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Review Article

Sacrococcygeal Chordomas in Childhood, Adolescents and Young Adults: A Review

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Received: March 10, 2020; **Published:** March 23, 2020

Abstract

Background and objectives: Until the past two decades, childhood and adolescents sacrococcygeal chordoma was in general sparsely documented. Study of its biology and cyto-morphology in recent years has classified the tumour into several subtypes. This paper attempts to relate the morphology and histopathology of these subtypes in terms of prognosis and to gain insights on the tumour's clinical behaviour and current management trends.

Material and Methods: The core material consists of seven articles on paediatric and adolescent sacrococcygeal chordoma and five review papers on the tumour's biology and clinical behaviour in the paediatric and young adult population.

Results:

1. The incidence of paediatric sacrococcygeal chordoma in comparison to its adult counterpart is low. In a series of 60 patients, only one belonged to the paediatric age. There are scant reports on patients with this condition in their second and third decade of life.
2. The gross features on computed tomography and magnetic resonance imaging are mainly indistinguishable from other benign and malignant sacral tumours. Though internal septations on T2W magnetic resonance imaging are characteristic, these also feature in Ewing's sarcoma and aneurysmal bone cysts. Among adolescents, computed tomography findings such as spotted calcifications and bone erosions are also found in chondrosarcoma, and sacral chondroblastic osteosarcoma.
3. The highly malignant dedifferentiated sacral chordomas affect up to 50% of young adults in their thirties and forties.

Conclusion: Gross total resection with wide negative margins remains the treatment of choice for both children and adults while magnetic resonance imaging plays an indispensable role in surgical planning and post therapy follow-up. Poor differentiation, cellular atypia and SMARCB1 INI loss are unfavourable prognostic signs indicative of concomitant metastases.

Keywords: *Adolescents; Childhood; Chordoma; Paediatric; Sacrococcygeal*

Abbreviations

COS: Chondroblastic Osteosarcoma; CC: Chondroid Chordoma; CS: Chondrosarcoma; DC: Dedifferentiated Chordoma; EP: Ecchordosis Physaliphora; MRI: Magnetic Resonance Imaging; TSC: Tuberous Scleroses Complex (TSC); T2W: T2 Weighted

Introduction

Chordomas are tumours of low-grade malignancy that essentially arise from the bones of the axial skeleton. The lesions are uncommon, occurring in less than one per million people [1,2]. Its highest incidence occurs among male adults in their 6th and 7th decades of

life. Contrarily, less than 5% is being diagnosed in children and adolescents [3]. In this age group these tumours almost solely originate from the clivus and the mobile spine. Chordomas in the sacrococcygeal spine are eminently rare [3,4]. No paediatric or adolescent-aged sacrococcygeal chordoma had been reported in two major teaching hospitals [5,6]. In the latter instance the data covered a 50-year period (1941 - 1991).

A challenging aspect of paediatric lumbosacral chordoma rests with the fact that other benign and malignant lesions can arise from the sacrum and surrounds; they share similar clinical presentations and morphological features [7-11]. They may possess imaging findings akin to those of sacral chordomas [12-16].

Al-Adra., *et al.* [17] highlighted the rarity of paediatric sacrococcygeal chordomas. Their literature review showed less than 25 cases were reported dating back to 1910. Significantly, only 19 of these were written in English, while two reports published in the 1990's [18,19] had not been included. Apart from the surgical technique on sacral tumours as clearly depicted by Cable., *et al.* [7], this study by Al-Adra., *et al.* [17] had centred on surgical principles, different approaches and the importance of management by a multi-disciplinary team. Such practice is similarly applied to children and adolescents suffering from other sacral malignancies [13,14,20].

One of the first to relate poor prognosis of paediatric lumbosacral chordoma to its atypical cytology was the St Louis Children's group [3]. They observed a link between early tumour recurrence post-surgery and metastatic disease at initial presentation. This concept of relating cytology atypia to distant metastasis was further substantiated by two other children aged 10 and below: one of who succumbed to multiple recurrences and extensive metastases nine months post-surgery [19]. Shih A., *et al.*'s [21] cohorts of 19 poorly differentiated paediatric clival, spinal and lumbosacral chordomas in all probability correspond to the atypical cellular subtypes described earlier [3]. They have identified nuclear pleomorphism, increased mitoses and early disseminated metastases as distinct clinical features; added to these are an abnormal immunohistochemical profile in which SMARCB1 loss is the main finding. Thus, by the close of the last decade, researchers have redefined in scientific terms chordoma's cellular pathology and genomic profile, identifying clinical, histopathological and genetic parameters that correlate with ultimate prognostication of the tumour [21,22].

On the surgical front, the high point consists of refining the techniques for sacral tumours, albeit in adults [23-25]. But the surgical principles and routes can be adopted for both adolescents and the paediatric population [2], placing emphasis on precision imaging, notably magnetic resonance imaging (MRI), as a key part of surgical planning [25].

Of late, McMasters., *et al.* [26] and Dahl., *et al.* [27] have emphasised on the origin and biology of neonatal sacral chordoma as part manifestation of tuberous scleroses complex (TSC). The main presentation is of a mass over the sacrum at birth although other clinical stigma such as epilepsy and subcutaneous skin nodules may not be evident as yet. They also draw attention to the better long-term overall survival rate of infants with sacral chordoma in comparison to the sporadic cases of childhood conventional chordoma. This places infantile and congenital chordoma associated with TSC in a special sub-group in which favourable prognostication is conceivably due to TSC 's special genomic profiling [26].

The truly malignant sacral chordoma is uncommon and until recently sparsely reported. There exists a dedifferentiated form that is part of the histopathological fabric of chordoma wherein partial transformation into a sarcoma has taken place. Other malignant components include fibrous histiocytoma and fibrosarcoma. Those affected are young adults and some of older age [28,29]. The infrequency of dedifferentiated sacral chordoma is attested by its absence in 52 patients who received radical surgery at the Mayo Clinic [24].

However, our lack of insight into sacrococcygeal chordoma in the paediatric and adolescent population stems from its occasional uncertain biological behaviour and the paucity of fully documented cases. Apart from advocating total tumour resection with wide margins a unanimous surgical approach has not been finalised, compounded by difficulties in identifying sacral nerve roots due to the infiltrative and invasive tendency of the tumour. These themes are worthy of exploration, which forms the objective of this review.

Materials and Methods

A Medline database search on publications in English language on childhood and adolescent sacrococcygeal chordoma from 1989 to December 2019 was performed. The search terms included "childhood/adolescent" and "sacrococcygeal chordoma". Forty-three papers were found in the primary search; only 21 of these met the criteria. These included five review papers as sources of reference.

The core material consisted of 12 publications on sacral chordoma on patients in their first two decades of life. Of these, seven papers contain material relevant to our interests, illustrating (a) the various forms of extraosseous origins in two; (b) two with difficulties at surgery; (c) management of the dedifferentiated subtypes; and (d) discussions on a case of uncertain diagnosis.

Results, Case Illustrations and Discussion

Illustrative cases

Extraosseous origins

- Case I - Hamilton., *et al* [30].
- Case II - Soo., *et al* [10].

Case I: Eleven-year-old boy with low back pain and progressive gait difficulties [30].

The authors have argued their case as the first extraosseous intradural sacral chordoma ever reported (compare this with similar claim by Horton., *et al.* [8]). Nonetheless, modern spinal surgery using neurophysiologic monitoring, direct nerve stimulation and preceded by precision MR imaging proved successful in performing gross total resection. Discovery of residual tumour adhering to sacral nerve roots was the prime reason for the boy to receive a full course of proton beam radiotherapy; such mode of treatment would not have been advocated for a skull base chordoma. By quoting the experience of others (though essentially confined to the posterior fossa), the Hamilton group [30] have laid emphasis on the less aggressive nature of this extraosseous subtype, typified by the absence of recurrences and distant metastasis in comparison with conventional chordoma.

Finally, a sacral chordoma of extraosseous origin is compared and contrasted with an Ecchordosis Physaliphora (EP) as they stem from similar embryological origins: the classical physaliferous cells are present in both. But EP is benign, does not enhance with contrast on MRI and does not have Ki-67 proliferation. Extraosseous chordoma shows variable contrast enhancement and shows KI-67 proliferation. But there exists a remote possibility EP can turn into an intradural chordoma with Ki-67 proliferation.

Case II: Eighteen-year-old male with constipation and perineal pain for 16 weeks [10].

This is an example of mistaken pathological identity - a sacrococcygeal chordoma in the presacral space with features suggestive of a large intra-pelvic teratoma. This error should not be made because characteristic internal septations were present within the whole tumour on T2 weighted MRI. The significance of minor tumour extension into the deep layer of the gluteus muscle was overlooked. A team of abdominal surgeons used a three-stage abdominal-perineal approach for complete excision of the 15 cm diameter lesion, confirmed as conventional chordoma. A small part of the tumour-infiltrated coccyx was also removed. In consequence he received a full course of adjuvant radiotherapy and has been well and disease free at follow-up 30 months post-surgery. This case reinforces the hypothesis that extraosseous sacral chordoma belongs to a subtype with more favourable outcome than conventional chordoma as proposed by Hamilton., *et al* [30].

The literature does not dwell fully on the abdominal-perineal approach for presacral chordoma since a lesion of such dimensions is infrequently encountered. At late adolescent age differentiating sacral chordoma from its morphological mimicker teratoma is based on the notion the latter has a better prognosis: this may not be necessarily true since pelvic teratomas can turn malignant [11].

Presacral chordomas: No surgery offered in one and complicated surgery in the other (Horton., *et al* [8] and Cable., *et al* [7])

For children below five-years of age, there is always a possibility a presacral lesion can be one in a group of teratoid tumours. Besides these are usually indolent and benign [8], although this is debatable. The tumour's T1 shortening was reasonably interpreted as fat and sebaceous material within a teratoma. A history of limping and unsteady gait was discovered to be caused by a 14 cm diameter presacral chordoma adhering firmly to the retroperitoneal space, making it unresectable. The child succumbed three months after diagnosis was confirmed.

Contrarily in the second case, despite the tumour's enormous size (15 cm x 12 cm) Cable., *et al.* [7] recruited a team of orthopaedic, paediatric and neurological surgeons to carry out a gross total resection (an abdominal-sacral approach). The task was successful but had been titanic, requiring transfusion of 5 U of blood and 2 U of frozen plasma. The S2 and S3 roots on both sides were sacrificed, leaving the 12-year-old child to attend to loss of rectal sphincter control and frequent urinary retention.

The lesson from both cases is to inform referring doctors the importance of regular visits for children suspected of sacral tumours: with early discovery, its lesser dimensions are more amendable to successful surgery.

Dedifferentiated subtypes (Chou., *et al* [28] and Kim., *et al* [29])

According to Chou., *et al.* [28] only 15 cases of sacral dedifferentiated chordoma (DC) have been reported since 1970. DC is more frequently the transformation type; those arising *de novo* is less common. Transformation refers to those lesions that turned malignant due to disease recurrence or following radiotherapy. Of the *de novo* group the youngest was a 24-year-old male who died from an aggressive form of the disease three months following initial presentation. The literature shows most were harbouring concomitant metastases on first presentation: most had a past history of radiotherapy to treat a conventional chordoma. The *de-novo* form of DC seems to fare no better although the average age of these patients is younger - more in the young adult-age. Metastases occurs frequently in both groups.

In the report by Kim., *et al.* [29] gross total resection was successful on an apparently conventional chordoma in a 40-year-old woman but tumour recurrence within four months proved to be a DC. Repeat surgery was partially successful due to firm tumour adhesions to the rectum. Cyber knife radiotherapy was effective in tumour control though by then metastases to the lungs and liver had set in; she lived for 31-months after the first surgery.

A case of uncertainty in which the lesion could be a sacral chondroid chordoma (CC), a chondrosarcoma (CS) or a chondroblastic osteosarcoma (COS) (Akpolat., *et al*. [31])

This is a discursive debate on clear identification of a sacral tumour on histopathological grounds. It concerns a 17-year-old male who had a sacral tumour excised following complaints of progressive lower limb pains. There are histological similarities between CC and myxoid CS. Discussion shifted to whether it was a CS or COS: the key in distinguishing the myxoid/mesenchymal type of CS from COS is the presence of osteoid tissues within the latter. One is reminded to look beyond cyto-morphology and consider the site of tumour origin and patient's age. The final arbitrator rests with immunohistochemical studies. From their literature review, it is concluded that recurrence rate of CC post-surgery borders on 70% compared with 1.5 to 53% in CS and 4% in COS. A firm diagnosis is crucial in terms of prognosis which favours COS on this occasion.

Conclusion

The key to further insights in the biological nature of sacrococcygeal chordoma lays with our cognisance with the broad range of cellular atypia and in consequence of the patients' prognostication. New surgical techniques are emerging for gross total resection of sacral tumours afflicting children and adolescents. MRI continues to be essential in surgical planning and post-surgical follow up.

Acknowledgements

The author thanks Ms Pam Dougan, the Department's Senior Research Assistant for her outstanding editorial skills and exceptional professionalism in helping to complete this project.

Conflict of Interest

The author has no conflict of interest to report.

Bibliography

1. Walcott BP., *et al*. "Chordoma: current concepts, management, and future directions". *Lancet Oncology* 13.2 (2012): e69-e76.
2. Beccaria K., *et al*. "Paediatric Chordomas". *Orphanet Journal of Rare Diseases* 10 (2015): 116.
3. Coffin CM., *et al*. "Chordoma in Childhood and Adolescence: A clinicopathologic Analysis of 12 Cases". *Archives of Pathology and Laboratory Medicine* 117.9 (1993): 927-933.
4. Sebro R., *et al*. "Differences in sex distribution, anatomic location and MR imaging appearance of pediatric compared to adult chordomas". *BMC Medical Imaging* 16.1 (2016): 53.
5. Tsitouras V., *et al*. "Management and outcome of chordomas in the pediatric population: The Hospital for Sick Children experience and review of the literature". *Journal of Clinical Neuroscience* 34 (2016): 169-176.
6. Chandawarkar RY. "Sacrococcygeal chordoma: review of 50 consecutive patients". *World Journal of Surgery* 20.6 (1996): 717-719.
7. Cable DG and Moir C. "Pediatric sacrococcygeal chordomas: a rare tumor to be differentiated from sacrococcygeal teratoma". *Journal of Pediatric Surgery* 32.5 (1997): 759-761.
8. Horton KM., *et al*. "Metastasizing Chordoma in early Childhood: Report of a Case at 1.5T". *Magnetic Resonance Imaging* 7.6 (1989): 689-691.
9. Schiavello E., *et al*. "Pediatric extraspinal sacrococcygeal ependymoma (ESE): an Italian AIEOP experience of six cases and literature review". *Child's Nervous System* 34.7 (2018): 1291-1298.
10. Soo MYS and Wong L. "Sacrococcygeal Chordoma". *Journal of Hong Kong College of Radiology* 5.2 (2002): 117-125.
11. Kumar N., *et al*. "Sacro-coccygeal teratoma in adult: Two rare case reports and review of literature". *International Journal of Applied and Basic Medical Research* 4.2 (2014): 122-124.
12. Srinivasalu S and D'Souza A. "Sacral Ewing's Sarcoma and Challenges in its Diagnosis on MRI". *Journal of Radiology Case Reports* 3.1 (2009): 23-26.
13. Kupeli S., *et al*. "Sacral mesenchymal chondrosarcoma in childhood: a case report and review of the literature". *Pediatric Hematology and Oncology* 27.7 (2010): 564-573.
14. Ilaslan H., *et al*. "Primary Ewing's sarcoma of the vertebral column". *Skeletal Radiology* 33.9 (2004): 506-513.

15. Katonis P., *et al*. "Spinal Osteosarcoma". *Clinical Medicine Insights: Oncology* 7 (2013): 199-208.

16. Singh AP., *et al*. "Sacrococcygeal Teratoma in an Adolescent: A Rare Case Report". *International Journal of Scientific Study* 2.6 (2014): 157-159.

17. Al-Adra D., *et al*. "Pediatric metastatic sacrococcygeal chordoma treated with surgery". *European Journal of Pediatric Surgery* 21.3 (2011): 196-198.

18. de Noronha L., *et al*. "Sacrococcygeal Chordoma in a 9-year old boy". *Arquivos de Neuro-Psiquiatria* 53.3B (1995): 654-658.

19. Iwasa Y., *et al*. "Sacral chordoma in early childhood: clinicopathological and immunohistochemical study". *Pediatric and Developmental Pathology* 1.5 (1998): 420-426.

20. Wu AM., *et al*. "Chondrosarcoma in a paediatric population: a study of 247 cases". *Journal of Children's Orthopaedics* 13.1 (2019): 89-99.

21. Shih AR., *et al*. "Clinicopathologic characteristics of poorly differentiated chordoma". *Modern Pathology* 31.8 (2018): 1237-1245.

22. Beccaria K., *et al*. "Pediatric Chordomas: Results of a Multicentric Study of 40 Children and Proposal for a Histopathological Prognostic Grading System and New Therapeutic Strategies". *Journal of Neuropathology and Experimental Neurology* 77.3 (2018): 207-215.

23. Pendharkar AV., *et al*. "Surgical management of Sacral Chordomas: Illustrative Cases and Current Management Paradigms". *Cureus* 7.8 (2015): e301.

24. Fuchs B., *et al*. "Operative management of sacral chordoma". *Journal of Bone and Joint Surgery - American* 87.10 (2005): 2211-2216.

25. Fourney DR and Gokaslan ZL. "Current management of sacral chordoma". *Neurosurgical Focus* 15.2 (2003): E9.

26. McMaster ML., *et al*. "Clinical features distinguish childhood chordoma associated with tuberous sclerosis complex (TSC) from chordoma in the general paediatric population". *Journal of Medical Genetics* 48.7 (2011): 444-449.

27. Dahl NA., *et al*. "Chordoma Occurs in Young Children with Tuberous Sclerosis". *Journal of Neuropathology and Experimental Neurology* 76.6 (2017): 418-423.

28. Chou WC., *et al*. "*De Novo* Dedifferentiated Chordoma of the Sacrum: A Case Report and Review of the Literature". *Chang Gung Medical Journal* 32.3 (2009): 330-335.

29. Kim SC., *et al*. "Two cases of Dedifferentiated Chordoma in the Sacrum". *Korean Journal of Spine* 12.3 (2015): 230-234.

30. Hamilton K., *et al*. "Pediatric extraosseous sacral chordoma: case report and literature review of embryonic derivation and clinical implications". *Journal of Neurosurgery Pediatrics* 23.5 (2019): 628-633.

31. Akpolat N., *et al*. "Sacral Chondroblastic Osteosarcoma Misdiagnosed as Chondrosarcoma and Chordoma". *Turkish Journal of Medical Sciences* 37.4 (2007): 243-249.

Volume 9 Issue 4 March 2020