Magnetic Resonance Imaging Evaluation of the Clivus and Nasopharyngeal Carcinoma

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ABSTRACT

Objectives: To establish the age-related distribution of clival marrow magnetic resonance imaging appearances in ethnic Chinese and to compare these findings with the clival marrow magnetic resonance imaging appearances seen in Chinese patients with nasopharyngeal carcinoma.

Materials and Methods: T1-weighted sagittal cranial magnetic resonance images of 41 normal individuals and 40 patients newly diagnosed with nasopharyngeal carcinoma were reviewed. The clivus marrow signal intensity pattern seen for each normal subject was graded. The clivus marrow signal intensity pattern of patients with nasopharyngeal carcinoma without direct clival involvement was also graded, using the same grading system.

Results: Grade 2 clivus marrow signal intensity pattern (heterogeneous pattern, with the low intensity portion occupying 20 to 50%) was the most common pattern in the youngest age group (20-39 years old) of normal subjects. The proportion of grades 1 and 2 clivus marrow signal intensity pattern declined steadily in the intermediate (40-59 years old) and oldest (> 60 years old) age groups. The grade 3 clivus marrow signal intensity pattern (homogeneous high signal intensity pattern, with the low signal portion occupying less than 20%) was the most prevalent pattern in normal subjects over 60 years of age. In patients with nasopharyngeal carcinoma without direct clival invasion, similar age-related patterns were observed.

Conclusion: The age distribution of clival bone marrow signals on magnetic resonance imaging has been described in Chinese subjects. No significant difference in pattern between patients with nasopharyngeal carcinoma without direct clival invasion and normal subjects was seen. This suggests that infiltration of the clivus in nasopharyngeal carcinoma is by direct contiguous invasion.

Key Words: Carcinoma, nasopharyngeal, Clivus, aging, Magnetic resonance imaging

INTRODUCTION

Nasopharyngeal carcinoma (NPC) is the most common primary malignant tumour in the head and neck region in southern China and Southeast Asia. Skull base involvement is not an uncommon finding in patients with NPC. In the era of computed tomography (CT), when diagnosis was frequently made in the later stages of the disease, skull base involvement was seen in up to 31% of patients.1 In staging NPC by magnetic resonance imaging (MRI), heterogeneous signal intensity in the clivus is frequently encountered, which poses diagnostic difficulty in confidently excluding neoplastic involvement. In addition, as part of the axial skeleton, the bone marrow signal of the clivus is subjected to age-related changes. This study aims to establish the age-related distribution of MRI appearances of clival marrow in a normal population and to compare this pattern with patients with NPC.

MATERIALS AND METHODS

T1-weighted sagittal cranial images of 41 normal individuals (25 men, 16 women, 22-67 years old, mean age 45 years) and 40 newly diagnosed patients with NPC (26 men, 14 women, 21-72 years old, mean age of 46 years) were reviewed retrospectively. The MRI examination was performed using a 1.5 Tesla magnetic resonance imager (Gyroscan ACS, Philips Medical System, Best, The Netherlands). Sagittal T1-weighted cranial images (TR/TE 450-500 ms/15-20 ms, contiguous
4 mm slice thickness, field of view 230 mm, matrix size 256 x 256) were used for the evaluation of the signal intensity of the clivus.

The marrow signal intensity pattern of the clivus for each normal subject was evaluated and graded as specified by Kimura et al:

• grade 1 — homogeneous, with predominantly low signal intensity occupying more than 50% of the clivus (Figure 1)
• grade 2 — heterogeneous, with low signal intensity portion occupying less than 50% but more than 20% of the clivus (Figure 2)
• grade 3 — homogeneous and predominantly high signal intensity, with low signal intensity occupying less than 20% of the clivus (Figure 3).

For each patient with NPC, the presence of direct clival invasion was evaluated and confirmed when the tumour mass abutted upon and replaced the marrow signal of the clivus (Figure 4). For patients with NPC without evidence of clival invasion, the signal intensity pattern of the clivus is was graded as for the normal subjects.

RESULTS
The graded T1-weighted signal intensity of the clivus marrow for normal subjects according to age is outlined in Table 1. Grade 1 was observed in a quarter of the patients in the third and fourth decades. The proportion of patients with grade 1 gradually decreased and the grade 1 signal intensity pattern was not seen in patients over 60 years of age. Grade 2 clival marrow signal was the most common pattern in the third and fourth decades (42%) but the proportion gradually decreased thereafter. Grade 3 was observed in one third of patients in the third to fourth decades. The prevalence
gradually increased in older age groups and became the commonest pattern after the fourth decade. Among the 40 patients with NPC, eleven cases (28%) showed direct clival invasion. The graded T1-weighted signal intensity of the clivus in relation to age for the patients without evidence of invasion is reported in Table 2. A similar distribution in clival marrow signal pattern was observed in this group of patients to that seen in the control group. Statistical analysis using a log linear model showed no significant difference in the clival signal pattern between these 2 groups (p < 0.01).

**DISCUSSION**

Bone marrow mainly consists of haematopoietic tissues and fatty elements. Theoretically, the appearance of bone marrow on T1-weighted MRI depends on the proportion of fat and other cellular elements. Fatty marrow gives a high signal on T1-weighted images, while predominately haematopoietic marrow results in low signal intensity. This explains the observation that bone marrow signal intensity, particularly within the axial skeleton, is subject to age-related changes. The clivus, which is a central structure of the skull base, is almost always included in the assessment of local tumour extension in head and neck tumours. Okada et al., in a study of normal children and young adults, demonstrated that signal intensity from the clival marrow was age-related and changed successively from uniformly low to uniformly high signal intensity on T1-weighted images. A study of a Western population by Kimura et al., reported grade 1, 2 and 3 clivus marrow signal intensity patterns in one third of patients in their third decade. The grade 2 pattern peaked in the fifth decade (44%) and the grade 3 pattern was seen to increase relative to age, reaching 100% in the ninth decade. Oyar et al. also reported a similar age-related distribution of clivus marrow signal intensity patterns. The current study of a normal Chinese population essentially shows a similar age distribution pattern to these previous reports.

Skull base tumour infiltration affects prognosis and treatment planning for patients with NPC. Jian et al. showed that tumour classification and radiation field margin at the clivus were the most important factors governing locoregional control of the tumour. In the past, CT was generally believed to be superior to MRI in the detection of bony invasion of the clivus by demonstrating erosion of anterior bony cortex. MRI is now regarded as the best investigation in this clinical context, in view of its ability to produce direct sagittal images and higher contrast resolution. On sagittal images, clival invasion is evident when the tumour mass abuts and disrupts the anterior cortical line, with replacement of the clival marrow. Once the entire thickness of the clivus is involved, the presence of dural thickening on its dorsal surface, with abnormal contrast enhancement, further substantiates the presence of tumour invasion. Chong and Fan reported that MRI is more sensitive in detecting bony involvement than CT in the petrous apex, clivus and sphenoid wing. The incidence of local tumour invasion of the clivus identified in the current series was 28%.

In conclusion, the age-related signal intensity pattern of the clivus in a normal Chinese population has been described. A heterogeneous signal intensity pattern is commonly seen in normal subjects and patients with NPC without direct tumour invasion. This finding cautions against the false positive diagnosis of clival tumour involvement based on heterogeneous signal intensity of the clival marrow in the absence of contiguous tumour invasion.
REFERENCES