct segments: tympanohyal, stylohyal, ceratohyal and hypohyal segments [1,4]. These segments are derived from Reichert’s cartilages that ossify in 2 parts. The SP develops from the tympanohyal (first) and stylohyal (second) segments that usually fuse at puberty. The lesser cornu of the hyoid bone arises from the hypohyal (fourth) segment. Connecting these two structures, the SHL originates from the ceratohyal (third) segment. It is normally composed of dense fibrous connective tissue in adults but may retain its embryonic cartilage and the potential for ossification [1,2].

Several theories have been proposed to explain the induction of ossification, including congenital factors [1], reactive metaplasia after local trauma [4,14], calcification with the ageing process [15], subtle neck trauma that causes an unregulated inflammatory response [15] and callus deposition from sub-clinical SP fractures [15,16,17].

Excessive or abnormal ossification of stylohyoid chain components may result in several peculiarities including true
SP elongation and thickening of the hyoid bone \([_{111}1415]\). A solid stylohyoid chain results when the entire SHL ossifies, but many variations can occur including incomplete ossification, segmentation, pseudo-articulation and variations in thickness and/or angle \([_{111}]\). The resultant abnormal stylohyoid chain may then compress or irritate nearby structures and is believed to be responsible for the stylohyoid syndromes \([_{411}231716]\).

Many different names have been coined to describe the presence of symptoms associated with an elongated stylohyoid chain, including “Eagle’s Syndrome”, “Elongated Styloid Process Syndrome”, “Carotid Artery Syndrome”, “Styloid Process Neuralgia”, “Stilalgia”, “Stylohyoid Syndrome” and “Pseudohyoid Syndrome” \([_{111}231718}\]. Regardless of nomenclature, they are a constellation of subtle head and neck pain syndromes associated with true SP elongation or stylo-hyoid chain ossification.

Due to the vague clinical features, most patients are diagnosed incidentally at imaging or retrospectively at post-mortem examination \([_{2311}2312}\]. The symptomatic patients tend to be older than 40 years \([_{111}1]\). The elongated SPs in this post-mortem series occurred in skulls at an estimated age of 60.4 years. Unfortunately, we were unable to correlate the presence of symptoms due to the origin of the skulls (all donations for medical sciences without accompanying medical records).

Although women tend to be diagnosed more commonly during life, autopsy studies have revealed that elongated SPs have no sex predilection \([_{12}1215]2\]. Most of these studies evaluated Caucasian cohorts. It was interesting that there was a 4:1 preponderance of male skulls in this post-mortem series. The male predilection may be related to the Afro-Caribbean ethnicity, although a larger sample size is required to make a definite association.

Elongated SPs are present bilaterally in up to 75% of cases \([_{193}2122]\). In this post-mortem series, there was bilateral elongation in three cases and the thick basal remnant of the two broken SPs suggested that these were likely also longer than 3cm. The mean length of the intact SPs was 4.58cm on the left side and 3.58cm on the right. The clinical relevance of this finding is uncertain since there is no reliable correlation between symptomatology and SP length or the extent of SHL ossification \([_{311}231230212223}\].

Several attempts have been made to differentiate between true SP elongation and secondary ossification of the SHL. True elongation results in a smooth, regular, well corticated bone of varying lengths projecting continuously from the skull base \([_{103}]\). Secondary SHL ossification usually results in an irregular surface with thickened areas that extend toward the lesser horn of the hyoid bone, usually with marked medial angulation \([_{102}4212}\]. The ossified complex may be segmented with a thin cortex or a bulky irregular contour \([_{15}]\).

Four of the SPs encountered in this series were uniform and regular in contour, with smooth, thick cortices and a rounded tip. These are all characteristic features of true SP elongation. The high proportion of true elongation may suggest a genetic predisposition in this Afro-Caribbean population.

It is also interesting that the features of true elongation were present in all the male skulls while the sole female specimen was the only one with features suggestive of secondary ossification of SHL centres. We suspect that there may be an association between male sex, Afro-Caribbean origin and a genetic predisposition to true SP elongation, but continued evaluation of a larger study cohort is required before a definitive association can be ascertained.

**CONCLUSION**

This is the first anthropometric report of elongated SPs in a cohort of Afro-Caribbean skulls from the Caribbean. Four of the five skulls possessed features suggestive of true SP elongation. There seems to be a relationship between sexual dimorphism, Afro-Caribbean descent and true SP elongation. A larger study cohort is needed to definitively make this association.

**References**

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