

Luschka's Forked Rib: a Rare Anatomical Variant And its Clinical Relevance

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Disclose and conflicts of interest: none to be declared by all authors

ABSTRACT

Introduction: the thoracic cavity contains 12 pairs of ribs; the typical ribs are attached anteriorly to the sternum and posteriorly to the bodies of the thoracic vertebrae. The ribs are flat bones with anterior and posterior ends, two borders, and two surfaces. When the anterior end is bifurcated then it is known as bifid rib. Bifid ribs are due to incomplete fusion or anomalous chondrification of the cephalic and caudal segments of the sclerotome during the 4th to 6th weeks of development. Fork ribs are a very rare entity and are discovered incidentally either by radiological or cadaveric methods. It occurs in 1.2% of the population, usually unilateral and its overall prevalence is 0.15 – 3.4% (mean 2%), it accounts for 20% of all congenital anomalies of the ribs.

Case Presentation/observation: during a routine osteology class for undergraduate medical students on ribs, it was observed that the anterior end of the 4th rib was bifurcated. The two limbs of the bifurcated rib was making an angle of 60°. The rib belonged to the right side of a female cadaver. All other ribs were normal.

Discussion: the description of the anomalies of the ribs is very minimal in the literature, their incidental finding through chest X-rays is usually associated with various underlying clinical syndromes. The Luschka's forked rib is most commonly found to be associated with Gorlin – Goltz syndrome or Nevoid basal cell carcinoma syndrome which is an autosomal dominant with a prevalence of one in 57,000 cases. It is also seen associated with Job's syndrome, Kindler syndrome, and other malignancies in children like neuroblastoma.

Conclusion: anatomical knowledge of such a rare entity is very essential for surgeons operating on the anterior thoracic wall involving the rib cage. Since it is in close association with childhood malignancies like Gorlin-Goltz syndrome, its early radiological detection can reveal the underlying malignancies, especially in children and preventive measures can be taken at an early stage.

Keywords: Bifid rib; Rib bifurcation; Intrathoracic rib; Chest wall anomaly.

Introduction

The thoracic cavity contains 12 pairs of ribs which are flat elastic bones that typically (3rd rib to 9th ribs) articulate anteriorly with the sternum and posteriorly with the articular facets of the bodies of thoracic vertebrae. The first two and last three ribs are atypical ribs. Each typical rib has two ends – anterior and posterior, two borders – upper and lower and two surfaces – outer and inner^{1,2}. Each rib develops from the costal process of developing adjacent thoracic vertebrae through the endochondral ossification³. Bifid ribs are due to incomplete fusion or anomalous chondrification of the cephalic and caudal segments of the sclerotome during the 4th to 6th weeks of development.

Variations in the structure of the ribs are usually overlooked due to their asymptomatic presentations and are incidentally discovered either radiologically or in a cadaver. Their clinical importance is associated with the underlying syndromes^{4,5}. Anomalies of the ribs have been documented in very few previous articles, some of them mentioned are the cervical rib which

occurs in 0.2% to 2% of the population, is an accessory rib that articulates with the C7 vertebral body, more common among females and commonly associated with Klippel-Feil syndrome^{4,5,6}. Other anomalies include short rib, intrathoracic rib, rib fusion, rib foramen, rib notching, and bifid ribs⁶.

The Luschka's forked rib is an unusual malformation characterized by the splitting of the anterior end of the rib, typically affecting the 4th rib, and found to be associated with Gorlin syndrome⁵ or Basal cell nevus syndrome and jaw cysts⁵. The bifid rib remains asymptomatic and occurs in 1.2% of the population, it is usually unilateral. Its overall prevalence is 0.15 – 3.4% (mean 2%) and accounts for 20% of all congenital anomalies of ribs⁷.

Observation

During routine osteology class for undergraduate medical students on ribs, it was observed that the anterior end of the 4th rib was bifurcated. The two limbs of the bifurcated rib were making an angle of 60°. The rib belonged to the right side of a female cadaver.

All the other ribs were normal. The bifid rib showed articular facets over the head, tubercles & angle were present, subcostal groove was seen over the inferior border indicating the features of a typical rib. The rib was lightweight, small, delicate, and muscular markings were not well demarcated indicating that the rib belonged to a female cadaver. The various measurements of the rib were taken using a measuring tape and the dimensions were recorded (Refer to Table 1) (Refer to Figure 1).

Table 1. Anatomical dimensions of the bifid rib.

Anatomical features	Measurements (cms)
Length of total bifurcation	04
Distance between the two forked limbs	02
Total maximum width of the rib before bifurcation	2.5
Width of the upper limb of the bifid rib	02
Width of the lower limb of the bifid rib	3.75



Figure 1. Bifid rib seen in the 4th right rib of a female cadaver.

Discussion

Bifid ribs have been identified as early as 1944 by Etter, wherein out of 40,000 chest x-ray films about 257 cases (0.64%) of bifid ribs were found⁸. Schumacher et al (1992) reported that various kinds of rib anomalies are associated with childhood malignancies such as Gorlin-Goltz syndrome⁹.

The Nevus basal cell carcinoma syndrome is considered the most prominent genetic syndrome

associated with bifid ribs. Other syndromes include Job's syndrome, Kindler syndrome, malignancy in children like neuroblastoma, etc.¹⁰. The association between the bifid ribs and Gorlin syndrome was first established in 1960 and was considered as the major criteria in cases of vertebral anomalies. The Gorlin syndrome is an autosomal dominant disorder with a prevalence of 1 in 57,000 cases^{11,12}. It is characterized by odontogenic keratocysts of the jaw and multiple basal cell carcinoma in childhood malignancies, cardiac fibromas in infants, and ovarian fibromas in women¹³. Gorlin & Goltz also observed palmar/plantar pits, spinal/costal abnormalities, and calcification of the falx cerebri. They proposed the involvement of simple pleiotropical genes or multiple closely linked genes¹⁴.

The previous literature shows that the percentage of incidence of bifid ribs through chest X-rays varies in different ethnic groups (Refer to Table 2).

Table 2. Incidence of bifid ribs among different populations by chest x-rays.

Author	Population	Incidence (%)
Etter	Americans	0.64
Lim et al	Koreans	2.8
Gorlin et al	Samoans	8.4
Davran et al	Pakistanis	6.76

Previous studies have also shown that the presence of bifid ribs is more common among females and that the right-sided ribs are commonly involved, especially the 4th & 5th ribs (Refer Table 3).

Table 3. Cadaveric studies showing the various features of the bifid ribs.

Author	Population	Sex	Side of rib	Number of ribs
Tokuji Osawa et al	Japanese	Male	Left	5 th rib
Christopher et al	American	Female	Right	4 th rib
Wu-chul song et al	Korean	Male	Right	4 th rib
Present study	Indian	Female	Right	4 th rib

Conclusion

The incidental detection of the malformations of ribs plays a very important role in radiographic and genetic evaluation. The rib anomalies detected in the chest X-rays may be associated with underlying clinical syndromes like Gorlin syndrome or childhood malignancies. Early diagnosis of the syndromes can reduce the severity of long-term complications and will also help to investigate further skeletal malformations.

References

1. Talbot BS, Gange CP Jr, Chaturvedi A, *et al.* Traumatic rib injury: patterns, imaging pitfalls, complications & treatment. *Radio-graphics.* 2017; 37: 628-51.
2. Levine BD, Motamedi K, Chow K, *et al.* CT of rib lesions. *AJR Am J Roentgenol.* 2009; 193: 5-13.
3. White TD, Folkens PA. *Human osteology.* 2nd edition. San Diego: Academic Press. 2000; 29pp.
4. Guttentag AR, Salwen JK. Keep your eyes on the ribs: the spectrum of normal variants & diseases that involve the ribs. *Radiographics.* 1999; 19: 1125 – 42.
5. Glass RBJ, Norton KI, Mitre SA, *et al.* Pediatric ribs: a spectrum of abnormalities. *Radiographics.* 2002; 22: 87-104.
6. Farias LPG, Menezes DC, Fae IS, Arruda PHC, Santos JMMM, Teles GBS. Anatomical variations and congenital anomalies of the ribs revisited by multidetector computed tomography. *Radiol Bras.* 2020; 53(6): 413-418.
7. Tokuji Osawa, Masao D, Xin-Yan Feng, Nobuhide S, Satonu N, Yoko M, *et al.* Two cases of bifid ribs were observed in the fourth & fifth rib. *Dent J Iwate Med Univ.* 2002; 27: 98-103.
8. Etter LE. Osseous abnormalities of the thoracic cage were seen in forty thousand consecutive chest photo roentgenograms. *Am J Roentgenol.* 1994; 51: 359-363.
9. Schumacher R, Mai A, Gutjahr P. Association of rib anomalies and malignancy in childhood. *Eur J Pediatr.* 1992; 151: 432-434.
10. Mythili KR, Haresh Kumar P. Bifid rib: A rare anomaly. *Medical J of Dr. D.Y. Patil University.* 2015; 8(5): 670-671.
11. Kimonis VE, Goldstein AM, Pastakia B, Yang M, Kase R, DiGiovanna J, *et al.* Clinical manifestations in 105 persons with nevoid basal cell carcinoma syndrome. *Am J Med Genet.* 1997; 69(3):299-308.
12. Evans DGR, Burnell L, Gattamaneini HR, Birch JM. The incidence of Gorlin syndrome in 173 consecutive cases of medulloblastoma. *Br J cancer.* 1991; 64(5):959.
13. Foulkes WD, Kamihara J, Evans DGR, Brugieres L, Bourdeant F, Molenaar JJ, *et al.* Cancer surveillance in Gorlin syndrome and rhabdoid tumor predisposition syndrome. *Clin Cancer Res.* 2017; 23(12):e62-e67.
14. Gorlin RJ, Goltz RW. Multiple nevoid basal cell epithelioma, jaw cysts, and bifid rib: a syndrome. *N Engl J Med.* 1960; 262: 908-12.

Mini Curriculum and Author's Contribution

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Received: December 12, 2025
Accepted: May 5, 2025

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