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Prevalence of TMJ Disc Displacement in a Pre-Orthodontic Adolescent Sample

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ABSTRACT

This study evaluated the prevalence of temporomandibular joint (TMJ) disc displacement in preorthodontic adolescents (75 boys, 119 girls) by means of magnetic resonance imaging (MRI). One hundred thirty-eight consecutive subjects were recruited regardless of TMJ signs or symptoms, whereas 56 other subjects were referred with associated signs or symptoms. Quantitative measurements of disc displacement and disc length were used to classify the degree of internal derangement into 6 categories on the basis of sagittal MRI slices of the joints. In addition, sideways disc displacement was determined from coronal MRI images of the joint. Unilateral and bilateral normal disc position was more prevalent in boys compared to girls. All forms of anterior and rotational disc displacement were more prevalent in the female sample than in the male. Sideways displacement was more prevalent in girls than boys and occurred more frequently in a lateral rather than a medial direction. This study supports previous studies in suggesting that disc displacements occur frequently in preorthodontic adolescents.

KEY WORDS: Adolescent, Temporomandibular joint, Magnetic resonance imaging, Prevalence.

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INTRODUCTION Return to TOC

Traditionally, the prevalence of a disease or disorder is established by making use of epidemiological studies and a random selection of large samples of individuals with and without a disorder of interest.[1] The prevalence of temporomandibular joint dysfunction (TMD) in the adolescent population has been reported previously[2–4] and varies considerably depending on the sample selection, the criteria used to define disc displacement, and the type of study conducted.

Until recently, a clinical evaluation of joint sounds was used as a standard to determine the prevalence of disc displacement in TMD subjects. Joint sounds were found to occur in 10.0% of a sample of 3428 grade schoolchildren between 6 and 12 years of age.[2] In another study conducted by Gazit et al,[3] the prevalence of joint sounds in 369 individuals aged 10 to 18 years was reported to be 35.8%. In a review by Mintz,[5] the prevalence of joint sounds in adolescent individuals varied between 0% and 35.8%, with an average of 17.0%. These studies are further complicated by the findings of Egermark-Eriksson et al[4,6] and Nilner and Kopp,[7] who showed a positive association between joint sounds and aging in adolescent individuals. These findings highlight the importance of defining specific criteria for evaluation of the disorder of interest as well as defining the study population when the prevalence of a disorder is investigated.

Associations between occlusal characteristics and signs and symptoms of TMD have also been attempted in the adolescent population. In a cross-sectional evaluation of 1342 subjects aged 6 to 17 years, Riolo et al[8] showed that a functional shift of the occlusion was negatively associated with temporomandibular joint (TMJ) and muscle tenderness, that open bite was positively associated with TMJ and muscle tenderness, and that joint noises were positively associated with a class II molar relationship. In contrast, Keeling et al[2] were not able to show associations between molar relationship and TMJ sounds but did show associations between joint sounds and larger maximal mouth opening, anterior dental crowding, and deeper incisor overbites. These studies made use of different criteria to categorize joints as dysfunctional or normal, and the conflicting results highlight the need to establish specific parameters to define normal and abnormal joint function or TMD.

Numerous causes of TMD have been proposed, but some are more readily identifiable than others. Certain forms of disc displacement result in TMD and are often associated with considerable suffering and loss of joint function. Disc displacement is readily identified with magnetic resonance imaging (MRI) of the joint. The technique is noninvasive, pain free, of minimal risk potential, and free of ionizing radiation exposure, and it can be applied to both dysfunctional and control subjects.[9] The prevalence of disc displacement in the asymptomatic adult population has been shown to be approximately 30%,[10–12] whereas the prevalence in symptomatic patients ranges from 77.0%[11] to 82.0%[12] when MRI was used to determine disc position. In a study to determine the prevalence of MRI-determined disc displacement in 51 children between the ages of 8 and 15 years who presented with malocclusions, the prevalence of disc displacement was shown to be 11.8%.[13] Although this was a small sample of children, it did include individuals with both normal and abnormal disc position and did not rely on a sample of patients presenting for treatment of TMD-related symptoms. The prevalence of disc displacement is naturally expected to be higher in patients than in asymptomatic individuals and, therefore, prevalence studies should not be based on bias sample selections, as may have occurred in previous studies.

The purpose of the present study is to report on the prevalence of disc displacement in a preorthodontic adolescent sample drawn to determine the associations between disc displacement and craniofacial morphology. This study reports on the prevalence of various forms of disc displacement identified by making use of a newly established and tested quantitative technique for evaluation of MRI-determined disc position.

MATERIALS AND METHODS Return to TOC

One hundred thirty-eight consecutive subjects were recruited from the graduate orthodontic program at the University of Alberta and from a private orthodontic practice in the area before they underwent orthodontic treatment. The group consisted of subjects with and without clinically detectable TMJ signs and symptoms (capsular pain, joint sounds, masticatory muscle tenderness, limited mandibular range of motion, and deviation on opening).

Practicing orthodontists in the Edmonton area were asked to screen preorthodontic patients for signs and symptoms of TMD and to refer individuals with TMJ symptoms for MRI evaluation if consent was given. A total of 56 other subjects were recruited in this way. No individuals with a history of juvenile rheumatoid arthritis were included in the study.

MRIs of the TMJs were obtained on all 194 subjects (75 boys and 119 girls) between the ages of 10 and 17 years, regardless of TMJ disc position. All individuals consented to inclusion in the study, and the study was approved by the Joint Dentistry/Pharmacy Human Ethics Committee.

MRIs of the TMJs were performed without sedation by using a 1.0 T magnet (Shimadzu Corporation 3, Tokyo, Japan) and a unilateral 76-mm surface receiver coil. Axial scout images were obtained to identify the condyles. Bilateral closed-mouth sagittal sections were obtained perpendicular to the long axis of the condyle, and coronal images were obtained parallel to the condylar long axis. Closed mouth images were obtained with polyvinylsiloxane (President Jet-Bite, Coltene/Whaledent Inc, Mahwah, NJ) centric occlusion bite registration. To prevent muscle fatigue, bilateral open-mouth sagittal images were produced by making use of a Burnett caliper (Medrad, Pittsburgh, Pa) set at 10 mm below the maximal voluntary interincisal mouth opening. Subjects were instructed to rest the anterior teeth on the blades of the caliper. T1-weighted 500/20 (TR ms:TE ms) pulse sequences were performed on all subjects by using a 3-mm slice thickness, 140-mm field of view, NEX of 2, and image matrix of 204 × 204 pixels.

An experienced maxillofacial radiologist subjectively determined the disc position from the coronal and sagittal MRI slices of the joints. Of the 194 subjects imaged (387 joints), only 35 joints were excluded because of poor MRI quality, possibly as a result of motion artifacts. Six categories of disc position were identified, all exhibiting disc reduction on mouth opening.

Disc position categories

Category 1: normal disc position. In the closed-mouth position, the intermediate zone of the disc was interposed between the head of the condyle and the posterior slope of the articular eminence, with the anterior and posterior bands equally spaced on either side of the condylar load point in a bow tie appearance (Figure 1).[14]

Category 2: slight disc displacement. The intermediate zone of the disc was slightly anteriorly displaced from between the osseous articular components. The head of the condyle opposed the posterior band of disc (Figure 2).

Category 3: moderate disc displacement. The intermediate zone of the disc was completely displaced from between osseous articular structures. The head of condyle was in contact with the junction between posterior band of the disc and the bilaminar zone (Figure 3).

Category 4: full disc displacement. The entire articular disc was anteriorly displaced relative to the posterior slope of the articular eminence and head of the condyle. The bilaminar zone of the disc was interposed between the osseous articular structures and occupied the narrowest joint space. The disc reduced on mouth opening (Figure 4).

Category 5: full disc displacement with severe loss of morphology. Identical description to category 4, but without reduction of the disc on mouth opening and morphological alteration of the disc evident (Figure 5).

Category 6: noncategorical disc position. MRI images produced were of poor diagnostic quality and could not be interpreted for disc position.

The subjective categorization of disc position was used in a discriminant analysis to determine whether quantitative measurements of disc length and disc displacement could be used to classify the position of the disc on each sagittal MRI slice of the joint.[15] Quantitative measures of disc length and disc displacement were obtained with reference planes transferred from corresponding lateral cephalometric radiographs for each subject; this aided in standardization of joint position and measurement technique.[15] Discriminant analysis revealed that categorization into the subjectively determined categories by using the quantitative measures of disc length and disc displacement was feasible.

In boys, 70 left joints and 68 right joints were available for analysis. In girls, an equal number of right and left joints (107) were available for analysis. The newly defined discriminant category per slice of the joint was used to determine the degree of disc displacement in each joint. A joint was assigned to these categories only if all slices within the joint were assigned the same discriminant category (Figure 6). Joints that did not have a consistent discriminant score assigned to each slice throughout the joint were assigned to 1 of 2 groups.

Anterolateral disc displacement. The medial pole of the disc has lost its attachment or has become elongated. The degree of disc displacement in the medial part of the joint exceeds that noted in the lateral region of the joint when discriminant scores of sagittal MRI slices are used for classification. In this situation, the bulk of the displaced disc is located in an anterolateral position when the teeth are in intercuspation (Figure 7).

Anteromedial disc displacement. The degree of disc displacement in the lateral region of the joint was more severe than in the medial region of the joint, as determined by the discriminant score assigned. This means that the disc exhibits a rotational displacement, with the bulk of the disc located in the medial region of the joint in the closed-mouth position (Figure 8).

Sideways disc displacement has recently been identified by Tasaki et al[12] when making use of coronal MRI images. In joints affected by sideways disc displacement, the articular disc is displaced either medially or laterally relative to the condyle and apparently shows no component of anterior disc displacement. To determine the prevalence of sideways disc displacement in the current study, sagittal and coronal images were subjectively assessed to determine the presence of a medial or lateral sideways displacement that may have occurred. No quantitative score was assigned to this type of disc displacement.

Data analysis

The percentage prevalence of disc displacement was determined independently for right and left joints separately for girls and boys and assessed independently on the basis of symptomatic referral or consecutive referral from referring orthodontists and graduate orthodontic programs. These data were further utilized to determine the prevalence of bilateral joint involvement by making use of the discriminant categories. Unilateral normal disc position in an ipsilateral joint and contralateral disc displacement were also determined for boys and girls. The prevalence of bilateral or unilateral joint involvement was determined for 104 girls and 68 boys for whom bilateral MRI data were available.

RESULTS Return to TOC

The percentage prevalence of normal and disc displacement according to the discriminant scores per joint are presented in Tables 1 and 2 for nonconsecutive and consecutive subjects included in the study, respectively. From these data, it is evident that approximately 50% of the male consecutive joints were normal, with minimal joint-side bias. A slightly smaller percentage of normal disc position was evident in the nonconsecutive sample. Normal female joints ranged from 23% to 29%, with little difference in percentage prevalence between consecutive and nonconsecutive groups (Figure 1). Full disc displacement with loss of morphology occurred more frequently in girls than in boys in this sample of adolescents (Figure 5).

Bilateral normal joints were more common in boys than in girls, whereas bilateral full disc displacement with loss of morphology was far more prevalent in girls than in boys (Table 3). Bilateral occurrence of the intermediate stages of disc displacement was poorly represented in both boys and girls in this adolescent sample when only the sagittal slice information meeting requirements for discriminant categorization was assessed. The occurrence of unilateral normal disc position with contralateral disc displacement of any form was more prevalent in boys at 36.36% for the nonconsecutive group and 26.31% for the consecutive group, compared with girls, who showed 18.0% for the nonconsecutive group and 18.5% for the consecutive group (Table 3).

Regardless of sex or joint side, anteromedial disc displacement was more prevalent than anterolateral displacement (Table 4). Overall, girls exhibited more rotational disc displacement than boys. The prevalence of sideways disc displacement for boys and girls, as determined from coronal images of the joints, is presented in Table 5. Figure 9 depicts a lateral sideways disc displacement as seen on coronal MRI images of the TMJ.

DISCUSSION Return to TOC

The sample under consideration was recruited to determine whether MRI-determined disc position could be associated with alteration in craniofacial morphology. Although this was not the topic of discussion in this investigation, this sample of preorthodontic subjects allowed for assessment of the prevalence of disc displacement in subjects referred directly for symptomatic joint assessment and the prevalence of disc displacement assessment in subjects referred consecutively from the graduate orthodontic program.

Subjects recruited for this study included individuals with and without clinically detected signs and symptoms of TMD. It was attempted to derive a study sample on the basis of clinical signs and symptoms that would be equally distributed between symptomatic and asymptomatic assignment. This seems to have been achieved in the consecutive male sample, in which approximately 50% of the males had either right or left TMJs with normal categorization. Only 40.4% of the consecutive boys, however, were bilaterally normal according to discriminant analysis assignment of TMJ category. In nonconsecutive symptomatic boys, normal joint categorization was slightly lower, at 36.4% for right and 40.1% for left joints. Bilateral normal disc position in the nonconsecutive group was observed in only 18.2% of the boys. Noticeably fewer bilateral normal joints were seen in the nonconsecutive symptomatic male sample under investigation.

In the consecutive female sample, only approximately 25% to 29% of the joints were normal on either the left or right side, and only 15.4% had bilateral normal disc position. Even fewer nonconsecutive symptomatic girls presented with normal disc position, and bilateral normal disc position was assessed in only 12.8% of this sample.

Full disc displacement and full disc displacement with loss of morphology occurred with greater prevalence in the nonconsecutive symptomatic female sample than in the consecutive female sample. Girls showed a higher prevalence of full disc displacement than boys for nonconsecutive symptomatic and consecutive samples.

On the whole, bilateral disc displacement, whether full disc displacement or full disc displacement with loss of morphology, was more prevalent in girls than in boys, but boys exhibited more bilateral normal joints than girls. Boys seemed to be more affected by unilateral joint involvement than were girls. This may be related to the etiology of the displacement. From evaluation of clinical history obtained from our subjects, trauma to the mandible and joint seems to be more prevalent in boys than in girls. A history of trauma may be associated with the greater prevalence of unilateral disc displacement in boys than in girls. Possibly other mechanisms are responsible for bilateral disc displacement in girls. It has been suggested in animal studies that joint laxity involving any joint occurs more commonly in girls than in boys.[16,17] These findings may represent a sex-limited expression of joint laxity that is related to altered collagen synthesis, which is affected either by the level of circulating estrogen or the concentration of estrogen receptors within joints.[18] It is suggested that individuals with joint laxity as a result of altered collagen synthesis are at greater risk of developing bilateral TMD when subjected to etiological factors such as trauma, joint overextension, or joint overuse.[19]

Anteromedial disc displacement involving a straight anterior displacement of the lateral region of the disc and a sideways shift of the displaced lateral pole of the disc in a medial direction was shown to be more prevalent than anterolateral disc displacement. These findings are comparable to those of Tasaki et al,[12] who termed these displacements *partial anterior displacement of the disc in the lateral part of the joint* and *partial anterior displacement of the disc in the medial part of the joint,* respectively. In keeping with the overall higher level of disc displacement identified in girls, the prevalence of anteromedial and anterolateral rotational disc displacements was higher in girls than in boys. Rotational disc displacement did not, however, show any side-specific bias in either boys or girls. These forms of rotational disc displacement were the most prevalent of all forms of displacement identified. This may be an indication that a disc displacement in a single region of the joint is common compared with the disc displacement throughout the joint needed to satisfy the strictly applied discriminant categories of disc displacement.

Anteromedial or anterolateral disc displacement may be viewed as a form of slight or moderate disc displacement if the functional effects of disc displacement are considered. A rotational disc displacement functions similarly to a slight or moderately displaced disc in that during some phase of the masticatory cycle, the disc is displaced, whereas during another phase, the disc is once more interposed between the osseous articular surfaces. Rotational displacements may be an intermediate stage of disc displacement in which only one collateral discal ligament is elongated and the other collateral ligament may not yet have elongated sufficiently to allow for the developed of full disc displacement throughout the joint. If anteromedial and anterolateral displacements are considered as slight or moderate disc displacements, then it may be appreciated that these 2 categories do form a continuum in the distribution of disc displacements identified.

The prevalence of sideways disc displacement in girls was higher than that in boys and was more common in a lateral direction, as identified by a lateral bulging of the joint capsule on coronal MRI images. Lateral sideways disc displacement was more prevalent in the left TMJ than the right for both boys and girls, whereas medial sideways disc displacement was more common in the right TMJ. Only 1 boy exhibited medial sideways disc displacement, and this affected a left TMJ. In joints with a sideways component to the disc displacement, the sagittal MRI images did contain an area of reduced signal intensity anterior to the condyle, inferior to the height of the articular eminence, and superior to the lateral pterygoid muscle insertion into the condyle neck in the region of the anterior joint recess. This area of reduced signal intensity was interpreted to be the elongated medial or lateral collateral discal ligament maintaining communication between the displaced disc and the corresponding condylar pole of attachment (Figure 10).

The prevalence of medial sideways disc displacement for boys in this study is significantly less than that previously reported by Tasaki et al[12] in their evaluation of patients and symptom-free individuals. In addition, the present study reports a significantly higher prevalence of lateral sideways disc displacement in girls compared with the findings of Tasaki et al.[12] The age of the individuals included in the respective studies may be a factor responsible for the differences observed between the 2 studies.

The prevalence of disc displacement identified in this sample of adolescent individuals should not be extrapolated to the general orthodontic population or to the population at large. This study is not representative of these populations because it was not selected on a random basis. The study, however, does recognize that disc displacement is prevalent in the adolescent population and is more prevalent in the female sample. The present study shows that disc displacement involving the TMJ affects individuals presenting for orthodontic consultation. Disc displacement may be associated with altered facial morphology or malocclusion, and these may be a clinical treatment challenge if normal facial growth is anticipated with disc displacement.[20–22] Furthermore, disc displacement may be associated with the development of clinical symptoms of craniofacial pain once the adaptive capacity of the joints is reduced when active growth is complete. A failure to identify individuals with disc displacement may have medicolegal implications if symptoms appear after orthodontic treatment has been completed. In addition, the use of only sagittal MRI slice information may not identify the full prevalence of disc displacement because the lateral or medial sideways disc displacements, seen on coronal MRI images, may not be visualized on the sagittal images.

CONCLUSIONS Return to TOC

The prevalence of disc displacement in this study sample of preorthodontic adolescent individuals was shown to be higher in girls than in boys. Unilateral disc displacement was more common in boys than in girls, but no side-specific bias in the prevalence of disc displacement was identified. Anteromedial disc displacement was shown to occur more commonly than anterolateral disc displacement. These rotational disc displacements were the most common form of disc displacement affecting joints and were most likely included in the moderate disc displacement group.

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TABLES Return to TOC

TABLE 1. Percentage Prevalence of Disc Displacement in Symptomatic Nonconsecutive Adolescent Sample[a]

Category of Disc Position	Boys		Girls	
	Left, %	Right, %	Left, %	Right, %
Normal disc position	40.0	36.4	27.5	23.1
Slight disc displacement	0.0	9.1	5.0	7.7
Moderate disc displacement	10.0	18.2	0.0	0.0
Full disc displacement	30.0	0.0	15.0	18.0
Full disc displacement with loss of morphology	10.0	9.1	25.0	18.0
Other	10.0	27.3	27.5	33.3

[a] Disc position per joint was determined by making use of all sagittal magnetic resonance imaging slices per joint. All slices per joint had to be similarly scored to be placed into 1 of the 6 categories. Joints with slices having different scores assigned to the slices were placed in the "Other" category, which was further analyzed for direction of disc displacement.

TABLE 2. Percentage Prevalence of Disc Displacement in Consecutive Adolescent Sample[a]

Category of Disc Position	Boys		Girls	
	Left, %	Right, %	Left, %	Right, %
Normal disc position	51.7	59.7	25.4	29.4
Slight disc displacement	15.0	8.8	19.4	5.9
Moderate disc displacement	5.0	5.3	3.0	2.98
Full displacement	3.3	7.0	10.5	23.5
Full disc displacement with loss of morphology	0.0	1.8	7.5	10.3
Other	25.0	17.5	34.3	27.9

[a] Disc position per joint was determined by making use of all sagittal magnetic resonance imaging slices per joint. All slices per joint had to be similarly scores to be placed into one of the 6 categories. Joints with slices having different scores assigned to the slices were placed in the "Other" category, which was further analyzed for direction of disc displacement.

TABLE 3. Percentage Prevalence of Bilateral and Unilateral Disc Displacement[a]

Joint Status	Symptomatic		Consecutive	
	Boys, %	Girls, %	Boys, %	Girls, %
Bilateral status				
Normal	18.2	12.8	40.4	15.4
Slight disc displacement	0.0	0.0	3.5	1.5
Moderate disc displacement	0.0	0.0	0.0	0.0
Full disc displacement	9.1	7.7	0.0	4.6
Full disc displacement with loss of morphology	0.0	10.3	0.0	3.1
Unilateral status[b]	36.4	18.0	26.3	18.5

[a] Disc position per joint was determined by making use of all sagittal magnetic resonance imaging slices per joint. All joints previously classified into one of the 6 categories were used to determine bilateral classification. Unilateral joint category was determined by combining normal-only joints with either moderate disc displacement, full disc displacement, or full disc displacement with morphological alterations.

[b] One side normal, other side disc displaced.

TABLE 4. Percentage Prevalence of Anteromedial and Anterolateral Disc Displacement for All Joints[a]

Category of Disc Position	Symptomatic				Consecutive			
	Boys		Girls		Boys		Girls	
	Left, %	Right, %	Left, %	Right, %	Left, %	Right, %	Left, %	Right, %
Anterolateral disc displacement	9.1	0.0	2.5	5.1	6.8	8.8	17.9	17.7
Anteromedial disc displacement	9.1	18.2	25.0	28.2	17.0	8.8	16.4	10.3

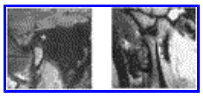
[a] Disc position per joint was determined by making use of all sagittal magnetic resonance imaging slices per joint. All joints previously classified as "Other" in Table 1 were evaluated to determine direction of disc displacement when a full category could not be assigned throughout the joint.

TABLE 5. Percentage Prevalence of Medial and Lateral Sideways Disc Displacement[a]

Disc Displacement	Boys		Girls	
	Right, %	Left, %	Right, %	Left, %
Lateral	2.9	5.7	11.8	19.1
Medial	0.0	1.4	6.4	2.7

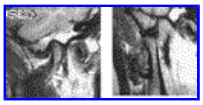
[a] Disc position determined by subjective evaluation of coronal magnetic resonance images of joints.

FIGURES Return to TOC



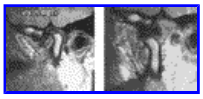
Click on thumbnail for full-sized image.

FIGURE 1. Sagittal closed-mouth magnetic resonance image depicting normal disc position



Click on thumbnail for full-sized image.

FIGURE 2. Sagittal closed-mouth magnetic resonance image depicting slight disc displacement



Click on thumbnail for full-sized image.

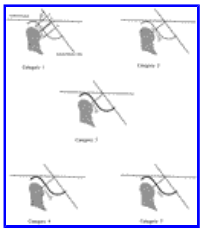
FIGURE 3. Sagittal closed-mouth magnetic resonance image depicting moderate disc displacement

Click on thumbnail for full-sized image.

FIGURE 4. Sagittal closed-mouth magnetic resonance image depicting full disc displacement

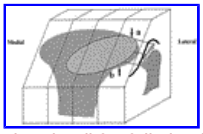
Click on thumbnail for full-sized image.

FIGURE 5. Sagittal closed-mouth magnetic resonance image depicting full disc displacement with loss of morphology



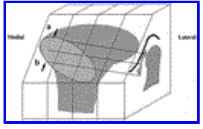
Click on thumbnail for full-sized image.

FIGURE 6. Discriminant categories of disc position. (a) Posterior band of disc; (b) anterior band of disc



Click on thumbnail for full-sized image.

FIGURE 7. Anterolateral disc displacement. (a) Posterior band of disc; (b) anterior band of disc

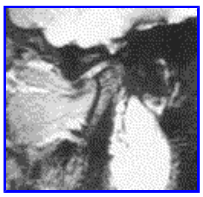


Click on thumbnail for full-sized image.

FIGURE 8. Anteromedial disc displacement

Click on thumbnail for full-sized image.

FIGURE 9. Coronal magnetic resonance image of TMJ depicting sideways disc displacement



Click on thumbnail for full-sized image.

FIGURE 10. Sagittal magnetic resonance image of temporomandibular joint depicting elongated collateral ligament associated with sideways disc displacement

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