BJR

Received: 28 November 2013 | Revised: 17 January 2014 | Accepted: 13 February 2014

doi: 10.1259/bjr.20130777

Cite this article as:
Ozawa Y, Kobayashi S, Hara M, Shibamoto Y. Morphological differences between schwannomas and ganglioneuromas in the mediastinum: utility of the craniocaudal length to major axis ratio. Br J Radiol 2014;87:20130777.

FULL PAPER

Morphological differences between schwannomas and ganglioneuromas in the mediastinum: utility of the craniocaudal length to major axis ratio

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Objective: To evaluate the diagnostic value of the craniocaudal length (CC) to major axis ratio (CC/M R) for differentiating between schwannoma and ganglioneuroma in the mediastinum on CT/MRI.
Methods: 22 schwannomas (Group A: 7 schwannomas in the posterior mediastinum; Group B, 15 schwannomas located in the chest wall or regions of the mediastinum other than the posterior mediastinum) and 14 ganglioneuromas in the posterior mediastinum (Group C) were evaluated. For each tumour, the major and minor axes on the largest transaxial image and the CC were measured on CT/MRI. The CC/M R was calculated, and differences among the three groups were analysed.
Results: The major axis, minor axis and CC measurements and CC/M R ranged from 23 to 52 mm (mean, 37 mm), 15 to 38 mm (28 mm), 25 to 62 mm (42 mm) and 0.66 to 1.4 mm (1.1 mm), respectively, in Group A; from 18 to 97 mm (37 mm), 10 to 71 mm (28 mm), 18 to 80 mm (35 mm) and 0.59 to 1.3 mm (0.95 mm), respectively, in Group B; and from 20 to 70 mm (49 mm), 15 to 60 mm (32 mm), 30 to 110 mm (74 mm) and 1.0 to 2.6 mm (1.5 mm), respectively, in Group C. The mean CC/M R of Group C was significantly higher than those of the other two groups ($p < 0.005$). There was no difference between the mean CC/M R of Groups A and B.
Conclusion: Ganglioneuromas display higher mean CC/M R than schwannomas. The CC/M R is a useful index for differentiating between these neurogenic tumours.
Advances in knowledge: The CC/M R is a practical and effective index for differentiating between ganglioneuromas and schwannomas.

Schwannomas and ganglioneuromas are the two major neurogenic tumours that arise in the posterior mediastinum. Although these two tumours have different clinical characteristics, their appearances on CT and MRI are often similar, and the differences between the morphological features of these tumours have not been clarified. Empirically, it has been demonstrated that ganglioneuroma has an elongated tail-to-head axis. However, no studies have demonstrated definitive differences between the morphological characteristics of ganglioneuroma and other mediastinal tumours. Therefore, it would be useful if a simple diagnostic criterion for evaluating the morphological features of these neurogenic tumours could be established. We hypothesized that the craniocaudal length (CC) to major axis ratios (CC/M Rs) of the mediastinal schwannomas and ganglioneuromas differ. The purpose of this study was to evaluate the diagnostic value of the CC/M R for differentiating between schwannomas and ganglioneuromas in the mediastinum on CT/MRI.

METHODS AND MATERIALS

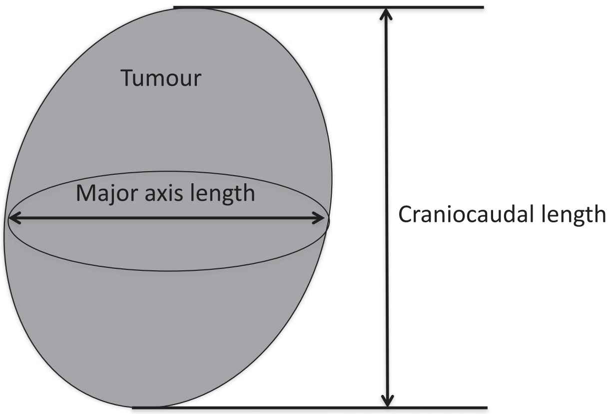
Subjects

36 pathologically proven tumours that were detected between 1983 and 2009 were included in this study. The 36 tumours were classified as follows: Group A, 7 cases of schwannoma in the posterior mediastinum (patient age, 22–73 years; mean, 50 years); Group B, 15 cases of schwannoma in the chest wall or regions of the mediastinum other than the posterior mediastinum (patient age, 20–76 years; mean, 48 years); and Group C, 13 cases (14 tumours) of ganglioneuroma in the mediastinum (patient age, 6–62 years; mean, 34 years). The locations of the mediastinal tumours were determined on CT or MRI according to the classification developed by Felson.[1]

Methods

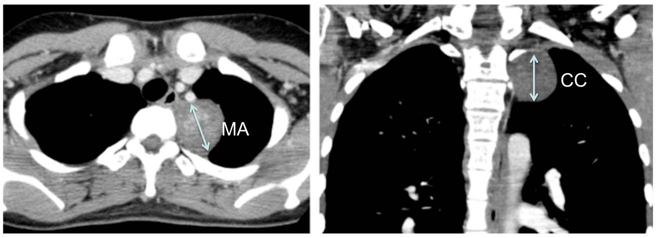
We retrospectively reviewed CT or MRI images of the 36 tumours. Several CT and MRI scanners were used because of the relatively long data collection period, and

Figure 1. The major and craniocaudal axes of a tumour. The major axis length was measured on the transaxial CT or MRI image at a slice of the largest tumour area.



detailed information about the scan protocols was not available. The slice thickness of the CT images was set at 2 mm for sagittal and coronal reconstructed images and ranged from 3 to 10 mm for transverse sections. On MRI, slice thickness ranged from 4 to 10 mm for transverse images and from 3 to 8 mm for coronal and sagittal images. For each tumour, the major and minor axes were measured on the transaxial CT or MRI images with the largest tumour area, and CC was measured on sagittal or coronal images (Figure 1). These measurements were performed by at least two diagnostic radiologists with experience ranging from 3 to 26 years in thoracic radiology. In all cases, consensus was reached among the radiologists. When only transaxial CT or MRI images were available, the number of slices multiplied by the slice thickness was used as the CC. We calculated the CC/M R of each tumour from the abovementioned measurements.

Figure 2. Transverse (a) and coronal (b) CT images of a 22-year-old female with a schwannoma in the posterior mediastinum (Group A). The major and craniocaudal axis measurements and the craniocaudal length (CC) to major axis ratio of this tumour were 40 mm, 40 mm and 1.0, respectively. MA, major axis length.



(a) (b)

Statistical analysis

The differences in the CC/M R among the three groups were analysed using one-way analysis of variance and Tukey's multiple comparisons test as a *post hoc* test. *p*-values of <0.05 were considered significant.

RESULTS

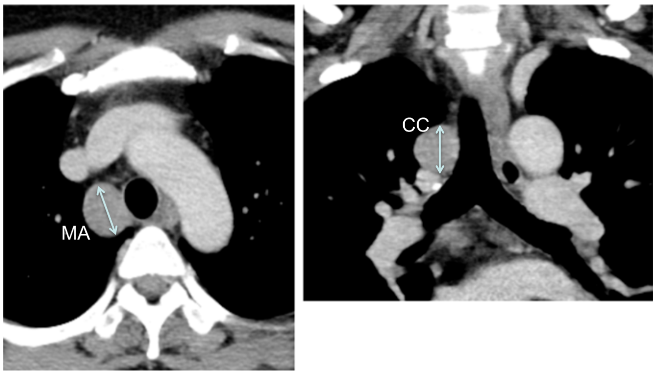
The maximum, minimum and mean values of the major axis, minor axis and CC measurements and the CC/M R for each tumour group are shown in Table 1. The mean CC/M R was 1.1 in Group A (Figure 2), 0.95 in Group B (Figure 3) and 1.5 in Group C (Figure 4).

Figure 5 shows the distribution of the CC/M R among the three groups. The mean CC/M R of Group C was significantly higher than that of the other two groups ($p < 0.005$). There was no significant difference between the mean CC/M R of Groups A and B. All of the tumours with a CC/M R of >1.4 were ganglioneuromas (9/14 in Group C). When a CC/M R of 1.4 was used as the cut-off value for differentiating between ganglioneuromas and

Table 1. The major axis, minor axis and craniocaudal length (CC) measurements and CC to major axis ratios (CC/M Rs) of 7 schwannomas in the posterior mediastinum (Group A), 15 schwannomas located in the chest wall and regions of the mediastinum other than the posterior mediastinum (Group B) and 14 ganglioneuromas in the posterior mediastinum (Group C)

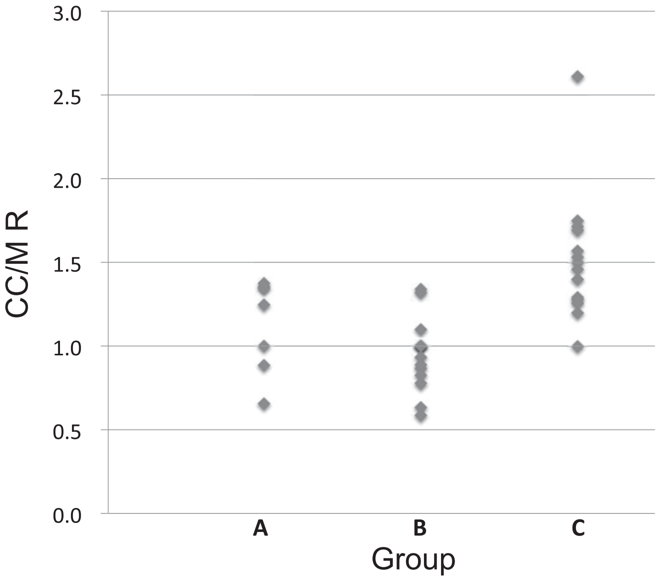
Tumour group	Major axis (mm)	Minor axis (mm)	CC (mm)	CC/M R
Group A				
Maximum	52	38	62	1.40
Minimum	23	15	25	0.66
Mean	37	28	42	1.10
Group B				
Maximum	97	71	80	1.30
Minimum	18	10	18	0.59
Mean	37	28	35	0.95
Group C				
Maximum	70	60	110	2.60
Minimum	20	15	30	1.00
Mean	49	32	74	1.50

Figure 3. Transverse (a) and coronal (b) CT images of a 47-year-old female with a schwannoma in the middle mediastinum (Group B). The major axis and craniocaudal axis measurements and the craniocaudal length (CC) to major axis ratio of this tumour were 24 mm, 24 mm and 1.0, respectively. MA, major axis length.



(a) (b)

Figure 5. Distribution of the craniocaudal length to major axis ratio (CC/M R) among the three groups. The CC/M R of Group C was significantly higher than that of the other two groups ($p < 0.005$). There was no difference between the CC/M R of Groups A and B.

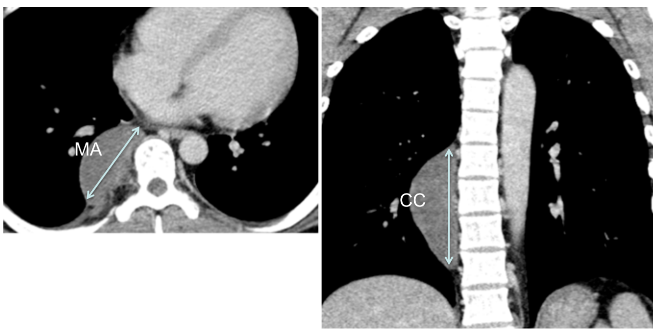


schwannomas, sensitivity and specificity values of 64% and 100%, respectively, were obtained. Cut-off values of 1.1, 1.2 and 1.3 exhibited sensitivity and specificity values of 93% and 68%, 93% and 73% and 64% and 77%, respectively.

DISCUSSION

The imaging findings of ganglioneuromas and schwannomas have been described previously.[2–9] Ganglioneuromas are derived from the primordial neural crest cells that form the sympathetic nervous system and are composed of a combination of mature ganglion cells and other mature tissues. Ganglioneuromas are most commonly located in the posterior mediastinum, followed by the retroperitoneum and adrenal gland. Regarding the characteristics of their internal structures, calcifications are often seen and they predominantly exhibit low to intermediate signal intensity on CT.[3–5] Previous studies have reported that some ganglioneuromas display a whorled appearance caused by curvilinear internal structures or fatty components, which are detected in approximately half and one-third of cases, respectively.[4,6,7] Schwannomas are encapsulated spherical masses that are mainly found in the posterior mediastinum. However, they sometimes grow through the intervertebral foramina and form dumbbell-shaped lesions. Schwannomas have been reported to exhibit a target-like appearance, *i.e.*, peripheral high-signal intensity and central low-signal intensity, on T_2 weighted MRI. These findings might facilitate the differentiation of typical cases of schwannoma and ganglioneuroma, but in many cases, it would be difficult to make a differential diagnosis based on these findings, as shown in Figures 2–4. Therefore, further diagnostic criteria would be beneficial.

Figure 4. Transverse (a) and coronal (b) CT images of a 36-year-old female with a ganglioneuroma in the posterior mediastinum (Group C). The major axis and craniocaudal axis measurements and the craniocaudal length (CC) to major axis ratio of this tumour were 64 mm, 82 mm and 1.3, respectively. MA, major axis length.



(a) (b)

Schwannomas arise from the nerve sheath and are encapsulated, therefore surgical enucleation can be performed to prevent damage to the nerve fascicles.[10,11] On the other hand, to completely remove ganglioneuromas that arise from nerve ganglion cells, involved nerves need to be resected together. Hence, knowledge about whether a mediastinal tumour was a ganglioneuroma or schwannoma would help surgeons during the development of the preoperative strategy. Therefore, differentiating between these neurogenic tumours is important. In the present study, the mean CC/M R of the mediastinal ganglioneuromas was significantly higher than that of the mediastinal schwannomas. Morphologically, mediastinal ganglioneuromas have relatively long craniocaudal axes compared with schwannomas, and evaluations of the CC/M R seem to be useful for differentiating between these two tumours in the mediastinum. A CC/M R cut-off level of 1.2 might be appropriate in view of its high sensitivity (93%) and specificity (73%). Measuring a tumour's CC and its major axis on the transaxial image that exhibits the largest tumour area is easy and does not take long. Thus, the CC/M R could be a useful index for differentiating between schwannomas and ganglioneuromas in the mediastinum, especially in the posterior mediastinum.

The main limitation of our study was the relatively small number of tumours. Neurogenic tumours are not very rare, but neurogenic tumours that are confined to the mediastinum are not encountered very often. In addition, various CT and MRI scanners were used for this study, and the slice thickness varied slightly because of the long study period; however, we consider that these limitations had little effect on our tumour measurements.

In conclusion, we found that mediastinal ganglioneuromas had a significantly higher CC/M R than mediastinal schwannomas. The CC/M R could be used as an additional objective imaging finding for more accurately differentiating between these neurogenic tumours, which would facilitate preoperative planning.

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