VIA MEDICA

CASE REPORT

Folia Morphol.
Vol. 83, No. 2, pp. 472–477
DOI: 10.5603/FM.a2023.0055

ISSN 0015–5659
eISSN 1644–3284
journals.viamedica.pl

Rare discovery of sacral "ribs": a cadaveric case report

Jonathan A. Millard[1], Kaivon Kouhestani[1], Ahmed Qizilbash[1], Christine Mayuga[1], Casey Moore[1], Kim A. Nguyen[2], Paul Anthony Carpio[1], Rachel E. Haley[1]

[1]*Edward Via College of Osteopathic Medicine, Blacksburg, VA, United States*
[2]*New York University School of Medicine, New York, NY, United States*

[Received: 25 May 2023; Accepted: 5 July 2023; Early publication date: 4 August 2023]

Supernumerary ribs are a well-documented congenital anomaly that can occur at any point of the vertebral column, most commonly in the cervical or lumbar region. However, accessory ribs found in the sacrococcygeal region are exceptionally rare and may be difficult to distinguish from other bony manifestations of the pelvic girdle. During cadaveric dissection, a pair of sacral "ribs" were found projecting from the left posterolateral sacral region. The bony projections shared a broad base from the posterior sacrum. The projections followed an anteroinferior trajectory, mimicking the thoracic rib structure. Computed tomography (CT) revealed further bony anomalies, including bilateral ossifications embedded in the sacrotuberous ligament, and a blunt bony protrusion extending toward the ischial spine. Most documented supernumerary ribs in the lumbar and sacrococcygeal regions are asymptomatic and are incidental findings in radiographic studies during the exploration of other medical complaints. Correlated symptoms mentioned in the literature include pelvic pain and decreased hip range of motion, with potential obstetric complications. Owing to their asymptomatic nature, sacral ribs may be underreported. The primary aim of this report is to provide a detailed description of these sacral "ribs" in the unique setting of a cadaveric dissection supplemented with medical imaging to enhance visualization. (Folia Morphol 2024; 83, 2: 472–477)

Keywords: accessory rib, supernumerary rib, pelvic digit, iliac horns, sacral variation

INTRODUCTION

The phenomenon of accessory ribs is well described in the anatomical and clinical literature; however, reports of supernumerary ribs in the sacrococcygeal region are exceedingly rare [28]. During typical development, skeletal elements of the vertebral column and ribs derive from the ventral and medial sclerotomal components of somites [13]. Costal processes of the thoracic vertebrae give rise to ribs, while the costal processes in the sacral region form the sacrum's lateral masses [4]. The costal processes of the cervical spine fuse with the transverse processes to form the transverse foramina [4]. In a review, Spadliński et al. reported the typical prevalence of cervical ribs to be less than 3% but varied broadly between ethnic groups [28]. Cervical ribs, which usually arise from C7 and often fuse with the first rib, are associated with symptoms of thoracic outlet syndrome [3]. A large meta-analysis of 141 studies revealed that cervical ribs were found in al-

Address for correspondence: Jonathan A. Millard, Edward Via College of Osteopathic Medicine, 2265 Kraft Drive SW, 24060 Blacksburg, Virginia, United States; e-mail: jmillard@vt.vcom.edu

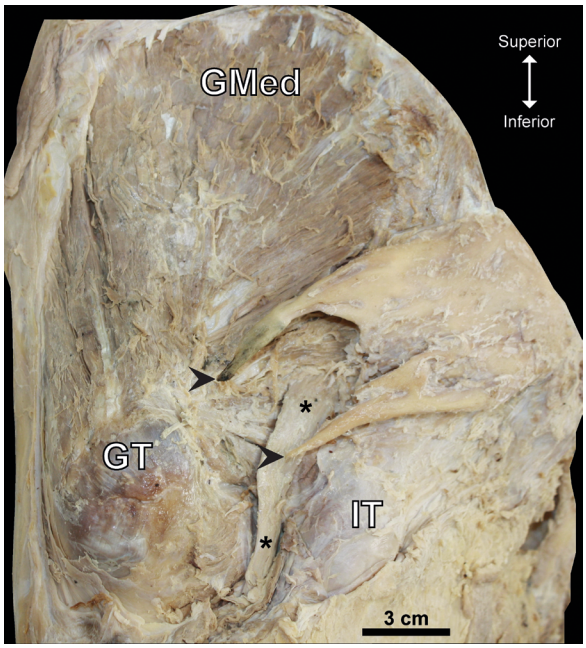

Figure 1. Dissection of the left gluteal region; GMed — gluteus medius muscle; GT — greater trochanter; IT — ischial tuberosity; arrowheads — sacral "ribs"; asterisks — sciatic nerve.

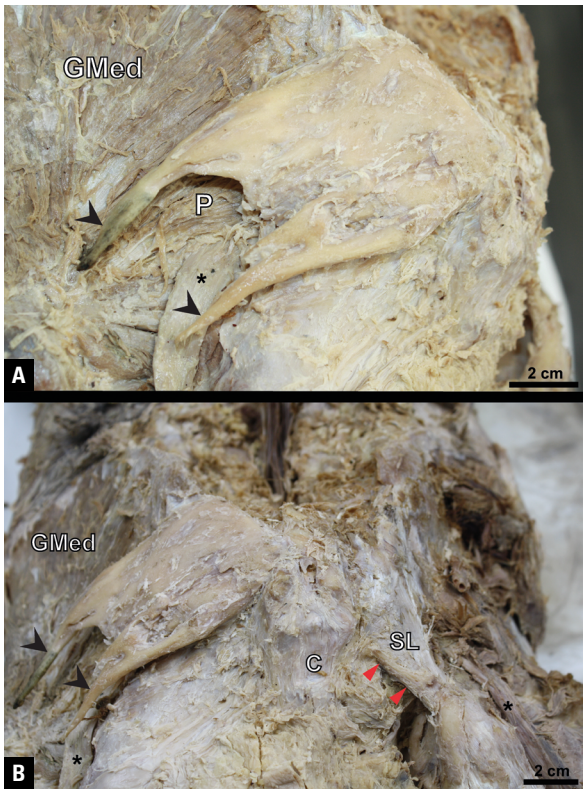

Figure 2. Dissection of the gluteal region; **A.** Left gluteal region; **B.** Posterior view of gluteal region; GMed — gluteus medius muscle; P — piriformis; C — coccyx; SL — sacrotuberous ligament; black arrowheads — sacral "ribs"; asterisks — sciatic nerve; red arrowheads — bony structure within the sacrotuberous ligament.

most 30% of patients with thoracic outlet syndrome, highlighting the clinical significance of this atypical anatomy [12]. Lumbar ribs typically occur in more rostral lumbar regions and are frequently coincident with lumbarization of the S1 vertebra [21]. Reports of lumbar rib prevalence range from as low as 0.04% to as high as 16% [18, 29]. There is no consensus on the prevalence of ribs originating from the sacrococcygeal spine, and case reports are sparse. Rib-like osseous formations from the base of the vertebral column and pelvis have many potential aetiologies, many of which are pathological and unrelated to congenital ribs. Here, we present a cadaveric specimen with features suggestive of sacral ribs.

CASE REPORT

The whole-body donor used in this report was obtained from the Virginia State Anatomical Program (Richmond, VA, USA). The research plan related to this report was evaluated by the Edward Via College of Osteopathic Medicine Institutional Review Board and was determined not to be human subject research project 197075-1. Relevant self-reported medical history included osteoporosis and arthritis.

During a routine cadaveric dissection of the gluteal region in a 76-year-old white female, two accessory bone formations were found extending from the left posterolateral sacrum. The two sacral "ribs" were found in the plane between the gluteus maximus and lesser gluteal muscles (Fig. 1). The projections originated from a shared bony platform that blended with the posterior sacral surface. None of the gluteal muscles were atrophied and the surrounding anatomy appeared normal except for notable dextroscoliosis. The more superior "rib" coursed over the piriformis muscle, hanging over the greater sciatic foramen, while the inferior "rib" extended over the lateral hip rotators and sciatic nerve. Both "ribs" were angled like floating ribs, tapering to a sharp tip. Another bony feature was palpated in the inferior border of the left sacrotuberous ligament (Fig. 2). A CT scan and three-dimensional reconstruction revealed several bony structures embedded bilaterally in the sacrotuberous ligament, discontinuous from the surrounding skeleton (Fig. 3). A thicker blunt growth was found on the left side extending from the anterior surface of the bony platform toward the ischial spine. Aside from the free bony entity in the sacrotuberous ligament, the right side did not contain any notably

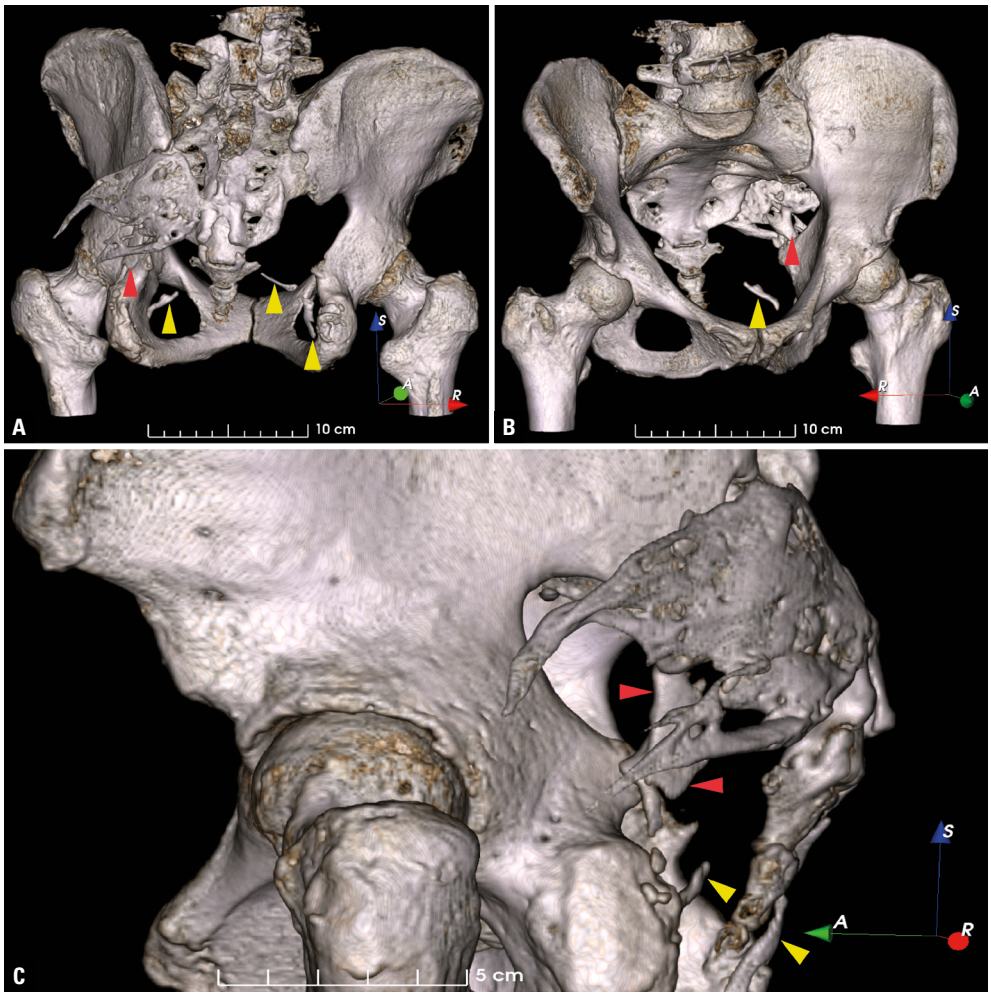

Figure 3. 3-D CT reconstruction of the pelvis; **A.** Posterior view; **B.** Anterolateral view; **C.** Lateral view of right pelvis; yellow arrowheads — free bony structures within sacrotuberous ligaments; red arrowheads — third protrusion from the shared sacral platform.

atypical anatomy. Sectional imaging showed the "rib" formations were well corticated with a distinct medullary cavity and heterogeneous zones at the sacral interfaces, suggesting pseudoarticulations (Fig. 4).

DISCUSSION

Some of the earliest reports of sacral or coccygeal ribs appeared in the 1930s by Dieulafé and Irnberger, although the identity of the structures as true ribs has been questioned [6, 14, 23]. The morphology and relative anatomical relationships of sacrococcygeal ribs reported in the literature are very diverse. They may be unilateral or bilateral. Some reports describe large irregularly shaped sacral extensions, while others describe ribs characterized by their narrow calibre and sharpness [2, 11, 19, 27]. Kaushal described smaller ossicles in the pelvis with less distinctive features [15]. Recently, Pasinato et al. reported an accessory bone articulating with the sacrum with three discrete projections [24]. Our finding shares many of these reported characteristics, including a large bony platform with both sharp and blunt extensions as well as loose ossifications without attachment to the surrounding skeleton. Our donor also exhibited significant scoliosis, which has been reported with other cases of sacral ribs [11, 19]. Coincident congenital sacral and vertebral column malformations are also frequently reported [5, 15].

Most sacrococcygeal ribs are found incidentally during examinations for other medical complaints although symptoms of pelvic pain and dysuria have been reported [1, 20]. The accessory ribs may be surgically removed to alleviate symptoms, but most do not require intervention. Sullivan and Cornwell elected to remove a rib-like structure from the upper coccyx of a 15-year-old female patient, citing potential future obstetric difficulties [30]. The idea that sacrococcygeal ribs may disrupt the normal dimensions of the pelvic

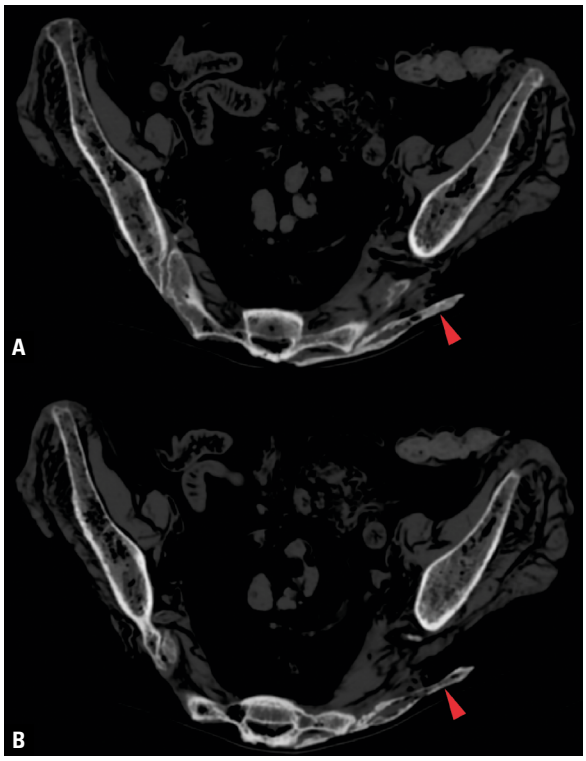

Figure 4. Axial CT images through pelvis; **A.** Level of S3 vertebra; **B.** Level of S4 vertebra; red arrowheads — sacral "ribs".

outlet is supported by the report of a sacral rib in a 34-year-old female with a history of two caesarean sections for fetopelvic disproportion [15].

The terms "pelvic digit", "pelvic rib", "pelvic finger", or "eleventh finger" are commonly used to describe bony outgrowths of the os coxae, which may appear rib- or phalanx-like in nature [16]. These "pelvic digits" often arise from the ilium and ischium and have been associated with hip pain, functional impairment, dyspareunia, and antalgic gait [7, 20, 25]. They are frequently found originating from the region of the acetabulum and in some cases contain multiple bony components resembling phalanges with intermediate articulations, which may be misinterpreted as fractures [31]. Many of these varieties appear to be distinct phenomena, with conspicuous features comparable to the broad heads and bases seen in metacarpal and phalangeal morphology [10]. Similar anomalies also include reports of bilateral iliac "horns", which are the pathognomonic feature of osteoonychodysplasia or Fong's disease and occur in roughly 75% of cases [8, 9]. In these cases, the iliac "horns" often accompany hypoplastic or absent nails, radial head subluxation, and patellar abnormalities [8]. Another potential cause for similar findings includes post-traumatic myositis ossificans, which develops in a region following trauma. Myositis ossificans lesions generally lack continuity with the surrounding skeleton and are characterized by a radiolucent core and calcified periphery [10]. Finally, osteochondroma, a ubiquitous type of benign bone tumour, could present with similar skeletal changes; however, these manifestations are directly contiguous with the surrounding bone and contain a cartilaginous cap [17].

The skeletal findings reported here share many features with previous reports, but conclusions must be drawn with caution as the information of the donor's medical history was limited. The gross appearance, size, shape, and relative anatomical course strongly suggest that these may be congenital ribs. Additionally, imaging revealed that the "ribs" had cortical bone with a regular medullary cavity and articulatory features, which seem to preclude myositis ossificans or osteochondroma. Our finding of bilateral bony fragments embedded within the sacrotuberous ligaments could be explained by idiopathic or post-traumatic calcification processes. Aside from case reports, few studies have evaluated the morphological features of sacrotuberous ligament ossification. Prescher and Bohndorf aimed to define commonalities in group of 13 ossified ligaments (eight individuals), finding that in all cases except one, the ossification arose as a broad origin from the ischial tuberosity tapering to a narrow point superomedially [26]. As the bony features we discovered in the sacrotuberous ligaments were loose, this suggests a potentially different aetiology. It may be useful to distinguish other pelvic bony anomalies from true congenital ribs, which one would expect to arise from the vertebral column. We suggest the use of more precise terminology that effectively discriminates between bony abnormalities with differing aetiologies, which may include their own coincident conditions and unique sequelae or necessitate differing clinical interventions.

CONCLUSIONS

Ribs originating from the sacrum and coccyx are rare. This report highlights an unusual case in the context of cadaveric dissection. While the literature describing similar unexpected bony features of the pelvic girdle is limited, there are definitive trends that may inform the use of more precise terminology, enhancing clinical understanding surrounding these anomalies.

ARTICLE INFORMATION AND DECLARATIONS

Acknowledgements

The authors would like to thank Edward Via College of Osteopathic Medicine (Blacksburg, VA, USA), Virginia State Anatomical Program (Richmond, VA, USA), and LewisGale Imaging Center (Blacksburg, VA, USA) for their contributions to anatomical research. The authors would like to extend their greatest appreciation to the anatomical body donors and their families for their unique gift, without which this research would not be possible.

Conflict of interest: None declared.

REFERENCES

1. Bohutová J, Kolár J, Vítovec J, et al. Accessory caudal axial and pelvic ribs. Rofo. 1980; 133(6): 641–643, indexed in Pubmed: 6453795.
2. Carbo G, Balliu E, Ortuño P, et al. Costilla sacra. Med Clin (Barc). 2015; 145(12): 556, doi: 10.1016/j.medcli.2015.04.003, indexed in Pubmed: 26004279.
3. Chang KZ, Likes K, Davis K, et al. The significance of cervical ribs in thoracic outlet syndrome. J Vasc Surg. 2013; 57(3): 771–775, doi: 10.1016/j.jvs.2012.08.110, indexed in Pubmed: 23446121.
4. Chernoff N, Rogers JM. Supernumerary ribs in developmental toxicity bioassays and in human populations: incidence and biological significance. J Toxicol Environ Health B Crit Rev. 2004; 7(6): 437–449, doi: 10.1080/10937400490512447, indexed in Pubmed: 15586878.
5. de Miguel I, Edouard F, Alvarez L, et al. Where ribs can be found in odd places. Spine J. 2007; 7(2): 256–257, doi: 10.1016/j.spinee.2006.02.027, indexed in Pubmed: 17402178.
6. Dieulafé R. Le coccyx: etude osteologique. Arch Anat Histol Embryol (Strasb). 1933; 16: 41–91.
7. Evangelista P, Evangelista G. Dyspareunia associated with a pelvic digit. J Surg Case Rep. 2011; 2011(12): 7, doi: 10.1093/jscr/2011.12.7, indexed in Pubmed: 24971838.
8. Guidera KJ, Satterwhite Y, Ogden JA, et al. Nail patella syndrome: a review of 44 orthopaedic patients. J Pediatr Orthop. 1991; 11(6): 737–742, indexed in Pubmed: 1960197.
9. Goshen E, Schwartz A, Zilka LR, et al. Bilateral accessory iliac horns: pathognomonic findings in Nail-patella syndrome. Scintigraphic evidence on bone scan. Clin Nucl Med. 2000; 25(6): 476–477, doi: 10.1097/00003072-200006000-00020, indexed in Pubmed: 10836702.
10. Granieri GF, Bacarini L. The pelvic digit: five new examples of an unusual anomaly. Skeletal Radiol. 1996; 25(8): 723–726, doi: 10.1007/s002560050168, indexed in Pubmed: 8958617.
11. Heligman D, Sullivan R, Millar E. Sacral ribs: a case report. Orthopedics. 1987; 10(10): 1439–1442, doi: 10.3928/0147-7447-19871001-14, indexed in Pubmed: 3317329.
12. Henry BM, Vikse J, Sanna B, et al. Cervical rib prevalence and its association with thoracic outlet syndrome: a meta-analysis of 141 studies with surgical considerations. World Neurosurg. 2018; 110: e965–e978, doi: 10.1016/j.wneu.2017.11.148, indexed in Pubmed: 29203316.
13. Huang R, Zhi Q, Schmidt C, et al. Sclerotomal origin of the ribs. Development. 2000; 127(3): 527–532, doi: 10.1242/dev.127.3.527, indexed in Pubmed: 10631173.
14. Irnberger T. Beobachtung eines Rippenrudimentes am menschlichen Steissbein. Anat Anz. 1938; 86: 369–378.
15. Kaushal SP. Sacral ribs. Int Surg. 1977; 62(1): 37–38, indexed in Pubmed: 832951.
16. Khatri K, Goyal D, Paul R, et al. Two pelvic digits on same side: double trouble? J Clin Diagn Res. 2015; 9(6): RD04–RD05, doi: 10.7860/JCDR/2015/12347.6013, indexed in Pubmed: 26266172.
17. Kitsoulis P, Galani V, Stefanaki K, et al. Osteochondromas: review of the clinical, radiological and pathological features. In Vivo. 2008; 22(5): 633–646, indexed in Pubmed: 18853760.
18. MacGibbon B, Farfan HF. A radiologic survey of various configurations of the lumbar spine. Spine (Phila Pa 1976). 1979; 4(3): 258–266, doi: 10.1097/00007632-197905000-00013, indexed in Pubmed: 472898.
19. Miyakoshi N, Kobayashi A, Hongo M, et al. Sacral rib: an uncommon congenital anomaly. Spine J. 2015; 15(6): e35–e38, doi: 10.1016/j.spinee.2013.08.055, indexed in Pubmed: 24268667.
20. Moreta-Suárez J, de Ugarte-Sobrón OS, Sánchez-Sobrino A, et al. The pelvic digit: a rare congenital anomaly as a cause of hip pain. J Orthop Case Rep. 2012; 2(4): 19–22, indexed in Pubmed: 27298880.
21. Nakajima A, Usui A, Hosokai Y, et al. The prevalence of morphological changes in the thoracolumbar spine on whole-spine computed tomographic images. Insights Imaging. 2014; 5(1): 77–83, doi: 10.1007/s13244-013-0286-0, indexed in Pubmed: 24052419.
22. Nastoulis E, Karakasi MV, Pavlidis P, et al. Anatomy and clinical significance of sacral variations: a systematic review. Folia Morphol. 2019; 78(4): 651–667, doi: 10.5603/FM.a2019.0040, indexed in Pubmed: 30949993.
23. Pais J, Levine A, Pais SO. Coccygeal ribs: development and appearance in two cases. AJR Am J Roentgenol. 1978; 131(1): 164–166, doi: 10.2214/ajr.131.1.164, indexed in Pubmed: 97972.
24. Pasinato G, Draily R, Launois PH, et al. Incidental discovery of a sacral rib: a case report. Surg Radiol Anat. 2023; 45(5): 661–663, doi: 10.1007/s00276-023-03113-y, indexed in Pubmed: 36871113.
25. Podgórski M, Gwizdała D, Flont P, et al. A symptomatic pelvic rib. Folia Morphol. 2018; 77(2): 406–408, doi: 10.5603/FM.a2017.0077, indexed in Pubmed: 28832092.
26. Prescher A, Bohndorf K. Anatomical and radiological observations concerning ossification of the sacrotuberous ligament: is there a relation to spinal diffuse idiopathic skeletal hyperostosis (DISH)? Skeletal Radiol. 1993;

22(8): 581–585, doi: 10.1007/BF00197139, indexed in Pubmed: 8291010.
27. Rashid M, Khalid M, Malik N. Sacral rib: a rare congenital anomaly. Acta Orthop Belg. 2008; 74(3): 429–431, indexed in Pubmed: 18686476.
28. Spadliński Ł, Cecot T, Majos A, et al. The epidemiological, morphological, and clinical aspects of the cervical ribs in humans. Biomed Res Int. 2016; 2016: 8034613, doi: 10.1155/2016/8034613, indexed in Pubmed: 27975060.
29. Steiner HA. Roentgenologic manifestations and clinical symptoms of rib abnormalities. Radiology. 1943; 40(2): 175–178, doi: 10.1148/40.2.175.
30. Sullivan D, Cornwell WS. Pelvic rib. Report of a case. Radiology. 1974; 110(2): 355–357, doi: 10.1148/110.2.355, indexed in Pubmed: 4810148.
31. Van Breuseghem I. The pelvic digit: a harmless "eleventh" finger. Br J Radiol. 2006; 79(945): e106–e107, doi: 10.1259/bjr/17378249, indexed in Pubmed: 16940362.