SHORT REPORT

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Incidence of biphalangeal fifth toes in South Indian fetuses, children and adults

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Summary

The human foot has a big toe and four lateral toes. The big toe has only two phalanges but each of the lateral toes has three. The presence of a two-phalangeal fifth toe was first described in 1492 by Leonardo da Vinci and later by a few others. It has not been reported in Indian populations. The present study estimated the incidence of this feature in a sample of South Indian fetuses, children and adults. Seven-month to full-term fetuses were collected at the Department of Anatomy. Stored X-ray images of the feet of children and adults were from the Department of Radiodiagnosis. Twelve pairs of fetal feet were used to count the number of ossified phalanges in the fifth toe by the Alizarine red technique. X-ray images (n = 112) of children, aged one to twelve years, and X-ray images (n = 263) of adults were grouped by gender and side. Twenty one feet (87.5%) of the fetuses had a biphalangeal fifth toe. Eleven X-ray images (9.8%) of children and thirty-one X-ray images (11.8%) of adults revealed a biphalangeal fifth toe. The percentage of incidence of this anatomical variant in the South Indian adult population was less than that reported for European (35.5%) and Japanese (80.4%) populations, probably because South Indians are not a consistently shoe-wearing community. The incidence of this feature was significantly ($p<0.001$) higher in females probably due to use of improperly designed foot-wear.

Key Words: Adults – Biphalangeal – Children – Fetuses – Fifth toe

Introduction

The human foot has a big toe and four lateral toes. The big toe has only two phalanges but each of the lateral toes has three. The presence of a two-phalangeal fifth toe was first described in 1492 by Leonardo da Vinci (O'Malley and Saunders, 1952). To date no cases have been reported in Indian populations. Biphalangeal fifth toes may be of ethnic origin. The present study was undertaken to estimate the incidence of biphalangeal fifth toes in South Indian fetuses, children and adults.

Materials and Methods

Alizarine Red S technique in fetuses

Seven-month to full-term fetuses were collected at the Department of Anatomy. The ossified bones in twelve pairs of feet were identified by the Alizarine Red S technique (Daws, 1982). The number of ossified phalanges stained red with alizarine in the fifth toe was counted and noted.

Radiological technique

This retrospective study of foot X-ray images was carried out using stored images from the Department of Radiodiagnosis of the feet of children and adults. The images were grouped according to gender and side. Biphalangeal fifth toes in the foot images (total = 112; male = 59, female = 53, right = 51, left = 61) of children aged one to twelve years and those (total = 263; male = 131, female = 132, right = 148, left = 115) of adults were counted and noted. The incidence of biphalangeal fifth toes between the genders and between the sides were compared using the chi-square test.

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RESULTS

Fetuses

Table 1 gives the total number of feet and number and percentage of feet with one-, two-, and three-phalangeal fifth toes. Twelve pairs of feet belonged to fetuses. Twenty-one feet (87.5%) had a biphalangeal fifth toe and three feet (12.5%) had a single phalangeal fifth toe (Fig.1). None (0%) had three phalanges on the fifth toe, even at full term.

Table 1.- Incidence of one-, two-, and three- phalangeal fifth toes in the feet (n = 24) of South Indian fetuses

Fifth toe	Number	Percentage
One-phalangeal	3	12,5
Two-phalangeal	21	87,5
Three-phalangeal	0	0

Fig. 1.- Biphalangeal fifth toe in an Alizarine red-stained foot on left side and single phalanx on the right side of a fetus.

Table 2 gives the total number of foot images and the number and percentage of foot images with a biphalangeal fifth toe in children (Fig. 2) and adults (Fig. 3).

Fig. 2.- Biphalangeal fifth toe in an X-ray image of the foot of a child.

Table 2.- Incidence of a biphalangeal fifth toe inthe foot images (n = 112) and foot images (n = 263) of adults

Number of foot-images		Number of biphalangeal fifth toes	Percentage	p
Children				
Total	112	11	9.8	
Male	59	3	5.1	
Female	53	8	15.1	NS
Right	51	6	11.8	
Left	61	5	8.2	NS
Adults				
Total	263	31	11.8	
Male	131	7	5.3	
Female	132	24	18.2	0.001
Right	148	15	10.1	
Left	115	16	13.9	NS

Male and female are compared and right and left are compared using chi-square tests. NS = not significant.

Fig. 3.- Biphalangeal fifth toe in an X-ray image of the foot of a adult.

Children

There were 112 children's feet images. A biphalangeal fifth toe was present in 9.8% (11 images) overall; 5.1% in males, 15.1% in females, 11.8% on the right, and 8.2% on the left foot.

Adults

Of the 263 foot-images of adults, a biphalangeal fifth toe was present in 11.8% (31) images overall; 5.3% in males, 18.2% in females, 10.1% on the right and 13.9% on the left foot. Thus, a biphalangeal fifth toe occurred in 31/263 (11.8%) of adults. The male:female ratio was 7/131:24/132, which was significantly different ($p<0.001$) and the right:left ratio was 15/148:16/115. Occasionally, some other lateral toes also had fewer than three phalanges.

Discussion

The vasculature seems to have an effect on ossification centers (Kedia and Czyz, 2003). Digital radiography examination is a useful method for determining skeletal ossification and is also simple, objective, fast, and relatively inexpensive (Burden et al., 2002).

The existence of a biphalangeal fifth toe has been reported previously (Ellis et al., 1968). It is probably a true anatomical variant, resulting from incomplete segmentation rather than the result of phalangeal fusion (Venning, 1960; Thompson and Chang, 1995). This variant is exclusively a human phenomenon, suggesting that it is a response to bipedalism and that it would result primarily from the failure of the distal interphalangeal joint to develop (Le Minor, 1995). Surgery is more common in fifth toes with two phalanges (Carroll et al., 1978; Thompson and Chang, 1995).

Phalanges are ossified from a primary center for the shaft and basal epiphysis. Primary centers for the distal phalanges appear between the ninth and twelfth prenatal weeks and even later in the fifth digit. Primary centers for the proximal phalanges appear between the eleventh and fifteenth weeks and later for the intermediate phalanges. The secondary center for their base appears between the second and eighth year and unites with the primary centre by eighteenth year (Williams et al., 2005). Therefore, at the time of birth all the phalanges are identifiable. This variant was reported to be present in fetuses from 12 weeks of gestation (Venning, 1960). In the present study, twenty-one (87.5%) of the twenty-four feet of the fetuses, including full term neonates, had a biphalangeal fifth toe. None had a three-phalangeal fifth toe, suggesting incomplete segmentation or phalangeal fusion.

In Ellis' work (Ellis et al., 1968) when both the feet were X-rayed, they were either both 2-phalangeal or both 3-phalangeal. However, the results of the present study do not agree with this since the feature was present on the right, left, or both sides.

The incidence of a biphalangeal fifth toe has been reported to be between 35.5 and 80.4%, the lowest value being seen in Europeans and the highest in Japanese (Venning, 1960; Thompson and Chang, 1995). In the present study, the incidence was only 11.8% in adults, probably because South Indians are not a consistently shoe-wearing community. In another study made in adults in the United Kingdom, 46% in the under-25 years age group and 31% persons in the over-75 years age group had a biphalangeal fifth toe (George, 2001). The incidence was lower in the elderly. The difference is significant ($p<0.05$), suggesting an increasing incidence in the more recent population. This suggests an acquired change due to a recent increase in shoe-wearing habits with reduced vasculature, disuse, etc. of the toes, particularly the fifth toe. In that study, there was no significant gender or side difference. However in the present study on adults, the incidence was significantly higher in the females probably due to improperly designed foot-wear.

The biphalangeal variant of the fifth toe may be expected to occur in more South Indians in succeeding generations due to increasingly or constant use of foot-wear and modern styles and designs in foot-wear.

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