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RESEARCH

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# Pathologic Changes of the Lateral Pterygoid Muscle in Patients with Derangement of the Temporomandibular Joint Disk: Objective Measures at MR Imaging

**BACKGROUND AND PURPOSE:** The superior head of the lateral pterygoid muscle (SHLP), which inserts on the anterior disk of the temporomandibular joint (TMJ), can spasm, contracting and exerting forward traction on the disk. This mechanism can lead to anterior displacement. In TMJ dysfunction, it is hypothesized that the SHLP will demonstrate morphologic changes with measurable changes in signal intensity related to atrophy or muscular edema, or both. The goal of this study was to evaluate the lateral pterygoid muscle (LPM) in patients with TMJ dysfunction.

**MATERIALS AND METHODS:** Patients with displacement of the TMJ disk with and without reduction were identified through a review of radiology reports. Absolute measurements of thickness as well as region-of-interest measurements were placed over the 2 heads of the LPM bilaterally on sagittal T1- and T2-weighted images. Statistically significant differences between the superior and inferior heads of the LPM were calculated with use of a 1-tailed Student *t* test and were correlated with the degree of disk derangement.

**RESULTS:** In patients with disk derangement, significantly increased region-of-interest values on T2- and T1-weighted images were demonstrated within the SHLP. No patients with anatomically normal disks demonstrated a statistically significant difference in region-of-interest values between the superior and inferior heads of the LPMs.

**CONCLUSION:** Correlation between increased region-of-interest values and pathologic alteration of the relationship between the condylar head and disk was identified. In patients with displacement of the anterior disk with and without reduction, region-of-interest values were significantly increased, which indicates abnormal signal intensity involving the superior head of the LPM.

The lateral pterygoid muscle (LPM), specifically the superior head, has been implicated in anterior dislocation of the disk in internal derangement of the temporomandibular joint (TMJ).<sup>1,2</sup> There has been extensive investigation of the anatomic relationship of the LPM to the condylar head, disk, and capsule, as well as multiple electromyographic studies that demonstrate the patterns of contraction of the muscles of mastication during both rest and motion.<sup>3-7</sup> Wang et al<sup>3</sup> recently demonstrated maximal activity of the superior head of the lateral pterygoid muscle (SHLP) during clenching, with its major function as a stabilizer of the disk and condylar head. The SHLP, which has been shown to frequently insert on the capsule of the TMJ and therefore the anterior edge of the disk, has been postulated to undergo spasm, which results in contraction of the muscle. This prolonged contraction places forward traction on the disk, which can result in anterior displacement.<sup>8</sup>

It is postulated that in the early stages of disk derangement, spasm involving the SHLP muscle would demonstrate edematous changes related to the sustained contraction. In the later, more chronic stages of disk derangement, a component of

fatty atrophic change may be seen as well.<sup>9</sup> It is suggested that the increased fluid within the SHLP during the more acute phase of disk derangement will lead to measurable changes in signal intensity on MR imaging. In the later stages of derangement, fatty atrophic change should also produce measurable changes in signal intensity. The contraction of the muscle related to spasm or edema, or both, would theoretically lead to increased thickness of the muscle belly, whereas atrophy could lead to a relative decrease in thickness, which would be measurable on MR imaging. The goal of this study was to determine the morphologic process and signal intensity present within the SHLP and correlate this with the degree of disk derangement.

## Materials and Methods

### Patients

We identified patients who had imaging of the TMJ through a retrospective review of 957 dedicated MR images of TMJ reports at our institution from January 1997 through August 2003. An abnormality of the TMJ was defined as anterior displacement of the disk in the closed-mouth position, either with or without reduction on opening. We identified a total of 110 TMJs and restored these images to the institution's PACS system. We established 4 groups on the basis of the level of disk derangement and designated these groups as follows: group 0, bilaterally normal TMJs (*n* = 28); group 1, unilaterally normal TMJs (*n* = 20), noting disk derangement in the opposing joint; group 2, ADWR (anterior displacement with reduction) (*n* = 40); and group 3, ADNR (anterior displacement without reduction) (*n* = 22).

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### Comparison of relative signal intensity of group 0 with the other groups on the basis of disk derangement

Group	One-Tailed Student <i>t</i> Test*			
	T2 Ratio	T1 Ratio	Muscle Ratio	Muscle Size
1 vs 0	0.0589	0.4721	0.7306	0.9535
2 vs 0	$P < .001$	0.8946	0.3425	0.4867
3 vs 0	$P < .001$	$P < .01$	0.7891	0.9781

**Note:**—0 indicates the bilaterally normal TMJ group; 1, unilaterally normal TMJ; 2, anterior displacement of the disk with reduction; 3, anterior displacement of the disk without reduction.

\* Significance was defined as  $P < .05$ ; highly significant,  $P < .01$ .

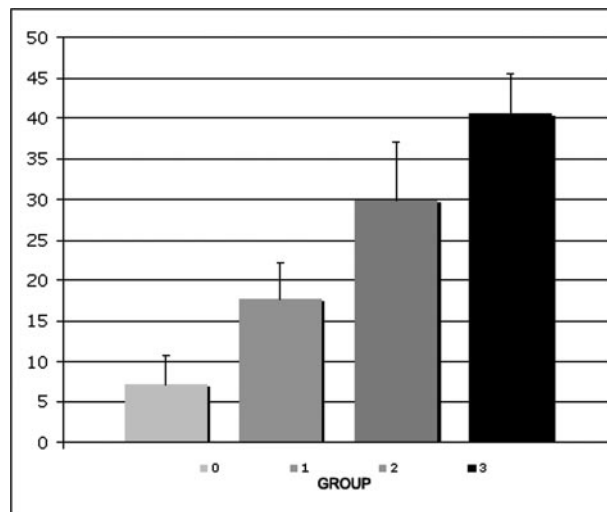
### MR Examinations

We performed all imaging on a GE Signa 1.5T magnet (GE Healthcare, Milwaukee, Wis) using an axial T1-weighted localizer, T1- and T2-weighted sagittal oblique closed-mouth, T1-weighted open-mouth, and T1-weighted coronal imaging sequences. We measured signal intensities (SI) retrospectively using representative regions of interest within the SHLP and the inferior head of the lateral pterygoid muscle (IHLP) on closed-mouth, T2 nonfat-saturated, and T1-weighted sagittal oblique images. Scrolling through the images, we selected the image that represented the midportion of the muscle belly, and we placed the region of interest at this level. In addition, absolute thickness of the SHLP as well as the relative thickness ratio between the SHLP and IHLP were measured in the superior-inferior dimension on the closed-mouth sagittal oblique T2-weighted images as morphologic parameters.

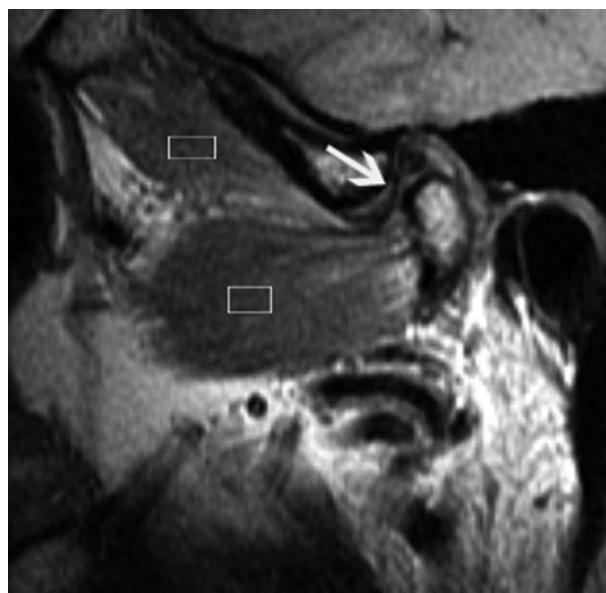
We used a 1-tailed Student *t* test to compare the bilaterally normal group (group 0), with the other groups to determine statistically significant differences in relative signal intensity between the SHLP and the IHLP as well as absolute muscular thickness of the SHLP and relative muscular thickness of the SHLP to the IHLP (Table). Significance was defined as a *P* value  $< .05$ . Highly significant was defined as a *P* value  $< .01$ .

### Results

In the first group, evaluation of the 28 joints in group 0 (bilaterally normal disks) demonstrated no significant difference in SI between the superior and inferior heads of the LPM on either the T2-weighted or T1-weighted images. In the second group, we evaluated a total of 20 joints in group 1 (unilaterally normal disks) with a normal relationship between the disk and condylar head but with the opposite TMJ demonstrating internal derangement. Also, near-significant differences in SI were identified between the superior and inferior heads of the LPM on the T2-weighted measurements. There was no significant difference in SI identified in the T1-weighted group. In the third group, we evaluated a total of 40 joints in group 2 (anterior displacement with reduction), and there was a highly significant difference ( $P = .0002$ ) identified on T2-weighted SI between the superior and inferior heads of the LPM. There was no significant difference in SI on T1-weighted imaging ( $P = .895$ ). In the fourth group, we evaluated a total of 22 joints in group 3 (anterior displacement without reduction). This was the most advanced stage of disk derangement, and a highly significant difference was identified on both T2-weighted ( $P < .001$ ) and T1-weighted ( $P = .002$ ) imaging SI between the superior and inferior heads of the LPM (Table). When the mean relative T2 SI of the 4 groups was plotted, there was a near-linear increase in SI from group 0 (bilaterally normal



**Fig 1.** Relative percentage of increase in T2 signal intensity of the SHLP.



**Fig 2.** Example of a normal TMJ with the arrow pointing to a normally positioned disk in relationship to the condylar head. Representative region-of-interest fields have been placed over the superior and inferior heads of the LPM.

disks) through group 3, the most severe level of disk derangement (disk displacement without reduction) (Fig 1). There was no level of significance identified in any group related to either absolute muscular thickness of the SHLP or relative muscular thickness of the SHLP compared with the corresponding IHLP.

### Discussion

A significant increase in SI was demonstrated within the SHLP relative to the IHLP on T2-weighted imaging. This increase in signal intensity correlated with the severity of the disk derangement, with near significance identified with the unilaterally normal TMJ group. An example of this normal group with representative regions of interest placed over the superior and inferior heads of the LPM is shown in Figure 2. The most severe level of disk derangement, depicted in Figure 3, was ADNR, which demonstrated a significant increase in signal



**Fig 3.** Example of anterior disk displacement (arrow) in the closed-mouth position. Representative region-of-interest fields have been placed over the respective muscle bellies.

intensity on both the T2-weighted and T1-weighted images. Given the fluid sensitivity of the T2-weighted images, these findings were highly suggestive of increased fluid within the SHLP muscle in patients with disk derangement. As well, the near-linear increase in signal intensity demonstrated with increasing levels of disk derangement would correlate with an increase in the severity of muscular spasm, which leads to an increased amount of muscular edema (Fig 1). The T1-weighted images render them relatively insensitive to fluid signal intensity and relatively more sensitive to fat signal intensity. The significant finding on the T1-weighted images at only the most severe level of disk derangement (ADNR) suggests that there are likely fatty atrophic changes within the SHLP at this most advanced stage.

The lack of significance related to the relative thickness of the muscle bellies may be related, in part, to the normal range of variation in size of the respective heads of the LPM between subjects. Also, in patients with disk derangement and associated atrophic change within the SHLP, the presence of fatty infiltration with pseudohypertrophy may help to maintain a relatively normal measurement.

A limitation of the study was that the population evaluated represented a select group of patients with pain referable to the TMJ. Therefore, the normal group (group 0) could potentially have had abnormalities involving the SHLP that have not yet resulted in disk displacement. Another limitation of the study was the inability to determine the relative contribution of fat-related signal intensity versus fluid-related signal intensity because of the lack of T2-weighted fat-saturated imaging. The demonstration of significant differences in the region-of-interest values for T1-weighted imaging only at the most severe level of disk derangement (group 4) implies increased fat-related signal intensity within the muscle bellies of this group, which would suggest fatty infiltration related to atrophic change. The addition of signal intensity related to the increased fatty infiltration contributing to the increase in the region-of-interest values on T2-weighted imaging cannot be ignored. This finding could be further investigated prospec-

tively with the addition of T2-weighted fat-saturated imaging to the current TMJ imaging sequences. Comparison of the T2-weighted nonfat-saturated images with the T2 fat-saturated images could provide an objective measure of the relative contribution of fat versus fluid signal intensity within the muscle bellies.

The presence of statistically significant differences in the region-of-interest values between the SHLP and the IHLP was significant in that objective measures have been identified that correlate with the level of disk derangement present. The fact that there was increased signal intensity within the SHLP in the unilaterally normal group was an unexpected finding, though the difference did not reach significance. It is postulated that although the disk and condylar head maintained a normal relationship in both the closed and open positions, the presence of disk derangement in the opposing TMJ may have resulted in unfavorable masticatory forces that caused at least some degree of muscular spasm with resulting edema within the SHLP.

## Conclusion

Alterations in signal intensity in the superior head of the LPM can be identified with region-of-interest values as an objective measurement of relative T2 signal intensity. Comparison of these values between the superior and inferior heads demonstrated a strong correlation between increased T2 signal intensity and pathologic alteration of the relationship between the condylar head and disk. This increased signal intensity may reflect increased fluid signal intensity related to muscular edema or fatty change, or both, secondary to atrophy. The significantly increased signal intensity in the SHLP on T1-weighted images only at the most severe level of disk derangement implies a component of fatty infiltration consistent with atrophic changes. By contrast, relative thickness between the 2 muscle heads as a morphologic measure is not useful in the identification of this pathologic process.

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