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The Likelihood of Remnant Nonfunctioning Pituitary Adenomas Shrinking Is Associated with the Lesion's Blood Supply Pattern

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■ OBJECTIVE: **Nonfunctioning pituitary adenomas (NFPA) often shrink after transsphenoidal surgery. However, little is known about the predictors of spontaneous NFPA regression. The aim of this study was to determine whether the blood supply pattern of remnant NFPA lesions was associated with the likelihood of such lesions shrinking.**

■ METHODS: **A total of 37 remnant tumors in 31 patients who were treated at the Department of Neurosurgery, Yamagata University Hospital, were included in this study. All patients underwent preoperative dynamic 3.0T magnetic resonance imaging (MRI) to evaluate their tumors' arterial blood supplies, followed by endoscopic transsphenoidal surgery and intraoperative 1.5T MRI. Follow-up MRI scans were obtained at 1–2 weeks and 3–6 postoperative months.**

■ RESULTS: **We detected tumor shrinkage in 15 of 37 (40.5%) remnant tumors on follow-up MRI scans obtained at 3–6 postoperative months. Remnant tumors were found in rostral and caudal locations in 21 and 16 cases, respectively. Rostral remnant tumors were significantly more likely to shrink ($P < 0.0001$). The tumors were classified into 3 groups according to their blood supply patterns (23 ascending, 6 descending, and 2 monophasic). The ascending blood supply pattern was found to be a positive predictor of tumor shrinkage ($P = 0.002$). Furthermore, no remnant tumors with rich blood supplies underwent spontaneous regression ($P < 0.0001$).**

■ CONCLUSIONS: **Evaluations of the blood supplies of remnant NFPA via preoperative dynamic MRI and the locations of the remnant tumors could be useful for predicting postoperative tumor shrinkage.**

INTRODUCTION

Nonfunctioning pituitary adenoma (NFPA) usually is treated with endoscopic transsphenoidal surgery (eTSS), which rapidly relieves the patient's symptoms. A recent meta-analysis reported that the initial rate of remission after transsphenoidal surgery (TSS) was approximately 44% among patients with NFPA.[1] Age, sex, tumor size, and tumor invasion were found to be correlated with prognosis in some studies but not in others.[2-12] In contrast, tumor shrinkage after TSS for NFPA has been observed in some studies.[8,13]

The incidence of tumor shrinkage has been reported to be approximately 50% among patients with NFPA, and cystic tumors, the additional resection of remnant tumors that are detected by intraoperative magnetic resonance imaging (MRI), a smaller tumor volume, and a smaller craniocaudal remnant tumor diameter were found to be associated positively with tumor shrinkage.[13] In this study, we focused on the blood supplies of pituitary tumors. We attempted to determine whether the tumor blood supply pattern is correlated with tumor shrinkage in NFPA.

MATERIALS AND METHODS

Patient Population

From January 2007 to June 2016, a total of 73 patients with NFPA underwent eTSS at Yamagata University Hospital. Of these, the 31 patients included in this retrospective study fulfilled the following criteria: undergoing a preoperative dynamic study involving

Key words
- Blood supply
- Dynamic MRI
- Pituitary adenoma
- Shrinkage
- Transsphenoidal surgery

Abbreviations and Acronyms
eTSS: Endoscopic transsphenoidal surgery
MRI: Magnetic resonance imaging
NFPA: Nonfunctioning pituitary adenoma
TIC: Time intensity curve
TSS: Transsphenoidal surgery

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high-field MRI conducted with a 3.0-T Discovery MR750w MRI scanner (GE Medical Systems, Milwaukee, Wisconsin, USA), found to have a remnant tumor after eTSS, and undergoing follow-up MRI without receiving additional treatment. Patients with pituitary apoplexy (symptomatic or asymptomatic), lesions that mainly were composed of calcification and/or cysts, or micro-adenoma were excluded.

The patients' mean age was 59.9 years (range, 23—83 years), and 18 (58.1%) patients were male. The mean duration of the follow-up period was 46.4 months (range, 6—119 months).

Operative Technique

TSS was performed via the transnasal or paraseptal-submucosal approach. We used a rigid endoscopic system (Olympus Co., Tokyo, Japan) equipped with angled tips (0, 30, and 70 degrees) and high-speed drills to open the anterior wall of the sphenoid sinus and make a window in the sellar floor. A frameless infrared-based navigation system (BrainLAB, Munich, Germany) was used in all cases. A navigation reference system was placed on the patient's forehead and held in place with a band. The tumors were removed piece by piece in the caudal to rostral direction via a curette and suction. If cerebrospinal fluid leakage occurred, the fat tissue removed from the lower abdomen was transferred to the sellar floor. The timing of intraoperative MRI (Signa HDx 1.5T; GE Medical Systems) was determined by the operator. In general, it was carried out after gross total removal or when further removal was judged to be impossible. When a resectable remnant lesion was found, the surgery was continued.

Radiologic Evaluation

All patients underwent 3.0-T high-field MRI before the eTSS. Before the administration of gadolinium-diethylenetriamine penta-acetic acid, routine T1- and T2-weighted images were obtained in the coronal and sagittal planes. Three sections (slice thickness: 6 mm) were chosen for each dynamic MRI study. After the rapid injection (0.2 mg/kg/5 seconds) of gadolinium-diethylenetriamine penta-acetic acid, dynamic coronal images were obtained at 10, 26, 42, 57, 75, 100, and 130 seconds after the injection, and 7 serial images were acquired. After the dynamic MRI study, routine T1-weighted images were obtained in the coronal and sagittal planes. As shown in Figure 1, we selected the section with the greatest longitudinal axis from among the 3 dynamic MRI scans and used it to evaluate the tumor's blood supply. The long axis was trisected to divide the tumor into 2 parts (Figure 1A). For each component, we randomly chose 3 points, calculated the mean signal intensity of the 3 points, and drew a time intensity curve (TIC). The hemodynamics of the tumors were classified into 3 TIC patterns: descending, ascending, and monophasic. The ascending pattern was defined as when the time to peak intensity was shortest in the caudal section followed by the middle section and then the rostral component, which indicated that arterial blood was supplied in the caudal to rostral direction (Figure 1B). In contrast, in the descending pattern, the time to peak intensity in each component

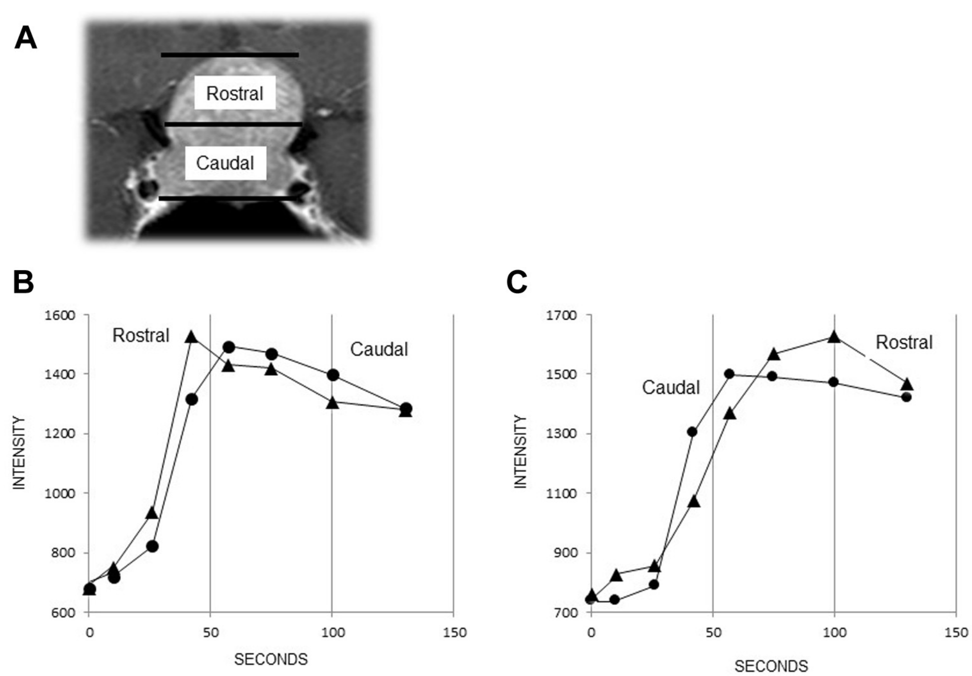

Figure 1. (**A**) The 2 components used to evaluate the blood supply patterns of the remnant tumors. (**B**) A representative graph showing the ascending hemodynamic pattern. (**C**) A representative graph showing the descending hemodynamic pattern.