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Supracondylar process of the humerus - A Morphometric Study

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Abstract

Background: The supracondylar process of the humerus, also referred to as the supra-epitrochlear process or supracondylar spur, is a bony protrusion resembling a beak that emerges from the anteromedial surface. It signifies the residual remains of a complete osseous bridge observed in climbing animals. The process is a rare anatomical variation connected inferiorly to the medial epicondyle of the humerus by the ligament of Struthers. Typically presenting unilaterally and located 5-7 cm superior to the medial epicondyle, the supracondylar process holds clinical importance due to its passage it forms with the humerus and the ligament of Struthers. This passage accommodates the median nerve and brachial artery, which may become compressed, leading to neurovascular impingement. The associated symptoms of this compression are exacerbated during hyperextension or pronation of the elbow.

Methods: A total of 83 dried humeri were examined at the Department of Anatomy, Goa Medical College, Bambolim, Goa, India. The distal parts of the humeri were assessed for any bony protrusions under daylight conditions. Upon discovery, their dimensions were documented and captured in photographs.

Results: Among the 83 dried humeri scrutinized, only one right-sided humerus exhibited an osseous spine on the anteromedial surface. The incidence calculated in this investigation was 1.2%.

Conclusion: The supracondylar process has garnered greater attention from anatomists and anthropologists due to its possible implications for the origins and relationships of human races, rather than from clinicians, many of whom are unaware of its infrequent occurrence. The present study, focusing on the Indian population in Goa, reports an incidence of 1.2%, which is relatively high compared to other Indian studies. This data highlights the diversity in the occurrence of the supracondylar process across different ethnic and regional groups, suggesting possible genetic and environmental factors influencing its prevalence.

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Highlights

What is current knowledge?

- Supracondylar process of the humerus is a rare hook-like bony spine projecting distally from the anteromedial surface of the humerus.
- It may be connected to the medial epicondyle by a fibrous band ('ligament of Struthers').
- The incidence of supracondylar process is very low (0.1% - 2.7%).
- Not many studies have been done on supracondylar process in Indian population.

What is new here?

- The present study reports a 1.2% incidence of the supracondylar process in the Indian population of Goa, which is relatively high compared to other Indian studies.

Introduction

The supracondylar process of the humerus, also referred to as the supra-epitrochlear process or supracondylar spur, is a bony protrusion resembling a hook that varies in size and extends distally from the front inner surface of the humerus. It is situated approximately 5 cm proximal to the medial epicondyle, with a length ranging from 2 mm to 20 mm. This process may be connected to the medial epicondyle by a fibrous band known as the ligament of Struthers, to which a portion of the pronator teres muscle is attached. Together, the band, the process, and the shaft of the humerus form a ring through which the median nerve and the brachial artery (Or one of its branches) may pass (1). The ligament of Struthers corresponds to the third head of the coracobrachialis (2). Compression of the brachial artery or the median nerve in this area may lead to supracondylar process syndrome. Struthers, Solieri and Aydinlioglu et al. (3,4) have documented cases of median nerve compression. Talha et al. (5), and Thompson and Edwards (6) have reported compression and claudication of the brachial artery. Furthermore, Spinner (7) has documented fractures of the supracondylar process.

The first depiction of a supracondylar process can be found in 'Tiedmann's Tabulae Arterium'(8). The incidence of this condition varies from 0.1% to 2.7% (9). According to Kessel and Ring (10), the ligament of Struthers represents the tendon of a vestigial muscle, the latissimo-condyloideus, present in marsupials, reptiles, cats, lemurs and American monkeys. Limited research has been conducted on the supracondylar process in the Indian population thus far (11-16). The primary objective of this study is to determine the prevalence of the supracondylar process of the humerus in individuals of South Indian descent and to discuss its clinical significance.

Methods

The study focused on examining 83 dried humeri from the osteological collection in the Department of Anatomy at Goa Medical College in Bambolim, Goa, India. This anatomical research was conducted under ethical guidelines, having received approval from the Institutional Ethics Committee of Goa Medical College (Approval number GMCIEC/2023/238) on July 15, 2023.

To identify and analyze the supracondylar process the bones were thoroughly inspected under natural light conditions. The inspection process involved a detailed examination of each humerus to detect the presence of any bony protrusions or abnormalities that could indicate a supracondylar process. Upon identifying a supracondylar process, precise measurements were taken using a digital Vernier Caliper. The measurements included parameters such as the length of the supracondylar process, the breadth at its base, and its distance from specific anatomical landmarks, like the medial epicondyle and nutrient foramen. Additionally, photographs of the supracondylar process were taken to provide a visual record of the findings and assist in further analysis.

Results

In our examination of 83 dried humeri, we observed a singular instance of a right humerus bearing a supracondylar process on its anteromedial surface (Figure 1 and 2). This process was located 4.4 cm proximal to the medial epicondyle, protruding 1.1 cm from the surface, with a base measuring 1.1 cm in length and 1 cm in width. The spine of the process extended downwards, forwards, and medially, with the distance from its tip to the medial supracondylar ridge measuring 4.4 cm. Additionally, the base of the spine was situated 4.7 cm from the nutrient foramen (Figure. 3). The overall length of this humerus, from the lowest tip of the trochlea to the highest point of the head, was 28.7 cm.

Comparing the present study with previous studies on the measurements of the supracondylar process in the Indian population, we observe several similarities and differences across four key parameters: the length of the spine, breadth at the base of the spine, distance of the spine from the medial epicondyle, and distance of the spine from the nutrient foramen (Table 1)

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Figure 1. Right humerus with supracondylar process

Figure 2. The distal part of the humerus with supracondylar process

Figure 3. Distance (Arrow) between nutrient foramen and supracondylar process

Table 1. Measurements of supracondylar process in Indian population reported by different authors

Authors	Length of spine	Breadth at the base of spine	Distance of spine from medial epicondyle	Distance of spine from nutrient foramen
Gupta and Mehta (12)	0.3 cm	1.1 cm	6.5 cm	-
Baruah et al. (14)	1.1 cm	1.5 cm	4.4 cm	6.5 cm
Shivaleela et al. (13)	1.0 cm	1.0 cm	6.0 cm	4.7 cm
Vandana and Patil (15)	0.8 cm	1.2 cm	5.3 cm	5.5 cm
Nikumbh et al. (16)	1.1 cm	1.0 cm	5.5 cm	6.5 cm
Present study	1.1 cm	1.0 cm	4.4 cm	4.7 cm

Length of spine:

The present study reports a length of 1.1 cm, consistent with the findings of Baruah et al. (14) and Nikumbh et al. (16) However, Gupta and Mehta(12) reported a significantly shorter length of 0.3 cm, while Shivaleela et al. (13) and Vandana and Patil (15) reported lengths of 1.0 cm and 0.8 cm, respectively.

Breadth at the base of the spine:

The breadth reported in the present study is 1.0 cm, matching the findings of Shivaleela et al. (13) and Nikumbh et al. (16) In contrast, Gupta and Mehta (12) and Vandana and Patil (15) reported slightly wider measurements of 1.1 cm and 1.2 cm, respectively. Baruah et al. (14) reported the broadest measurement at 1.5 cm.

Distance of spine from medial epicondyle:

The present study reports a distance of 4.4 cm, which is consistent with Baruah et al. (14) but shorter than the measurements reported by other studies. Gupta and Mehta (12) reported a distance of 6.5 cm, Shivaleela et al. (13) 6.0 cm, Vandana and Patil (15) 5.3 cm, and Nikumbh et al. (16) 5.5 cm.

Distance of spine from nutrient foramen:

The present study reports a distance of 4.7 cm, which matches the findings of Shivaleela et al. (13) However, this measurement is shorter compared to Baruah et al. (14) and Nikumbh et al. (16), who reported 6.5 cm, and Vandana and Patil (15), who reported 5.5 cm.

Overall, while there is consistency in some measurements, such as the breadth at the base of the spine, significant variability is seen in the length of the spine and the distances from the medial epicondyle and nutrient foramen.

The present study reports an incidence of 1.2% for the supracondylar process in the Indian population from Goa. This rate is relatively higher compared to several previous studies conducted within India and aligns more closely with rates observed in certain non-Indian populations (Table 2).

Table 2. The incidence of supracondylar process reported in studies of different races

Sl. No	Author	Incidence	Population/Race
1	Gruber (1865)	2.7%	European race
2	Hrdliyka (1923)	1%	American Indians
3	Danforth (1924)	0.5%	Mixed population
4	Adachi (1928)	0.8%	Mixed population
5	Terry (1930)	0.1%	Blacks
6	Terry (1930)	1.16%	European race
7	Parkinson (17) (1954)	0.4%	Mixed population
8	Dellon (18) (1986)	1.15%	European race
9	Oluyemi (19) (2007)	2.5%	Nigerians
10	Gupta and Mehta (12) (2008)	0.26%	Indians (Gujarat)
11	Natsis (20) (2008)	1.3%	Caucasians
12	Baruah et al. (14)(2012)	1.25%	Indians (Assam)
13	Shivaleela et al. (13) (2014)	0.41%	Indians (Karnataka)
14	Nikumbh et al. (16) (2016)	0.36%	Indians (Maharashtra)
15	Present study (2023)	1.2%	Indians (Goa)

Comparatively, Gupta and Mehta (12) found a much lower incidence of 0.26% in Indians from Gujarat, while Baruah et al. (14) reported an incidence of 1.25% in Indians from Assam, which is very close to the rate observed in the present study. Shivaleela et al. (13) reported a 0.41% incidence in Indians from

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Karnataka, and Nikumbh et al. (16) observed a 0.36% incidence in Indians from Maharashtra, both of which are lower than the present study's findings.

The incidence rates also vary in international contexts, Gruber (1865) reported a higher incidence of 2.7% in the European race, whereas Hrdliyka (1923) found a 1% incidence among American Indians, which is slightly lower than in the present study. Danforth (1924) and Adachi (1928) reported incidences of 0.5% and 0.8% respectively in mixed populations, which are also lower than the present study's rate. Terry (1930) observed a 0.1% incidence in blacks and 1.16% in Europeans, with the latter being comparable to the present study's findings. Parkinson (17) reported a 0.4% incidence in a mixed population, much lower than the present study. Dellon (18) observed a 1.15% incidence in Europeans, similar to the present study's findings. Oluyemi (19) reported a significantly higher incidence of 2.5% in Nigerians, and Natsis (20) found a 1.3% incidence in Caucasians, slightly higher than the present study.

Overall, the incidence of the supracondylar process varies widely both within and across different populations and ethnic groups. The 1.2% incidence rate found in the present study is notably higher than most reported in other Indian studies but falls within the range observed in some international populations, particularly among Europeans and Caucasians. This variability may be attributed to genetic, environmental, or methodological factors influencing the detection and reporting of the supracondylar process.

Discussion

The knowledge of anatomical variations is important to anatomists, radiologists, anaesthesiologists and surgeons in modern diagnostic medicine. Morphological differences are the tools to find the missing links between different stages of evolution. One such variation is the supracondylar process of the humerus.

The incidence of supracondylar process is usually very low. In 'Cornelia de Lange syndrome', an autosomal recessive trait, there is a high incidence of unilateral supracondylar process of the humerus, occurring in approximately one in every 10,000 live births (21). Though usually clinically silent, it may become symptomatic by presenting as a mass or associated with symptoms of median nerve compression and brachial artery claudication.

Entrapment of brachial artery and median nerve by Struthers' ligament at the level of supracondylar process is known as supracondylar process syndrome which is treated by surgical removal of the ligament and the process along with underlying periosteum to prevent recurrence (17). The compression symptoms include ischemic pain of the forearm, severe paraesthesia and hyperesthesia of the hand and fingers, embolization of the distal arm arteries and disappearance of the radial or ulnar pulse on full extension and supination of forearm (22). Rarely, ulnar nerve compression can also occur if the Struthers' ligament, instead of being attached to the medial epicondyle, extends downward as a band that blends with the fibrous arch between the two heads of flexor carpi ulnaris (23,24). A supracondylar process may be misdiagnosed as an osteochondroma. The process is oriented distally towards the elbow joint and there is no discontinuity in the cortex of the humerus in X-ray, whereas an osteochondroma points away from the joint and the cortex of the tumor is continuous with the humeral cortex. Heterotopic bone such as myositis ossificans can also mimic a supracondylar process (25).

The supracondylar process measurements exhibit variability among different studies. This could be due to differences in the sample sizes, demographic variations within the Indian population, or methodological differences in the studies. Despite these differences, some consistency is observed in measurements like the breadth at the base of the spine.

These measurements are crucial in clinical settings, especially in surgeries involving the humerus, as the supracondylar process can be a site of muscle and ligament attachment and may also affect nerve positioning. Understanding the variations in its anatomy is important for clinicians to avoid complications.

Conclusion

The supracondylar process, though usually clinically silent, may present as a mass or symptoms of median nerve compression and brachial artery claudication. Hence its knowledge becomes important to anatomists, radiologists, as well as surgeons to avoid misdiagnosis. The present study reports a 1.2% incidence of the supracondylar process in the Indian population of Goa, which is relatively high compared to other Indian studies. This suggests regional variations within India, potentially influenced by genetic, environmental, or methodological factors. The higher incidence in Goa highlights the need for further research to understand the underlying reasons for these regional differences in the prevalence of the supracondylar process.

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Ethical statement

This study was approved by the Institutional Ethics Committee of Goa Medical College, Bambolim (GMCIEC/2023/238) on 2023/07/15.

Conflicts of interest

The authors declare that they have no competing interests.

Author contributions

Ali Abdul Hameed and Uday Narayan Kudalkar: conceptualization; Ali Abdul Hameed: writing-original draft; Uday Narayan Kudalkar and Nilam Rajesh Madhale: writing-review and editing. All authors read and approved the final manuscript.

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