



# EVALUATION OF PREVALENCE AND PATTERNS OF ELONGATED STYLOID PROCESS ON DIGITAL PANORAMIC RADIOGRAPHS

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**Abstract:** Normal length of Styloid Process is between 16-30 mm and more than 30mm considered as elongation. Elongation of SPs may have signs and symptoms of orofacial pain which could be confused with a wide variety of facial neuralgias, Eagle syndrome and temporomandibular diseases. Hence evaluation of elongated SPs can avoid misdiagnosis of these pain disorders. 200 digital OPGs of both gender aged between 20-60 years was retrieved from the Department record among which Group-A and Group-B consisted of 100 scans individually. The length and type of SPs according to the subjects, gender and sides on OPGs were measured and evaluated. We found that the mean length in males and females was  $27.30 \pm 5.45$ mm and  $27.23 \pm 6.27$ mm on the right side and  $27.44 \pm 5.77$ mm and  $27.12 \pm 5.93$ mm on the left side respectively. The difference between the length in both gender and sides was statistically insignificant. The prevalence of elongation was 24.5% and 25% on right and left side. SP lengths were slightly longer in elderly patients (41-60 years) compared to the young. The elongated SPs showed a slight female (5%) predominance. Type I SP was the most common in both gender and sides followed by Type II and then Type III. Hence we conclude that OPGs play an important role in identifying the normal, elongated and type of SPs and could help to avoid misdiagnosis of other pain disorders in cervico-orofacial region.

## INTRODUCTION

The Styloid Process (SP) is a cylindrical bone arising from the posterior side of the temporal bone. SP is located in front of the Stylo mastoid foramen. Together with the Styloid ligament and the small horn of the Hyoid bone of the Styloid process, they form the Styloid apparatus. It is typically 16-30mm long with variations across individuals and even between the right and left sides of the same person, ethnic groups and geographics.<sup>1,2,3</sup>

Styloid process with length more than 30mm is considered as elongated SP. About 2-4% of the general population is known to have elongated SPs and majority of these are asymptomatic. It may cause compression of nerves and blood vessels in the region leading to neck pain, Orofacial pain, dysphagia and referred otalgia which are characteristic features of Eagle syndrome.<sup>4,5,6</sup> The elongation of the Styloid Process may be accompanied by calcification of Stylohyoid and Stylo mandibular ligaments which also produce many signs and symptoms of neck and cervicofacial pain. These features may be confused with some disorders like facial neuralgias, dental & oral diseases and Temporomandibular disorders.<sup>7,8,9,10,11,12</sup> Hence in some cases it is necessary to evaluate Styloid Processes before final diagnosis.

Usually anatomical and morphological features of SPs are evaluated and analyzed using different techniques like digital OPG,<sup>13,14</sup> Computed Tomography (CT), Cone Beam Computed Tomography (CBCT) & other radiographs<sup>15,16</sup> and human skulls.<sup>17,18</sup> Although CBCT has high precision with 3D measurements, digital OPG remains the primary resource for epidemiological and other studies because of its wide availability, economical, easy calibration along with the exact details of the elongated styloid processes, despite slightly compromised accuracy and magnification.<sup>13,14,15,16</sup>

Due to lack of any digital panoramic radiographic study, specifically focused on elongated Styloid Processes in the central Indian population, we aimed to evaluate the length and prevalence of elongated SPs using the digital OPGs in Chhattisgarh population. We also analyzed its type and relationship with gender, age and laterality in the specified population.

## NEED OF THE STUDY.

The study was done to evaluate the elongation of styloid process on the basis of gender, age group.

**MATERIALS AND METHODOLOGY:**

This retrospective study was carried out in the Department of Oral Medicine, Diagnosis and Radiology, Rungta College of Dental Sciences & Research, Bhilai, Chhattisgarh, India. 200 digital panoramic radiographs of subjects aged between 20-60 years retrieved from the archival records of the Department. The digital panoramic system, Dentsply, Orthophos SL 2D Ceph, Equipment ID: G-XR-47301, manufactured by Sirona Dental Systems<sup>19</sup> GmbH, Bensheim, Germany was used for the study. Group A consisted of 100 male scans (50 scans of 20-40 years and 50 scans of 41-60 years) and Group B consisted of 100 female scans (50 scans of 20-40 years and 50 scans of 41-60 years).

The length and type of the Styloid Processes according to the subjects, gender and sides on digital OPGs were evaluated for the required variables and parameters using the software provided by the manufacturer.<sup>19</sup> Only good quality OPGs showing both Styloid Processes were included; positioning & magnification errors, obscured images of styloid processes and superimposition of temporal bone in the radiographs were excluded from the study.<sup>1,2,3,4,5,6</sup> A master chart was prepared for both the groups and relevant data collected from the subjects were entered and sorted into several tables and graphs based on the variables and parameters of the study using appropriate statistical tests.

**RESULTS AND DISCUSSION**

A total of 200 patients (100 males & 100 females) were included in this one and half year retrospective study. The age of the patients was 20-60 years among which 102 were in the age group of 20-40 years and the remaining 98 were in 41-60 years. The mean SP length in males was 27.30±5.45mm (range 19-50.3mm) on the right side and 27.44±5.77mm (range 19.3-51.1mm) on the left side. The mean SP length in females was 27.23±6.27mm (range 13.3-47mm) on the right side and 27.12±5.93mm (range 15.7-48.7mm) on the left side. The difference between the length of SPs in males and females on both the sides was statistically insignificant (Table:1 and Figure:1).

Type I SP was commonly found in both males (80% on right side & 75% on left side) and females (73% on right side & 70% on left side) compared to Type II in males (20% on right side & 25% on left side), females (23% on right side & 29% on left side) and Type III (1% on left side of female), (Tables: 1and Figures: 1) in our study. Hence, Type I SP was the commonest among both the genders followed by Type II and Type III. The difference between the presence of Type I and Type II was significant but insignificant difference found between the genders, age groups and sides in the study (Tables:1&2 and Figures:1&2).

Subjects of 20-40 years had a mean SP length of 26.63±5.20mm on the right side and 26.51±5.68mm on the left side. Subjects in the age group of 41-60 had 27.92±6.43mm on the right side and 28.07±5.92mm on the left side. No statistically significant difference was found between SP lengths of the right versus left side of both the age groups, though elderly population had slightly longer Styloid Processes. Both intra and intergroup comparison was insignificant (Table:2 and Figure:2).

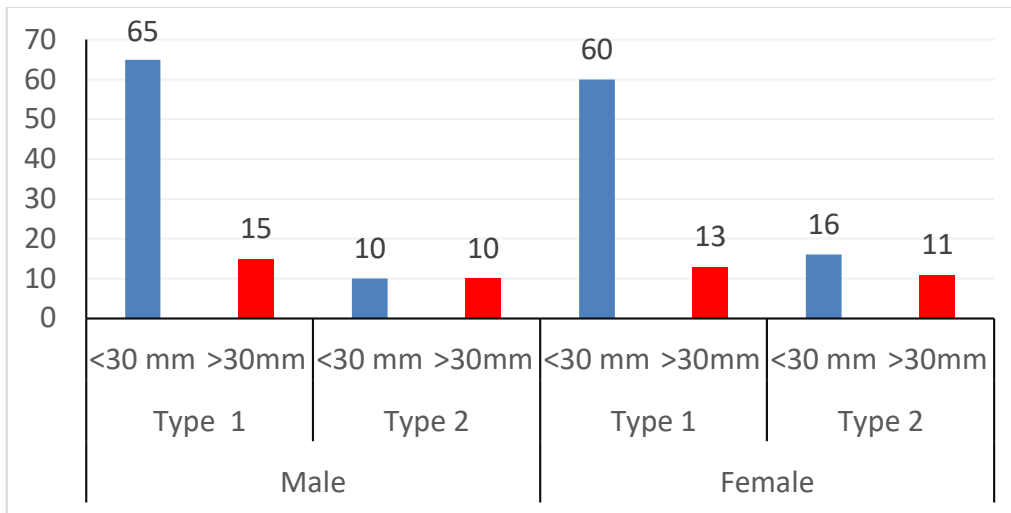
Finally, the prevalence of elongated SPs in our study was 24.5% on the right side and 25% on the left side with a slight female (5%) predominance. The elongated SPs occurred slightly more in the age group of 41-60 years compared to 20-40 years age group in the study. No statistically significant difference was observed regarding the side of occurrence though the left side had slightly longer SPs than the right side. Type I SP was the commonest even among the elongated SPs. Type II SP was slightly more in females compared to males but insignificant difference was present between the genders (Tables:1&2 and Figures:1&2).

**Table 1: Gender-wise comparison of elongation of the styloid processes**

|         |        |        | Right  |      | Left     |      |
|---------|--------|--------|--------|------|----------|------|
|         |        |        | N      | %    | N        | %    |
| Male    | Type 1 | <30 mm | 65     | 81.3 | 63       | 84.0 |
|         |        | >30mm  | 15     | 18.8 | 12       | 16.0 |
|         | Type 2 | <30 mm | 10     | 50.0 | 12       | 48.0 |
|         |        | >30mm  | 10     | 50.0 | 13       | 52.0 |
| F Score |        |        | 10.173 |      | 14.592   |      |
| P Value |        |        | 0.002* |      | <0.0001* |      |
| Female  | Type 1 | <30 mm | 60     | 82.2 | 58       | 82.9 |
|         |        | >30mm  | 13     | 17.8 | 12       | 17.1 |
|         | Type 2 | <30 mm | 16     | 59.3 | 17       | 58.6 |
|         |        | >30mm  | 11     | 40.7 | 12       | 41.4 |
|         | Type 3 | >30mm  | --     | --   | 1        | 1    |
| F Score |        |        | 5.298  |      | 5.064    |      |
| P Value |        |        | 0.007* |      | 0.008*   |      |

\*statistically significant

**Figure 1:** Graphical representation of Gender wise comparison of elongation of the styloid processes

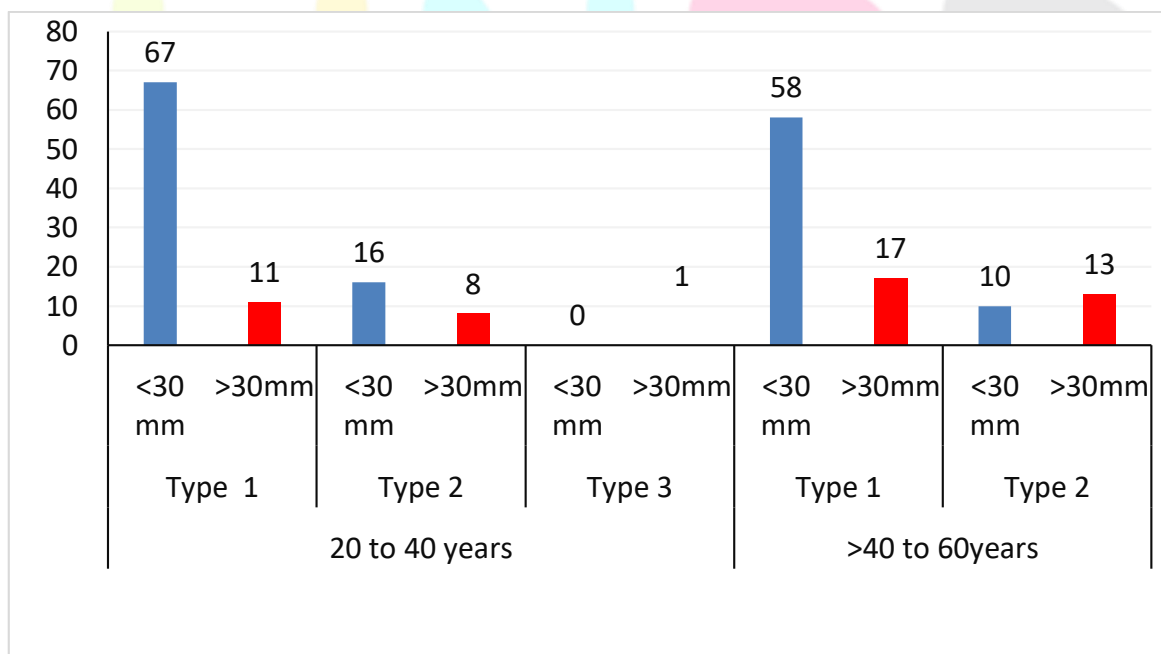


**Table 2:** Age-wise comparison of elongation of the styloid processes

|                |        |        | Right  |      | Left     |       |
|----------------|--------|--------|--------|------|----------|-------|
|                |        |        | N      | %    | N        | %     |
| 20 to 40 years | Type 1 | <30 mm | 67     | 85.9 | 60       | 87.0  |
|                |        | >30mm  | 11     | 14.1 | 9        | 13.0  |
|                | Type 2 | <30 mm | 16     | 66.7 | 22       | 68.8  |
|                |        | >30mm  | 8      | 33.3 | 10       | 31.3  |
|                | Type 3 | <30 mm | 0      | 0    | 0        | 0     |
|                |        | >30mm  | 0      | 0    | 1        | 100.0 |
| F Score        |        |        | 4.592  |      | 4.638    |       |
| P Value        |        |        | 0.035* |      | 0.012*   |       |
| >40 to 60years | Type 1 | <30 mm | 58     | 77.3 | 61       | 80.3  |
|                |        | >30mm  | 17     | 22.7 | 15       | 19.7  |
|                | Type 2 | <30 mm | 10     | 43.5 | 7        | 31.8  |
|                |        | >30mm  | 13     | 56.5 | 15       | 68.2  |
| F Score        |        |        | 10.303 |      | 22.864   |       |
| P Value        |        |        | 0.002* |      | <0.0001* |       |

\*Statistically significant

**Figure 2:** Graphical representation of Age wise comparison of elongated styloid processes.



The Styloid Process is a long cylindrical bone located on the floor of temporal bone. The elongation of SP and adjacent structures with calcification of associated ligaments could provoke dysphagia, tinnitus, otalgia, and other signs & symptoms mimicking oral, neck and cervicofacial pain disorders.<sup>5,6,7</sup> Elongated Styloid Processes can be detected by both clinical and radiographic examinations.<sup>1,2,3,4,5,9,10</sup> The radiographic views taken for the examination and evaluation of styloid processes are panoramic, lateral oblique of ramus, townes view, AP view, Transpharyngeal view, CT and CBCT scans.<sup>1,2,3,4,5,9,10,15,16</sup> OPGs are very useful, economic, ease of interpretation and widely available radiographs for identification and diagnosis of bone disorders related to styloid process elongation and ossification of related ligaments.<sup>1,2,3,4,7,8,9,10,11,12</sup> Hence, we chose to use digital OPGs for the examination and evaluation of the Styloid Processes in the study.

We found that the mean Styloid Process length in males was 27.30±5.4mm on the right side and 27.44±5.77mm on the left side. The mean SP length in females was 27.23±6.27mm on the right side and 27.12±5.93mm on the left side. Few studies have been conducted to determine the length of SPs in different populations across the globe, which are consistent with our observations. Similar to our findings, Balcioglu et al<sup>20</sup> analyzed Styloid Processes using OPGs in a Turkish population reported that the mean length of SPs in males and females on the right and left sides to be 25.78±5.68mm, 22.69±3.68mm, 25.80±5.75mm and 22.75±3.65mm respectively. Natsis et al<sup>21</sup> measured 262 Styloid Processes of dry skulls in Greeks and reported that the lengths of right Styloid Processes ranged from 6.4-70.2mm and left from 5.2-69.0mm, giving a wide range of lengths. Vadgaonkar et al<sup>22</sup> found the mean length of the SP was 17.8±9.3mm and 18.2±5.6mm for the right and left sides respectively in dry skulls of south Indians, and is slightly shorter compared to our subjects. The mean length of the SPs in the present study was also comparable to the results obtained by Patil et al<sup>23</sup> and some other studies.

Previous studies reported the normal length of Styloid Processes is between 16-30mm with a length more than 30mm considered as elongated SP. In few studies, variations in length of SPs ranged from 5.2-70.2mm depending on genetic backgrounds or geographic regions along with some other causative factors.<sup>1,2,3,4,5,7,8,10,12,24,25</sup> The prevalence of elongated SPs in our study was 24.5% on the right side and 25% on the left side. No statistically significant difference was observed concerning the side of occurrence though the left side had slightly longer SPs. These findings are similar to the results of the studies done by Bozkir et al,<sup>26</sup> Vadgaonkar et al,<sup>22</sup> Roopashri et al<sup>27</sup> and Shaik et al.<sup>13</sup> However, in contrast to our findings, C.B.More<sup>9</sup> observed that the elongated Styloid Processes was more common on the right side in their subjects. Interestingly, some studies have reported similar bilateral SP elongation and it could be attributed to the fact that strenuous exercise and chewing habits result in the clenching of jaw muscles that increases weight loading of the SP bilaterally and promotes ossification.<sup>3,14,28,29</sup> Ilgüy et al<sup>30</sup> and Custodio et al<sup>31</sup> also observed no differences in the length of the styloid process when the sides were compared.

The prevalence of Styloid Process elongation varied greatly across reports, from 2-84.4%. The exact cause of SP elongation is not clear, but cartilaginous calcification and ossification might be due to local chronic irritations related to endocrine disorders, osseous tissue calcification and formation, traumatic mechanical stress and aging.<sup>3,14,28,29,30</sup> Although different studies have reported wide range of incidences of elongated styloid process, it is commonly seen that only a small number of cases with elongated SPs present with symptoms of pain and discomfort<sup>1,5,7,11,12</sup>.

The prevalence of elongated SPs in our study showed a slight female (5%) predominance. Although most reports have overlooked the relationship of elongated SPs with gender, only a few reported that elongation of SPs is detected more readily in females. This is in agreement with the reports of some previous literature<sup>5</sup>. Similar to our observations, studies conducted by Roopashri et al,<sup>27</sup> Phulambrikar et al<sup>32</sup> and Ferrario et al<sup>33</sup> also found that females had elongated styloid processes than males, though their data were not statistically significant. But few studies have found that males had more elongated Styloid Processes than females.<sup>6,9,10</sup> In contrast to our findings, Scaf et al<sup>25</sup> reported an equal distribution of the elongated Styloid Processes in both males and females.

In our study, among the Styloid Processes, Type I SP was the most common occurrence in both males and females on both sides followed by Type II and Type III. The difference between the overall presence of Type I and Type II was significant but no statistically significant difference was noticed between the genders, age groups and sides. Type I SP was the highest even among elongated variants. Type II was slightly more in females compared to males but no statistically significant difference was present between the genders in our study. C.B.More et al<sup>9</sup> reported the prevalence of Type I and partially calcified Styloid Process in more than 85% of the Gujarat population which was similar to our observations. Our findings are also in agreement with the reports by a few other studies.<sup>1,3,8,24</sup>

SP lengths were a slightly longer in some elderly patients compared to younger subjects in our study. It was found in the age group of 41-60 years which is similar to some previous studies.<sup>2,26</sup> Anbiaee and Javadzadeh<sup>34</sup> used OPGs for the measurement of SP length and noticed that SP length was associated with increasing age, which is consistent with our findings. Ekici et al<sup>35</sup> registered the highest rate of elongated SP in fifth decade of life (65.4%). Al-Khateeb et al<sup>29</sup> found a significantly increased length of mineralized Stylohyoid complex with advancing age. Therefore, older patients are likely to have Styloid Process elongation situations. However, these findings differed from others who suggested that age may not have a role in the elongation of SPs.<sup>35</sup>

Several theories and causative factors are proposed to explain the variance in ossification and elongation of Styloid Processes namely, the theory of reactive metaplasia, reactive hyperplasia, anatomic variance, aging, developmental anomaly and trauma leading to loss of elasticity in ligament simulating tendinosis. Regional factors like dietary habits may also play a significant role for different patterns and types of SP elongation. Despite all these theories and assumptions, the etiology of elongated Styloid Processes remains unclear and is a mystery.<sup>3,16,20,21,22,35</sup>

#### **Limitations and Prospects:**

The limitations of our study was not able to examine and analyze the exact anatomy and morphology of elongated Styloid Processes because of variations in radiographic images attributed to technical reasons such as superimposition of other structures and inherent magnifications of panoramic images. Therefore, we have only sufficed to examine for the elongated versus non-elongated processes and types of Styloid Processes for comparing the relationship between age, gender and sides. Since OPG is a 2D imaging technique, the future may be focused on precise measurement of the elongated Styloid Processes and different types of calcification of Styloid ligaments using more advanced imagings such as CBCT, with a greater number of participants to establish three dimensional correlations, symptoms, dietary patterns and lifestyles with Styloid process elongation.

**CONCLUSION**

The present study was carried out on 200 digital OPGs of subjects aged 20-60 years. The mean SP length in males was 27.30±5.45mm on the right side and 27.44±5.77mm on the left side. The mean SP length in females was 27.23±6.27mm on the right side and 27.12±5.93mm on the left side. The prevalence of elongated SPs in our study was 24.5% on the right side and 25% on the left side. SP lengths were slightly longer in some elderly subjects compared to younger patients in the study and were found in the age group of 41-60 years. The prevalence of elongated SPs in our study showed a slight female (5%) predominance. Type I SP was the commonest in both males and females on both sides followed by Type II and Type III. Type I SP was the highest even among elongated Styloid Processes. Type II was slightly more in females compared to males but statistically insignificant. Hence we conclude that digital OPGs play an important role in identification of the normal, elongated and type of Styloid Processes. It helps to avoid misinterpretation of the signs and symptoms of cervico-orofacial pain, particularly eagle syndrome, tonsillar pain, pharyngeal, muscular pain and other pain disorders.

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