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The "botryoid sign": a characteristic feature of rhabdomyosarcomas in the head and neck

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Abstract We investigated nine patients with rhabomyosarcoma in the head and neck (6–53 years of age), using CT and MRI. The tumours originated in the paranasal sinuses (3), cheek (2), soft palate (1), orbit (1), sternocostoclavicular muscle (1) and parapharyngeal space (1). The histological subtype was embryonal in five, alveolar in three and pleomorphic in one case. The tumours enhanced markedly and heterogeneous on CT and MRI. The masses were isointense or gave slightly higher signal than surrounding muscles on T1- and heterogeneously high signal on T2-weighted images. In four tumours, multiple ring enhancement resembling bunches of grapes. This appears to be characteristic of rhabdomyosarcoma and probably reflects a component of botryoid-type rhabdomyosarcoma in which mucoid-rich stroma is covered with a thin layer of tumour cells. We have named this imaging feature the "botryoid sign".

Key words Rhabdomyosarcoma, head and neck · Magnetic resonance imaging · Computed tomography

Introduction

Rhabdomyosarcoma is one of the most common soft-tissue tumours in children, and the head and neck are the principal sites. Previous reports noted no specific imaging features [1–6]. We reviewed CT and MRI of rhabdomyosarcoma in the head and neck, and found in some cases a characteristic grape-like appearance on

Table 1 Summary of clinical and radiological data

Case	Age (years), sex	Tumour		Imaging						
		Site	Type	CT		MRI			Bone destruction	Haemorrhage
				Density	Contrast enhancement	Signal intensity		Contrast enhancement		
						T1-weighted	T2-weighted			
1	6, M	Maxillary sinus	Alveolar		Marked, heterogeneous	Isointense, homogeneous	High, heterogeneous	Grape-like	Yes	No
2	13, F	Ethmoid sinus	Alveolar		Marked, heterogeneous	Slightly high, heterogeneous	High, heterogeneous	Grape-like	Yes	Yes
3	13, F	Cheek	Embryonal	Low, homogeneous		Slightly high, homogeneous	High, homogeneous	Marked, heterogeneous	No	No
4	15, M	Orbit	Embryonal		Marked, heterogeneous	Isointense, homogeneous	High, heterogeneous	Grape-like	Yes	No
5	15, M	Parapharyngeal space	Embryonal	Low, homogeneous		Slightly high, homogeneous	High, heterogeneous	Marked, heterogeneous	No	No
6	23, M	Soft palate	Pleomorphic		Marked, homogeneous	Slightly high, homogeneous	High, heterogeneous	Grape-like	No	No
7	45, M	Sternocostoclavicular muscle	Alveolar		Marked, heterogeneous	–	–	–	No	No
8	49, F	Cheek	Alveolar		Marked, heterogeneous	Isointense, homogeneous	High heterogeneous	Marked, heterogeneous	No	No
9	53, F	Maxillary sinus	Embryonal		Marked, heterogeneous	Slightly high, heterogeneous	High, heterogeneous	Marked, heterogeneous	No	No

contrast-enhanced MRI. This is not found in other malignant tumours, and may therefore be characteristic of or even specific for rhabdomyosarcoma.

Materials and methods

We reviewed CT and MRI of nine cases of rhabdomyosarcoma in the head and neck in five male and four female patients aged 6–53 years (five under 15 years of age). The tumours originated in the paranasal sinuses (3), cheek (2), soft palate (1), orbit (1), sternocostoclavicular muscle (1) and parapharyngeal space (1). All were histologically proven; five were embryonal, three alveolar, one pleomorphic type, but none was of the botryoid subtype of the embryonal type. CT was performed in all cases, contrast-enhanced CT in seven. MRI consisted of axial and coronal T1- and T2-weighted images and contrast-enhanced T1-weighted images in eight cases. Two neuroradiologists independently reviewed the images for the density and intensity of the tumour on CT and MRI, contrast enhancement, bone destruction, haemorrhage and calcification.

Results (Table 1)

On CT, the tumours were homogeneously less dense than to muscle in two cases. Marked, homogeneous contrast enhancement was seen in one case and marked, heterogeneous enhancement in six. On T1-weighted images, the tumours were isointense or gave slightly higher signal than adjacent muscles in all eight cases, homogeneous in six and heterogeneous in two. On T2-weighted images, they gave heterogeneously higher signal than muscle in six cases and homogeneously high signal in two. There was marked, heterogeneous contrast enhancement in all eight cases, with multiple rings of enhancement, resembling bunches of grapes, in four. Bone destruction was observed in three cases, but bone structure tended to be preserved within the tumours. Haemorrhage was observed within one tumour on MRI. No calcification was found in any case.

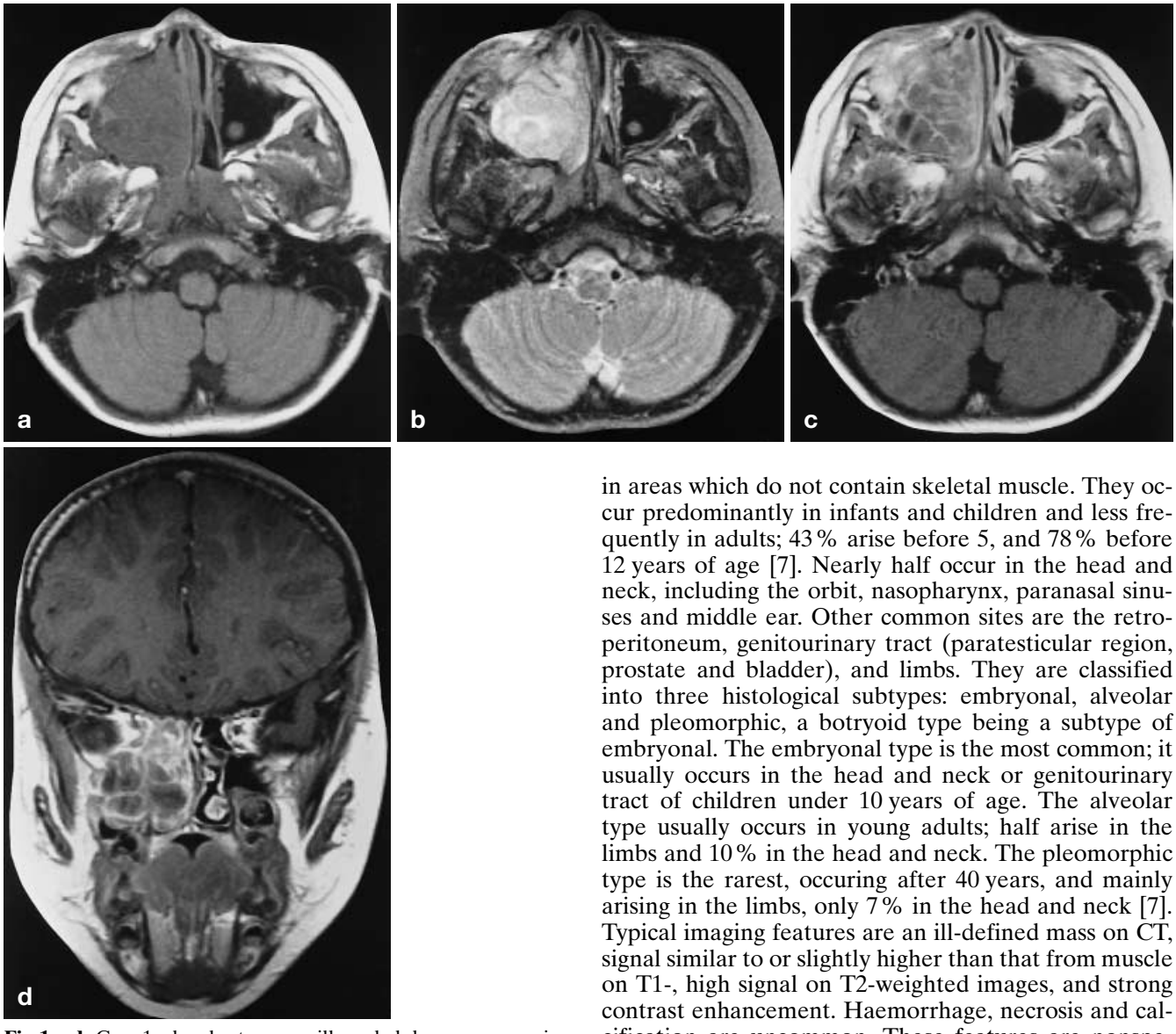

Fig. 1 a–d Case 1: alveolar type maxillary rhabdomyosarcoma in a 6-year-old boy. **a** Axial T1-weighted. **b** T2-weighted. **c** Enhanced axial T1-weighted images at the same level. **d** Contrast-enhanced coronal T1-weighted image. The tumour occupies the right maxillary sinus, extends into the nasal cavity and ethmoid sinus, and has invaded the orbit. It is homogeneously isointense with muscle on the T1-weighted image, and gives heterogeneously high signal on the T2-weighted image. Grape-like enhancement (the "botryoid sign") is seen in **c** and **d**

Discussion

Rhabdomyosarcomas are thought to develop not from muscle but from undifferentiated mesenchymal cells with the capacity to differentiate into striated muscle. They can therefore arise in any part of the body, even in areas which do not contain skeletal muscle. They occur predominantly in infants and children and less frequently in adults; 43 % arise before 5, and 78 % before 12 years of age [7]. Nearly half occur in the head and neck, including the orbit, nasopharynx, paranasal sinuses and middle ear. Other common sites are the retroperitoneum, genitourinary tract (paratesticular region, prostate and bladder), and limbs. They are classified into three histological subtypes: embryonal, alveolar and pleomorphic, a botryoid type being a subtype of embryonal. The embryonal type is the most common; it usually occurs in the head and neck or genitourinary tract of children under 10 years of age. The alveolar type usually occurs in young adults; half arise in the limbs and 10 % in the head and neck. The pleomorphic type is the rarest, occuring after 40 years, and mainly arising in the limbs, only 7 % in the head and neck [7]. Typical imaging features are an ill-defined mass on CT, signal similar to or slightly higher than that from muscle on T1-, high signal on T2-weighted images, and strong contrast enhancement. Haemorrhage, necrosis and calcification are uncommon. These features are nonspecific. It has been reported that the imaging features of the three histological subtypes do not differ [1–6].

In our study, CT and MRI features were almost as in previous reports, but "grape-like" enhancement was seen in four of the nine cases. This has never been described previously and has not apparently been observed in other malignant tumours of the head and neck [8–13]. Som et al. [14] described patients with aesthesioneuroblastoma, with large cysts with enhancing walls at the edge of an intracranial extension; pathological examination revealed that the cyst wall consisted of tumour cells [14]. This resembles what we describe in rhabdomyosarcoma, but does not look like bunches of grapes. Grape-like enhancement therefore appears to be characteristic of, or even specific to rhabdomyosarcoma. We speculate that this pattern reflects the histolo-

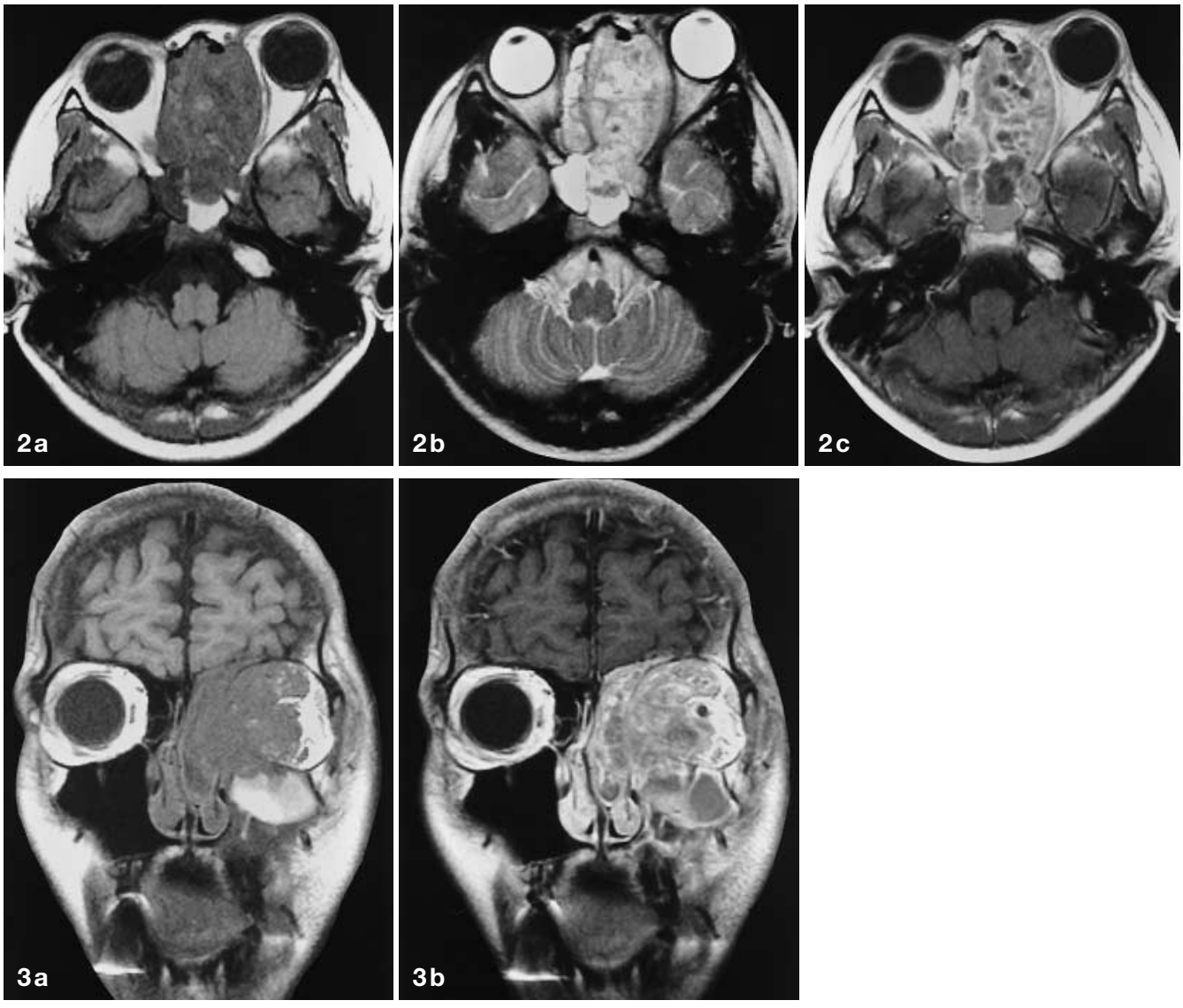

Fig. 2 a–c Case 2: alveolar type ethmoid rhabdomyosarcoma in a 13-year-old girl. **a** Axial T1-weighted. **b** T2-weighted. **c** Contrast-enhanced T1-weighted images at the same level. The rhabdomyosarcoma originates from the left ethmoid sinus, is heterogeneous and gives slightly higher signal than the temporal muscle, and a small high-signal area, presumably haemorrhage, is seen at its centre in **a**. The tumour gives heterogeneously high signal in **b**. The markedly high signal in the sphenoid sinus indicates retained fluid. Grape-like enhancement (the "botryoid sign") is observed in **c**

Fig. 3 a, b Case 4: embryonal type orbital rhabdomyosarcoma in a 15-year-old boy. **a, b** Coronal T1-weighted images before and after contrast medium. The rhabdomyosarcoma originates from the left orbit, and extends into the nasal cavity, paranasal sinuses and cranial cavity. Grape-like enhancement (the "botryoid sign") is not observed in the orbit, but is seen in the portion of the tumour invading the frontal sinus, ethmoid sinus and nasal cavity

gical features of botryoid-type rhabdomyosarcomas, and name it the "botryoid sign". "Botryoid" means grape in Greek, and botryoid rhabdomyosarcoma is characterised grossly by grape-like growth and microscopically by abundant mucoid stroma surrounded by a thin layer of tumour cells [15]. Unfortunately, one-to-one comparison was not possible between contrast-enhanced MRI and pathological specimens since the latter were very small. We speculate that the ring-like portion of the "botryoid sign" represents thin layers of tumour cells around mucoid stroma. The majority of botryoid rhabdomyosarcomas are found in hollow organs such as the nasal cavity, nasopharynx, bile duct and urinary bladder or in areas where the expanding neoplasm reaches the body surface, such as the eyelid and anal region. Botryoid rhabdomyosarcoma may thus have a grape-like appearance in a free space, as in hollow or-

gans or on the surface [15]. The rhabdomyosarcomas in which the "botryoid sign" was demonstrated originated from the paranasal sinuses in cases 1 and 2 (Figs. 1, 2), the soft palate in case 6 and the orbit in case 4 (Fig. 3). In case 4, the rhabdomyosarcoma developed in the right orbit and a grape-like appearance was noted in the portion invading the right frontal and ethmoid sinuses and nasal cavity, which are free spaces. In these cases, the histological diagnosis obtained by biopsy was alveolar type in two cases, embryonal in one, and pleomorphic type in one. These diagnoses do not accord with the general belief that botryoid rhabdomyosarcoma is a subtype of the embryonal type. There are two possible explanations as to why the "botryoid sign" was observed despite a histological diagnosis other than embryonal rhabdomyosarcoma. One is that because mixed subtypes are often found [15], the biopsy specimen did not include the portion in which the "botryoid sign" was observed, another that rhabdomyosarcomas of any histological type may grow like the botryoid type in hollow organs.

We do not know whether the "botryoid sign" can be observed in rhabdomyosarcomas in other areas. The urinary bladder is a common site for botryoid rhabdomyosarcomas, but few studies report contrast-enhanced MRI and none described a "botryoid sign" [16, 17]. To our knowledge, there has been no documentation of contrast-enhanced MRI of rhabdomyosarcomas in the bile duct, eyelid and anal region.

We saw the "botryoid sign" in young patients: three of the four were less than 15 years of age. Since botryoid type rhabdomyosarcomas occur predominantly in infants and children, the "botryoid sign" may be observed mainly in young patients. But as regards the relation between the "botryoid sign" and age, larger numbers of cases are necessary. When a tumour with malignant appearances is observed in the head and neck, particularly in children, rhabdomyosarcoma is in the first line of differential diagnosis, but there has fill now been no definite clue. When a "botryoid sign" is observed, rhabdomyosarcoma may be strongly suggested.

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