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Growth Restart / Recovery Lines involving the vertebral body: a rare, incidental finding and diagnostic challenge in two patients

Sandy Sajko, BPHE, MSc, DC, RCCSS(C)*
Kent Stuber, BSc, DC, MSc**
Michelle Wessely, BSc, DC, DACBR, FCC (UK), DipMEd§

Objective: *To present the phenomenon of growth restart lines and create awareness of the possible differential diagnoses.*

Clinical Features: *Two case reports outlining the presentation of growth restart lines found in the vertebrae of trampolinists. Emphasis in each case is placed on correlating the patient history with radiographic findings.*

Intervention and Outcome: *In both cases a conservative chiropractic treatment plan was initiated once the differential diagnoses could be ruled out.*

Conclusion: *Although the range of etiologies of growth restart lines is extensive, these case reports illustrate the importance of a comprehensive case history when presented with the radiographic finding of growth restart lines.*
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KEY WORDS: growth, restart line, vertebrae

Objectif : *présenter le phénomène des lignes de reprise de la croissance et faire connaître les diagnostics différentiels possibles.*

Caractéristiques cliniques : *deux rapports de cas mettant en relief la présentation des lignes de reprise de la croissance dans les vertèbres de trampolinistes. Dans les deux cas, nous mettons l'accent sur la corrélation entre les antécédents du patient et les résultats des radiographies.*

Intervention et résultat : *dans les deux cas, un traitement chiropratique conservateur fut mis en œuvre lorsque la possibilité de diagnostics différentiels fut éliminée.*

Conclusion : *bien que l'éventail des étiologies des lignes de reprise de croissance était vaste, ces cas démontrent l'importance des antécédents détaillés lorsque les résultats des radiographies portant sur les lignes de reprise de croissance sont connus.*
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MOTS CLÉS : croissance, ligne de reprise, vertèbres

Introduction

Growth restart lines are generally encountered in the ends of the bones of the lower limb that grow most rapidly, especially about the knee.[1] Although less common, other regions of the skeleton may be affected, particularly the spine. Growth restart lines (also known as Harris lines or growth arrest lines) are typically formed in the long bones when the trabeculae become dense and horizontally oriented to the long axis of the bone, resulting in the radiographical feature of lines. These restart lines may be due to a variety of disorders affecting skeletal development such as severe childhood infection, leukemia, malnutrition, immobilization, and medication use.[2–7] Interestingly, their identification has been used by paleontologists and anthropologists as a means of determining the health of ancient populations.[8,9] It is important to recognize and identify growth restart lines in order to determine their origin and to be able to differentiate growth restart lines

* Sports Clinic, University of Toronto, Mississauga
** Adjunct Professor, Division of Graduate Education and Research, Canadian Memorial Chiropractic College
§ Head of Radiology (Paris/Toulouse) Institut Franco-Europeen de Chiropratique (IFEC) France

from the reinforcement lines encountered in patients with reduced bone quantity.[10] This report presents two cases to illustrate the importance of a comprehensive case history along with imaging findings to aid with the determination of the etiology of growth restart lines.

Case One

History

A sixteen-year-old male elite trampolinist presented to a chiropractic clinic with neck pain which began immediately after falling from a trampoline during a practice where the athlete landed on the right side of his neck and right shoulder. At the time, he saw his family physician and was referred for cervical and thoracic spine radiographs, which were interpreted as unremarkable. The physician subsequently prescribed anti-inflammatory medications and advised him to rest for two weeks. With continued pain and restriction of neck movement one week after the fall, the athlete presented to a chiropractor.

The patient indicated that the pain was constant and the intensity was rated verbally as six out of ten, where zero equals no pain at all and a ten rating is the most pain the individual has ever experienced in his lifetime. The patient localized the pain to the cervicothoracic junction and reported that moving his head to the right and upwards aggravated the pain, whereas stretching provided some temporary relief. The patient had no previous history of neck pain but reported a history of recurrent low back pain. The patient denied having any previous childhood infections, malnutrition, immobilization, or prescription medication use. Further investigation into his past sporting activities revealed a history of competitive gymnastics that involved three hours of practice each day for six days per week since he was six years old. The athlete ceased competitive gymnastics at the age of nine to train for the trampoline competitively. At the time of his injury, his time commitment to trampoline training was approximately four hours per day, five days per week.

Physical Examination

Upon examination of the head and neck regions, no obvious deformities, effusion or muscle atrophy were noted. His cervical spine active ranges of motion (ROM) were all within normal limits except for right rotation, which was 45 degrees, extension was 30 degrees and right lateral flexion was 15 degrees. Passive ROM was five degrees greater in each direction. Resisted cervical spine flexion, extension, bilateral lateral flexion and rotation were all graded as 4/5 as the patient was unable to achieve full muscle strength due to reported pain during this procedure. A neurological sensory examination of the upper limbs for light touch, vibration, pain and crude touch was unremarkable. Deep tendon reflexes (DTR) at C5, C6, and C7 were graded 2+ bilaterally (normal). Motor testing for the upper limb myotomes of C5 to T1 were graded 5/5 in all directions, where a 5/5 is indicative of the client being able to full resist the practitioner's applied force. Orthopedic testing was not reliable due to the prominent muscular spasm in the cervico-thoracic spinal region. Aberrant motions with reported tenderness were identified through motion and static palpation in the right C7-T1 and T3-4 facet joints. The patient's right posterior scalene, upper trapezius, levator scapulae and rhomboid major/minor were mildly hypertonic and tender upon palpation.

Diagnostic Imaging

Cervical and thoracic spine radiographs requisitioned by the patient's medical physician were interpreted by the radiologist as unremarkable for fractures and dislocations. However these radiographs did reveal multiple linear growth recovery lines most prominent in the thoracic region, and less so in the cervical region (please see Figure 1).

Diagnosis

The patient was diagnosed by his chiropractor with acute mechanical cervicothoracic facet joint dysfunction with associated myofascial pain.

Plan of Management

The initial plan of management consisted of interferential current therapy (on a continuous bipolar setting at 120 Hz for pain relief), Active Release Techniques® to the affected musculature, and spinal manipulative therapy of the cervical and thoracic spine. The patient was seen three times per week for two weeks, followed by two times per week for one week. The patient was seen twice more over the next two weeks and at the end of this treatment plan the patient's cervical spine active, passive and resisted ROM were all within normal limits and reported as pain free.

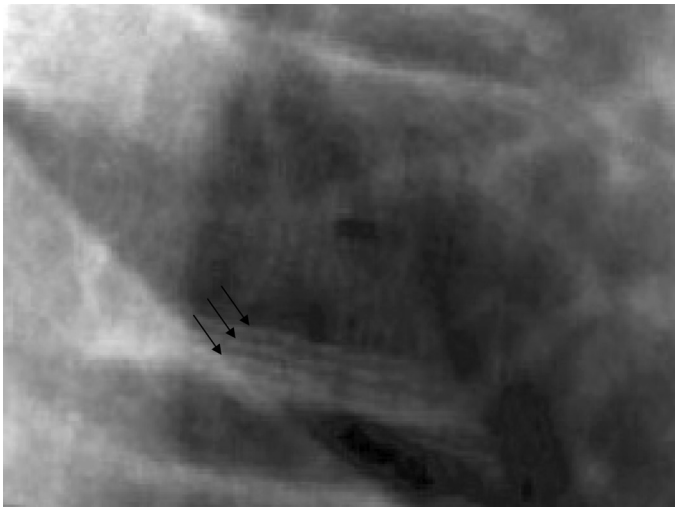

Figure 1 *Lateral thoracic spine view demonstrating growth restart lines (indicated by arrows).*

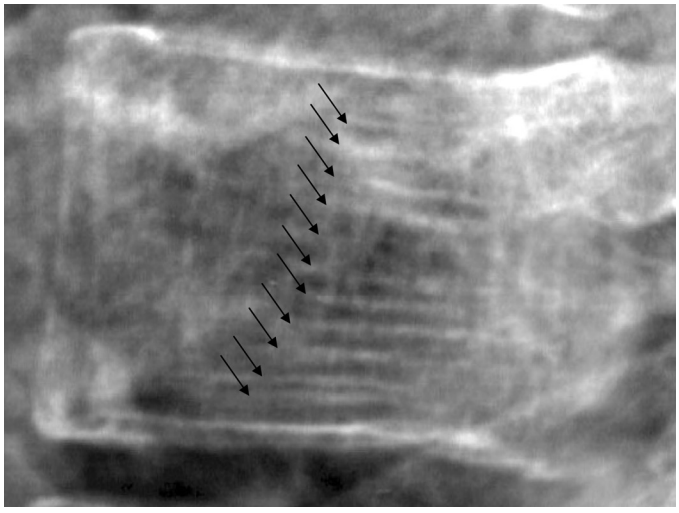

Figure 2 *Lateral lumbar spot view demonstrating growth restart lines (arrows).*

Case Two

History

A 27-year-old flight attendant presented to the chiropractor with a three-month history of low back pain that began when his flying hours were increased. He initially consulted the airline's occupational health physician who diagnosed him with a "lower back sprain". Due to the continuous pain the patient subsequently consulted his family physician who examined him and prescribed a seven-day course of non-steroidal anti-inflammatory medication.

The chiropractic history examination revealed the patient had a history of recurrent lower back pain as a young gymnast and that injury previously responded to conservative care. The current pain was localized to the thoracolumbar region without radiation to the buttocks or leg and was not associated with any sensory or neurological deficits. The patient reported that the pain was a consistent achy sensation and was uncertain of any aggravating or relieving factors. The patient reported that his annual airline medical examination included a full blood count, which had been reported as negative the previous month.

Physical Examination

The physical examination revealed that the patient's lumbar ranges of motion were within normal limits although he reported pain at the end-range of passive extension. All orthopedic and neurological testing was unremarkable. Motion and static palpation revealed segmental restrictions at the thoracolumbar junction. Muscle palpation revealed a mildly hypertonic quadratus lumborum bilaterally. Subsequently, the chiropractor determined that radiographs were required prior to commencing spinal manipulation due to patient's prior history of lower back pain and to rule out a spondylolysis owing to his high level of involvement in gymnastics.

Diagnostic Imaging

Radiographs of the thoracolumbar spine region demonstrated the presence of multiple radio-opaque horizontal lines along the vertebral bodies of both the lower thoracic and most of the lumbar spinal segments (please see Figure 2). The remaining alignment, bone, articulations and soft tissue structures were within normal limits.

Differential Diagnosis

The medical radiologist discussed the imaging findings with the patient and offered the diagnosis of leukemia as the explanation for the radio-opaque lines in the noted vertebral bodies. The patient returned to his family physician for further blood tests. To follow up the chiropractor consulted a chiropractic radiologist (MW) for additional imaging interpretation. Following analysis of the multiple radio-opaque linear lines, a more in-depth health his-

tory was performed and the patient reported that during his adolescence a relative had systematically physically abused him and that during these periods he suffered from mild bouts of anorexia nervosa. In addition, between the ages of 13 and 16 years of age he was in the national training program for trampolining, which consisted of two to three hours of daily training. This additional clinical information and the fact that repeated blood tests were unremarkable assisted in determining the most likely explanation that the presence of the linear radio-opaque lines was benign in nature and not due to leukemia as otherwise suggested.

Management

The patient received chiropractic treatment, which included spinal manipulation directed towards the thoracolumbar segmental dysfunction, along with soft tissue therapy for quadrates lumborum myofascial pain syndrome. At the patient's request he was referred to a counselor regarding his past physical abuse. The response to chiropractic treatment was rapid, with cessation of all pain after two chiropractic treatments.

Table 1 *Differential diagnoses for growth restart lines.*

Osteopetrosis
Hyper/Hypoparathyroidism
Sclerosing Spondylosis
Radiation Exposure
Cushing's Syndrome
Rickets (Healing)
Avascular Necrosis
Osteoporosis
Congenital Syphilis
Paget's Disease
Leukemia
Nutritional Deficiency
Scurvy
Fractures (Healing)
Childhood Stress
Infection

Discussion

Historically, conventional radiography has been an integral part of chiropractic practice to rule out specific sources of pain, such as infection, malignancy, fracture and dislocation. Abnormal findings apparent on radiographs are not overly common, with reported rates between one in 100 to one in 2500.[11–13] However, if such pathologies are missed the consequences could be severe for both the patient and the practitioner. The cases presented illustrate not only the importance of identifying growth restart lines on radiographs but also linking these findings with the clinical history.

Numerous authors have described the morphologic characteristics of growth restart lines and a general consensus has not been agreed upon.[2–5,13,14] The lines are more appropriately referred to as growth restart lines or recovery lines rather than the previously preferred term of growth arrest lines. This change in bony appearance on conventional radiography is due to the osteoblasts forming a thin transverse bone layer below the zone of provisional calcification during the time when growth has resumed after a period of growth cessation. When growth is re-established, cartilaginous proliferation and increased osteoblastic activity contribute to the thickening and metaphyseal migration of the transverse line.[14,15]

In the spine the restart lines typically parallel the vertebral endplates and occasionally form a bone within a bone (endobone) appearance when a remnant of the anterior vertebral surface persists. The appearance is similar to those seen in some patients with osteopetrosis or heavy metal poisoning.[16] As a clinician it is imperative to distinguish whether these lines may have developed as a result of repetitive trauma or from other pathologies such as infection,[2] malnutrition,[2,21] immobilization, [4,8] hypoparathyroidism,[16] alcohol consumption during growth,[9] juvenile chronic arthritis,[18] psychosocial short stature,[19] endemic skeletal fluorosis,[20] bisphosponate medication,[21] heavy metal poisoning[13] or leukemia.[5,23] (Please see Table 1 for a detailed list of differential diagnoses)

The cases presented above demonstrate that it can be difficult to solely attribute the presence of growth restart/recovery lines to one common factor but the authors postulate that repetitive axial compression activities such as in trampoline and gymnastics may contribute to these radiological findings. These cases also emphasize the im-

portance of conducting a comprehensive history and performing the appropriate investigative tests to render this diagnosis by exclusion.

Conclusion

The cases presented in this report illustrate an incidental radiological finding of growth restart/recovery lines in two trampoline athletes. It is the authors' opinion that health care practitioners should be cognizant of restart/recovery lines and should take every precaution not to misdiagnose or misinterpret these radiological findings as one of the more serious disorders with a similar radiographic appearance. Lastly, it is clear from the limited research in this area that further studies are warranted, in particular investigations into the hypothetical contribution of sporting activities that involve repetitive axial loading movements and their role in the possible cause of these radiological findings.

References

1 Siffert RS, Katz JF. Growth recovery zones. J Pediatr Orthoped. 1983; 3:196–201.
2 Park EA. The imprinting of nutritional disturbances on growing bone. J Pediatr. 1964; 33:815–862.
3 Silverman FN. Variants due to diseases of bone. In: Caffey's Pediatric X-ray Diagnosis: An Integrated Imaging Approach 9th Edition. Philadelphia: Mosby, 1994; 1521–1527.
4 Bar-On E, Beckwith JB, Odom LF, Eilert RE. The effect of chemotherapy on human growth plate. J Pediatr Orthop. 1993; 13(2):220–224.
5 Schwartz AM, Leonidas JC. Methotrexate osteopathy. Skeletal Radio. 1984; 11:13–16.
6 Peters W, Irving J, Letts M. Long-term effect of neonatal bone and joint infection on the adjacent growth plate. J Paediatr Orthopaed. 1992; 12(6):806–810.
7 Rosen RA, Desmukh SM. Growth arrest recovery lines in hypoparathyroidism. Radiology. 1985: 155(1):61–62.
8 Yao L, Seeger LL. Epiphyseal growth arrest lines: MR findings. Clin Imag. 1997; 21:237–240.
9 Gonzalez-Reimers E, Perez Ramirez A, Santolaria-Fernandex F, Rodriguez-Rodriguez E, Martinez-Riera A, del Carmen Duran-Castellon M, Alemain-Valls MR, Gaspar MR. Association of Harris lines and shorter stature with ethanol consumption during growth. Alcohol. 2007; 41:511–515.
10 Kursunoglu S, Pate D, Resnick D, Haghighi P, Tyson R, Pitt M. Bone reinforcement lines in chronic adult osteopenia: A hypothesis. Radiology, 1986; 158:409–415.
11 Brekkan A. Radiographic examination of the lumbosacral spine: An "age-stratified" study. Clinical Radiology. 1983; 34: 321–324.
12 Nachemson AL. The lumbar spine: An orthopaedic challenge. Spine. 1976; 1:59–71.
13 Resnick D. Diagnosis of Bone and Joint Disorders 4th Edition. W.B. Saunders Company, 2002; 2397–2401.
14 Frager DH, Subbarao K. The bone within a bone. JAMA. 1983; 249:77–79.
15 Nowak O, Piontek J. The frequency of appearance of transverse (Harris) lines in the tibia in relationship to age at death. Ann of Hum Bio. 2002; 29(3):314–325.
16 Rosen RA, Deshmukh SM. Growth arrest recovery lines in hypoparathyroidism. Radiology. 1985; 155:61–62.
17 Mays S. The relationship between Harris lines and other aspects of skeletal development in adults and juveniles. J Archaeol Sci. 1985; 22:511–520.
18 Fiszman P, Ansell BM, Renton P. Radiological assessment of knees in juvenile chronic arthritis (juvenile rheumatoid arthritis). Scand J Rheumatol. 1981; 10:145–152.
19 Khadilkar VV, Frazer FL, Skuse DH, Stanhope R. Metaphyseal growth arrest lines in psychosocial short stature. Arch Dis Child. 1998; 79:260–262.
20 Wang Y, Yin Y, Gilula LA, Wilson AJ. Endemic fluorosis of the skeleton: Radiographic features in 127 patients. AJR Am J Roentgenol. 1994; 162:93–98.
21 Hong IK, Suh JS, Lee YA, Kim DY. Scintigraphic findings of growth arrest lines after bisphosphonate administration in a steroid-induced osteoporosis patient. Clin Nuc Med. 2010; 35(9):740–742.
22 Hummert JR, Van Gerven DP. Observations on the formation and persistence of radiopaque transverse lines. Am J Phys Antropol. 1985; 66:297–306.
23 Meister B, Gassner I, Streif W, Dengg K, Fink FM. Methotrexate osteopathy in infants with tumors of the central nervous system. Med Pediatr Oncol. 1994; 23(6):493–496.