

Short Illustrated Review

Adult intramedullary mature teratoma of the spinal cord: review of the literature illustrated with an unusual example

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Summary

Intramedullary mature teratomas particularly in adults are rarely encountered. In this manuscript the authors have reviewed the adult intramedullary lesions of the spinal cord published in the literature that are harbouring the characteristics of a mature teratoma and analysed the results with respect to histopathology, epidemiology, diagnostic methods and treatment. An illustrative case of an extremely unusual localization is also presented.

Keywords: Intramedullary; teratoma; spinal cord; adult; cervical.

Introduction

Teratomas are by definition, tumors of multipotential cells that recapitulate normal organogenesis, producing tissues that represent a mixture of two or more germinal layers of ectoderm, endoderm and mesoderm. They are classified as mature, immature or malignant based on the degree of differentiation [29]. Intramedullary mature teratoma, particularly in adults are very rare. We have reviewed the adult intramedullary (IM) lesions of the spinal cord in the literature that are harbouring the characteristics of a mature teratoma and analysed the results with respect to histopathology, epidemiology, diagnostic methods and treatment. Concerning the numerous different names which were applied to such lesions in the literature, the search was not limited to the key word 'teratoma', but also included 'teratoid', 'teratoid cyst', 'cystic teratoma', 'teratomatous cyst', and 'cystic teratoid tumor'. An illustrated case of

an extremely rare location for an IM teratoma is also presented.

Literature review

The first proven case of an adult IM mature teratoma was presented by Hosoi in 1931 [15]. In 1954 Derey-maker added two cases including a 43 years old female possessing a teratoma between C5–T2 levels, which to our knowledge, is the first case of cervical IM mature teratoma reported in an adult [6]. In a series of 1322 primary IM neoplasms, reported by Sloof *et al.* in 1964, only two cases were found to be teratomas which were both encountered in adults [28]. Also in 1964 Rewcastle and Francoeur added one case of an IM mature teratoma located at T10 level in a 34 years old female [24]. From 1965 to 1982 four other adult IM mature teratoma cases were reported who were all males [7, 10, 13, 25]. In 1982, Padovani *et al.* presented a 21 years old female who had a lesion located between C6–T1 levels which turned out to be a mature teratoma, which is the 2nd case of this kind located cervically that we could identify [20]. One year later Padovani *et al.* added another case [19] and between 1986 and 1996 four other adult IM cases were reported with none located in the cervical region [4, 11, 16, 21]. In 1998 Al-Sarraj *et al.* reported their series composed of 25,000 neurosurgical biopsies in which only 7 case of spinal cord teratomas were

Table 1. Adult intramedullary mature teratoma cases reported in the literature

Author (year)	# of adult cases	Male/female	Mean age	Location	Removal	Outcome
Hosoi (1931)	1	1/-	24	L	incomplete	recovered
Dereymaker (1954)*	2	1/1	37.5	1 CT, 1 L	1. complete 2. incomplete	1. recovered 2. incomplete recovery
Sloof <i>et al</i> (1964)	2	2/-	43.5	1 TL, 1 T (lower)	1. complete 2. autopsy	1. recovered 2. _____
Rewcastle and Francoeur (1964)	1	-/1	34	T (lower)	incomplete	incomplete recovery
Hansebout and Bertrand (1965)	1	1/-	47	L	complete	recovered
Enestörm and Von Essen (1977)	1	1/-	36	TL	incomplete	recovered
Rosenbaum <i>et al</i> (1978)	1	1/-	49	T (lower)	complete	recovered
Garrison and Kasdon (1980)	1	1/-	23	conus medullaris	complete	recovered
Padovani <i>et al</i> (1982)*	1	-/1	21	CT	incomplete	recovered
Padovani <i>et al</i> (1983)	1	-/1	33	L	complete	incomplete recovery
Giacomini <i>et al</i> (1986)	1	1/-	31	TL	complete	recovered
Pelissou-Guyotat <i>et al</i> (1988)	1	1/-	33	L	complete	recovered
Nicoletti <i>et al</i> (1994)	1	1/-	47	TL	incomplete	recovered
Caruso <i>et al</i> (1996)	1	1/-	41	conus medullaris	complete	recovered
Al-Sarraj <i>et al</i> (1998)	1	1/-	35	L	?	recovered
Poeze <i>et al</i> (1999)	1	1/-	23	TL	incomplete	recovered
Fan <i>et al</i> (2001)	1	-/1	43	conus medullaris	complete	recovered
Nonomura <i>et al</i> (2002)	2	1/1	44.5	2 TL	1. incomplete 2. incomplete	1. incomplete recovery 2. incomplete recovery
Hejazi and Witzmann (2003)	2	1/1	32.5	1 TL, 1 L	1. complete 2. complete	1. recovered 2. recovered
Sharma <i>et al</i> (2003)	4	3/1	35.5	1 TL, 2 T (lower), 1 L	?	?
Fernandez-Cornejo VJ <i>et al</i> (2004)	1	1/-	46	conus medullaris	complete	recovered
Our case*	1	-/1	43	C	complete	recovered

C Cervical, CT Cervicothoracic, T Thoracic, TL Thoracolumbar, * indicates previously published cases located cervically.

detected in a period of 15 years [2]. From these 7 cases, only 1 of them was located IM. A meticulous review of the literature by Poeze *et al.* in 1999 disclosed 17 adult IM mature teratoma cases including one of their own [22]. The case reported by Al-Sarraj *et al.* was not included in that review. From 1999 to 2005 10 other adult IM teratomas were reported which were predominantly located in thoracolumbar region [8, 9, 14, 17, 27]. We also note the intraspinal teratoma cases reported by Okuyama *et al.* [18] and Allsopp *et al.* [1] in year 2000, which were found to be extramedullary in origin and the case report by Ates *et al.* in 2005 [3] in which the tumor was adjacent to the conus medullaris and related to a thickened film terminale, but was not intramedullary. The reported cases of adult IM teratomas are summarized in Table 1.

Analysis

28 Adult IM mature teratoma cases (20 Males/ 8 Females) were identified in the literature excluding the

case presented in this manuscript. The mean age of the patients was 36.2. The lesions were predominantly located in the lower thoracic and thoracolumbar region. In only two cases was the cervical region involved. Complete and incomplete resections were managed in 14 and 8 cases respectively. Although incomplete recoveries and recurrences seem to be associated with subtotal resections, the potential risk of recurrence for a mature teratoma is relatively low. Regarding the 4 cases presented by Sharma *et al.* in 2003 [27], the extent of the surgery and the outcome was not specifically mentioned for individual cases.

Illustrative case

A 43 years old caucasian female admitted through our outpatient clinic with the complaints of sensory loss in the lower parts of her body and neck pain radiating to her back for one year. She also noticed progressive muscle weakness and numbness in her lower extremities. Her past medical history and family history were unremarkable. On physical examination, a midline nodular

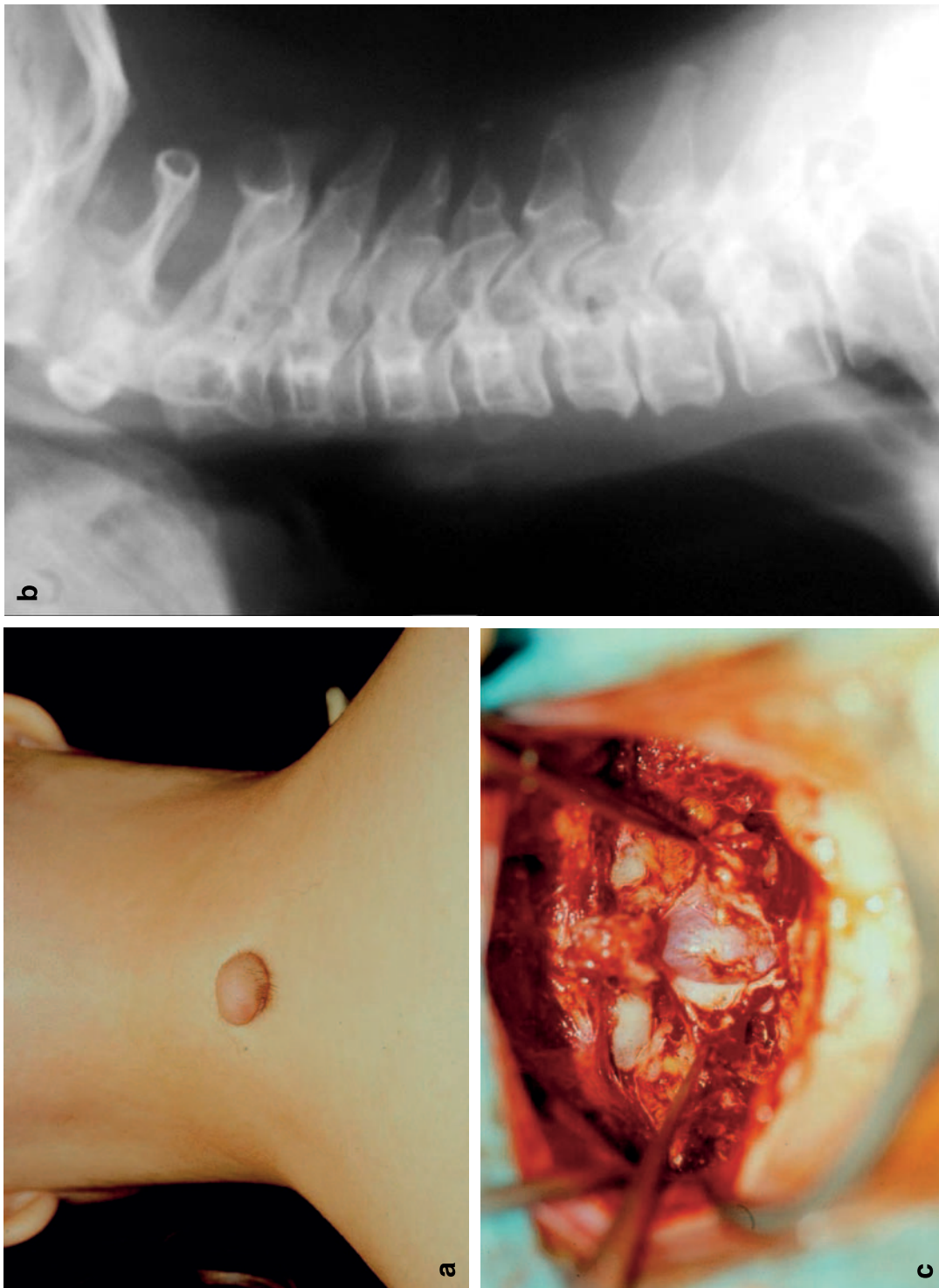


Fig. 1. (a) The midline nodular soft mass in the posterior cervical region, hairy at its root, overlying the spinous process of C5 vertebra. (b) The lateral X-ray of the cervical spine demonstrated subcutaneous calcification at the level of C5 and hypoplasia of the spinous process of the vertebra at the same level. (c) The intra-operative view of the lesion after the dura is opened.

mass in the posterior cervical region, approximately at the size of a hazelnut, hairy at its root, overlying the spinous process of C5 vertebra and somewhat soft in nature was identified (Fig. 1a). She said the mass tended

to grow bigger until she was 20 years old. The neurological examination revealed bilateral paresis of the proximal and distal lower extremities. The lower extremity deep tendon reflexes were bilaterally hyperactive

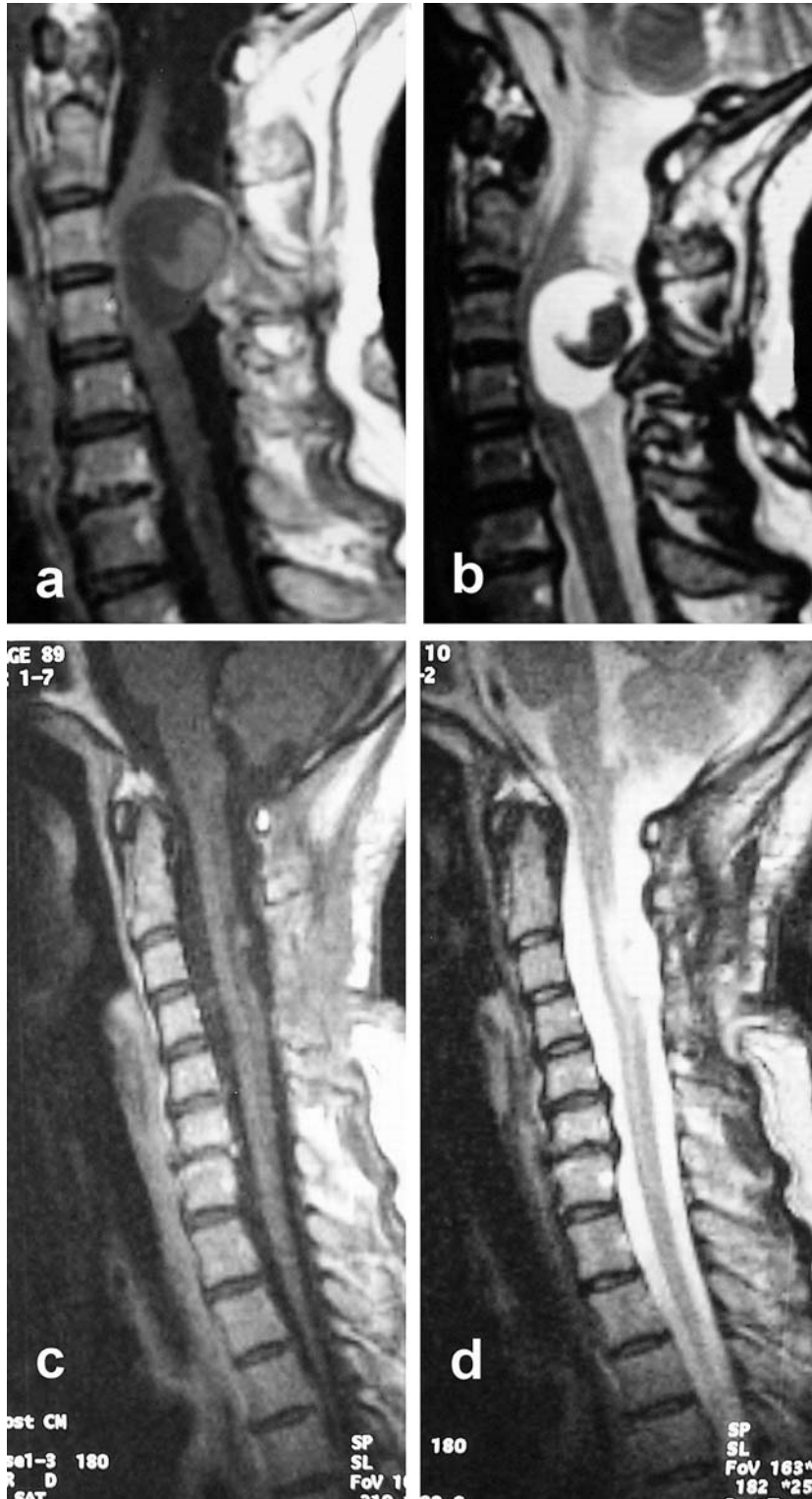


Fig. 2. (a) Sagittal T1 weighted contrast enhanced images revealed an intramedullary mass located along C2–C3 spinal cord levels which has displaced the spinal cord anteriorly. Note that the nodule is located at the C5 level. (b) Sagittal T2 weighted MRI image shows hyperintense well delineated intramedullary mass. A small hypo-intense component is noted in the center of the lesion. (c) The post-operative sagittal T1 weighted gadolinium enhanced and (d) T2 weighted MRI images showed total resection of the lesion and post operative changes posterior to the spinal cord and paravertebral area

with ankle clonus. Dorsal column signs like paresthesia, numbness, impairment of two point discrimination, vibration and conscious proprioception were identified below the level of T2. The lateral X-ray of the cervical spine demonstrated subcutaneous calcification at the level of C5 and hypoplasia of the spinous process of the vertebra at the same level (Fig. 1b). Sagittal T1 weighted contrast enhanced MRI images revealed an IM mass located along C2–C3 levels which has displaced the spinal cord anteriorly (Fig. 2a). The lesion was hypointense in the anterior and hyperintense in the posterior half. A small spinal cord tissue was covering the superior border of the mass. Sagittal T2 weighted MRI images showed a hyperintense well delineated IM mass (Fig. 2b). At operation, the skin nodule at the C5 level was preserved and the course of its stalk was traced up to the C3 vertebra where it entered the dura (Fig. 1c). The tumor was accessed by means of a C3–4 laminectomy and total excision is performed.

The postoperative period was uneventful and she was discharged from the hospital on the 8th postoperative day without any signs and symptoms. The postoperative sagittal T1 weighted gadolinium enhanced and T2 weighted MRI images showed total resection of the lesion and post operative changes posterior to the spinal cord and paravertebral area (Fig. 2c and d).

The pathological examination of the mass revealed a mature teratoma with fully differentiated components of mature cartilage tissue, mature glial tissue, dilated cysts lined with ciliated cuboidal epithelium, fibrofatty connective tissue and skin fragments. There was no evidence of immature or malignant components (Fig. 3).

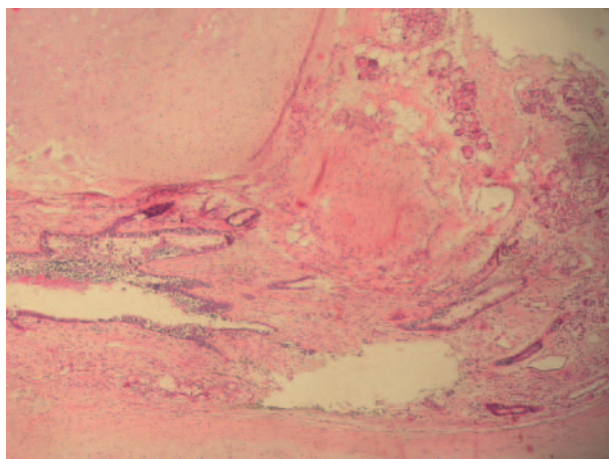


Fig. 3. Dilated cysts lined with ciliated cuboidal epithelium, mature cartilage tissue, mature glial tissue, fibrofatty connective tissue and skin fragments. (HE \times 100)

Discussion

Teratoma is one of the rarest intraspinal neoplasms. They tend to occur in young children, most commonly at midline sites and excluding the sacrococcygeal variant which is often encountered in neonates, they are rarely located in the spinal canal [8, 22]. Their incidence is found to be only 0.2–0.5% of all spinal cord tumors [17, 28]. To our knowledge, our case is the third adult IM cervical mature teratoma in an adult patient and the only one which is purely located at that region. We also provide the only MRI scans of the cervical teratoma of the spinal cord that can be found in the literature.

The diagnosis of teratoma is accomplished by the determination of tissues representing a mixture of all three germinal layers of ectoderm, endoderm and mesoderm histopathologically [27]. However, the presence of only two germinal layer elements does not rule out the diagnosis as derivatives of one or two layers may overgrow the others [17, 25]. Teratomas are classified as mature, immature or malignant based on the degree of differentiation, as advocated by Walter and Kleinert [29]. Mature teratomas are composed exclusively of fully differentiated “adult type” tissue elements and are considered as the benign forms. Immature teratomas, on the other hand, are aggressive tumors having primitive, undifferentiated components resembling “fetal” tissues which tend to recur frequently [26]. Malignant teratomas are derived from the yolk sac or endodermal sinus and are associated with high levels of serum α -fetoprotein and poor prognosis. Macroscopically teratomas have cystic and solid components and have a capsule which is adherent to the spinal cord parenchyma.

Many theories have been proposed in the literature concerning the development of intraspinal teratomas, but the most accepted embryogenetic theory is the displacement of primordial germ cells into the dorsal midline during their normal migration from primitive yolk sac to gonadal ridges [2]. Moreover, teratomas are thought to be associated with dysraphic defects harbouring cutaneous changes (hair patches, dimples, nodules... etc.) located at the median plane of the body which supports this theory [2, 8, 22]. In the present case, the midline hairy mass and hypoplasia of the C5 spinous process, subcutaneous calcification at the same location detected on radiographs and the MRI findings suggested a midline anomaly. In such cases, full spinal MRI is mandatory for the detection of possible dysraphic anomalies [9]. Concomitant presentation of a spinal cord teratoma and teratoma of left ovary in a 15 years old female

[5] and carcinoid tumor development in an IM mature teratoma [8] has also been reported before.

Conventional X-ray films provide limited information for the diagnosis of an IM mass, but laterally displaced pedicles, erosions, thinned laminae or calcifications identified in an asymptomatic patient can suggest to the physician that further investigations are indicated. In our case the subcutaneous calcification and hypoplasia of C5 spinous process detected on a lateral X-ray film would have been most valuable if the patient had not had any other symptoms and signs other than neck pain. Computerized tomography (CT) provides optimal assessment of bony structures and spinal canal occlusion due to the tumoral mass invasion, and has been suggested as an ideal diagnostic method for differentiating teratomas from other lesions by some authors [12]. On the other hand it has limited capacity for visualizing the changes in the spinal cord parenchyma and offer few advantages over MRI. MRI with and without gadolinium allows for specific evaluation of the degree of parenchymal involvement and remains the procedure of choice. Despite these imaging modalities the definite differentiation between IM and extramedullary tumors, can only be made intra-operatively. In our case the sagittal T1 weighted contrast enhanced MRI images showed that a small amount of spinal cord tissue was covering the superior border of the mass. This finding suggested that the lesion was located IM. In the differential diagnosis, other cystic lesions found in the spinal canal such as epidermoid and dermoid cysts, and particularly cysts which may possess radiological characteristics similar to those detected in teratomas should be kept in mind [22, 23, 26].

Surgery is the primary treatment modality for teratomas which is also true for other IM tumors of the spinal cord. Depending on the fact that immaturity or malignancy is a postoperative finding, Poeze *et al.* [22] suggested radical resection as the aim of surgery. Radical removal of the capsule is also offered as it is considered as a potential source of regrowth [23]. On the other hand the majority of authors discourage radical resection [14, 17, 27] as the recurrence rates for total and subtotal resection are very similar (9% and 11% respectively) [1] and because the nature of the teratoma is relatively benign. Moreover the intimate adhesion of the cyst wall to the adjacent neural tissues is reported to be seen in about half of the cases [25] which makes the procedure more complicated and vulnerable to postoperative problems. In our case we managed to resect the tumor totally but, we also agree that one should not attempt

to force total resection if a clear margin between the tumor and the spinal cord parenchyma is not readily apparent.

The adjuvant therapy for spinal teratomas remains controversial mainly because of the rarity of the condition and the limited experience regarding its management [1]. While several tumor markers like serum β -human chorionic gonadotropin (β -hCG) and alpha-fetoprotein (AFP) have been used for the detection of recurrences for sacrococcygeal teratomas, this seems to be a limited practice for mature IM teratoma as the recurrence can take place from non-secreting parts of the tumor [1]. The adjuvant therapy after surgery should be decided according to the pathological examination. If there are malignant histological features or germ cell elements, radiotherapy should be given even if the tumor is totally resected. In total or subtotal resections the patient should be followed up with serial MRI scans and considering its potential side effects, radiotherapy should be avoided. The role of chemotherapy in the treatment strategy has not been proved and remains obscure [1].

In conclusion, mature teratoma located in the cervical spinal cord of an adult patient is an extremely rare entity, but it should always be considered in the differential diagnosis especially when associated spinal anomalies co-exist. Radical surgery is not recommended since the pathology is benign and the recurrence rates are low even in subtotal resections. Histopathological examination is the key step to a decision regarding adjuvant therapy. Radiotherapy as an adjuvant treatment modality should be considered if the histopathological examination reveals malignant components.

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Comment

This is a very rare and attractive clinical case with demonstrative figures. The review of the literature is informative. Teratoma is one of the rarest intramedullary tumors. Two points of this review of the literature have to be emphasized: the first one is related to the absence of cleavage layer in half of the cases with high difficulties to perform total tumoral excision. Perhaps previous peritumoral haemorrhage may explain the presence of such peritumoral adhesences. It would be informative to compare the incidence of preoperative finding of absence of cleavage plan with the incidence of preoperative finding of absence of cleavage plan with the incidence of specific MRI characteristics such as peritumoral T1 hypersignal. As the tumor is macroscopically heterogeneous with cystic and solid components, the main preoperative risk for the surgeon is to miscalculate the exact tumoral volume and limits and to keep in place the adhesive tumoral component in contact with the normal spinal cord tissues. The second point is about the risk of recurrence in case of subtotal tumoral excision and the indication of radiation therapy. I remain so surprised by the report by Allsopp *et al.* (*Br J Neurosurg* 2000, 14: 482–488) quoted by the authors about similar recurrence rates for total and subtotal resection (9% and 11% respectively). With such data, subsequent adjuvant radiation therapy is not indicated in case of non-malignant teratoma due to the absence of evidence of benefits compared to the high risk of adverse spinal cord damage related to the radiation therapy.

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