Table 10: Firmness of the Tumor Mass

Author (Year)	Title	Study Description	Number of Patients	Evidence Class	Conclusions
Yamamoto (2014)[53]	Tumor consistency of pituitary macroadenomas: predictive analysis on the basis of imaging features with contrast-enhanced 3D FIESTA at 3T.	Patients underwent both conventional MRI and contrast-enhanced 3D FIESTA sequences pre-operatively. Two neuroradiologists evaluated MR imaging findings, specifically those on the FIESTA scan. During surgery, neurosurgeons classified the tumors as soft or hard. Postoperatively, collagen content and residual tumor size was calculated. Fisher exact probability tests and independent sample *t* tests were used to compare predictions of MR imaging findings to intraoperative tumor consistency, tumor collagen content, and postoperative tumor size.	29	Diagnostic / III	Sensitivity and specificity were higher for contrast-enhanced FIESTA (1.00 and 0.88-0.92, respectively) than for contrast-enhanced T1WI (0.80 and 0.25-0.33, respectively) and T2WI (0.60 and 0.38-0.54, respectively). Compared with mosaic-type adenomas, solid-type adenomas tended to have a hard tumor consistency as well as a significantly higher collagen content and lower postoperative tumor size. Contrast-enhanced FIESTA can provide preoperative characterization of the consistency of pituitary adenomas.

Author (Year)	Title	Study Description	Number of Patients	Evidence Class	Conclusions
Suzuki (2007)[64]	Apparent diffusion coefficient of pituitary macroadenoma evaluated with line-scan diffusion-weighted imaging.	Patients prospectively underwent line-scan diffusion weighted imaging (LSDWI) and had ADC values calculated. These ADC values were correlated with the consistency recorded at surgery.	19	Diagnostic / II	A soft consistency was found at surgery in 13 patients (mean ADC: 0.84+/-0.1x10(-3) mm2/s); an intermediate consistency was observed in 6 patients (mean ADC: 0.81+/-0.16x10(-3) mm2/s). No tumors of hard consistency were found. There was no significant difference in ADC values between tumors of soft consistency compared with tumors of intermediate consistency (P = .37). A relationship between tumor consistency and the ADCs of soft and intermediate macroadenomas was not shown in this study using LSDWI.
Bahuleyan (2006)[128]	To assess the ability of MRI to predict consistency of pituitary macroadenomas.	Patients prospectively underwent MR imaging. MR imaging characteristics were compared to tumor consistency as reported by the surgeon.	80	Diagnostic / II	Of the firm tumors, 4 (33%) were homogeneously isointense, 1 (8%) was homogeneously hyperintense, and 7 (59%) were heterogeneous in appearance in T2-weighted images. The consistency of pituitary macroadenomas cannot be accurately predicted based on MRI signal intensities.

Author (Year)	Title	Study Description	Number of Patients	Evidence Class	Conclusions
Iuchi (1998)[129]	MRI prediction of fibrous pituitary adenomas.	MR imaging of patients with either firm or soft tumors, as identified at surgery, were retrospectively evaluated. Collagen content of surgical specimens and tumor densities on imaging was expressed as numerical data using NIH-image. The relationship between collagen content and imaging characteristics were compared.	26	Diagnostic / III	Signal intensities on T1-weighted images were not correlated with tumor consistency, whereas those on T2-weighted images were significantly correlated with the percentage of collagen content. Adenomas, showing lower signal intensities on T2-weighted images, contained more collagen. On enhanced images, homogeneously enhanced adenomas tended to include more collagen, even though the grade of enhancement effect showed only weak correlation with the tumor hardness. Adenomas may be firm and fibrous if they show low signal intensities on T2-weighted images and homogeneous enhancement.
Kanou (2002)[130]	Clinical implications of dynamic MRI for pituitary adenomas: clinical and histologic analysis.	Patients underwent both conventional MR and dynamic MR imaging. Enhancement patterns and factors such as hormone status, tumor size, vascularity, arterial involvement, and tumor texture were compared in 2 image modalities.	67	Diagnostic / III	Adenomas inclined to have late enhancement patterns were relatively small compared to those with early patterns. Tumors with very early enhancement patterns were significantly more fibrous than those with the other 3 patterns. The factors that contribute to sequential enhancement patterns remain unclear. The dynamic sequential pattern may provide useful information about the texture of the tumor.

Author (Year)	Title	Study Description	Number of Patients	Evidence Class	Conclusions
Mahmoud (2011)[63]	Role of PROPELLER diffusion-weighted imaging and apparent diffusion coefficient in the evaluation of pituitary adenomas.	Patients who underwent conventional MR and periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER) DWI were retrospectively analyzed. Mean, max, and min values from the PROPELLER DWI images were calculated. Intraoperative tumor consistency was recorded by neurosurgeons. ADC values were compared to tumor consistency experienced intraoperatively and percent collagen content.	19	Diagnostic / III	Tumor consistency was strongly associated with the percent collagen content. However, neither the tumor consistency nor the percent collagen content was correlated with MRI findings or ADC values. The SI of growth hormone-producing adenomas on T2-WI was lower than of the other pituitary adenomas studied ($P < .01$); no other significant difference was found in the ADC or on conventional MRI between pituitary adenomas with different secretory functions. The MIB-1 LI of pituitary adenomas was not correlated with their appearance on conventional MRI or their ADC values. Unlike other studies, this study found tumor consistency was not correlated with ADC findings.

Author (Year)	Title	Study Description	Number of Patients	Evidence Class	Conclusions
Pierallini (2006)[131]	Pituitary macroadenomas: preoperative evaluation of consistency with diffusion-weighted MR imaging—initial experience.	Patients underwent both conventional MR and diffusion-weighted imaging. ADC was calculated and compared to the consistency of tumor evaluated at surgery as well as histologic characteristics such as percentage of collagen content.	22	Diagnostic / III	The mean value of ADC in the soft group was (0.663 +/- 0.109) x 10(-3) mm(2)/sec; in the intermediate group, (0.842 +/- 0.081) x 10(-3) mm(2)/sec; and in the hard group, (1.363 +/- 0.259) x 10(-3) mm(2)/sec. Statistical analysis revealed a significant correlation between tumor consistency and ADC values, DW image SI ratios, T2-weighted image SI ratios, and percentage of collagen content ($P < .001$, analysis of variance). Findings in this study suggest that DW MR images with ADC maps can provide information about the consistency of macroadenomas.

Author (Year)	Title	Study Description	Number of Patients	Evidence Class	Conclusions
Boxerman (2010)[132]	Preoperative MRI evaluation of pituitary macroadenoma: imaging features predictive of successful transsphenoidal surgery.	Patients with chiasm-compressing tumors who underwent conventional MR and DWI imaging were retrospectively evaluated. MR images were used to identify nonsolid and solid tumors by 2 neuroradiologists. Apparent diffusion coefficient values, T2-weighted signal intensity normalized to pons intensity were also calculated. Postoperative scans were evaluated for chiastmatic decompression and mean change in tumor height. Chiastmatic decompression defined surgical success. A neuropathologist assessed reticulin content in tumor samples. Each of these parameters was correlated with preoperative imaging findings using chi-square, Fisher exact, and t tests.	28	Diagnostic / III	The ratios of tumor to brainstem ADC in the 9 successfully resected solid tumors were higher than in the 8 cases of failed treatment (P = .008). All 6 solid tumors with enhanced diffusivity (ratio of tumor to brainstem ADC > 1.1) were successfully managed with transsphenoidal hypophysectomy, compared with 3 of 11 with an ADC ratio less than 1.1 (P = .009). Tumors with nonsolid features or an ADC ratio greater than 1.1 were highly resectable (P < .001; sensitivity, 0.84; specificity, 0.89). ADC ratios in reticulin-poor solid tumors were higher than those in reticulin-rich tumors (P = 0.024). Macrocystic and macrohemorrhagic adenomas and solid tumors with enhanced diffusivity determined with ADH are more likely to be successfully managed with transsphenoidal hypophysectomy. Transsphenoidal hypophysectomy of solid, enhancing tumors with restricted diffusion is more likely to fail. This may help with case selection for transsphenoidal versus transcranial approaches.