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Prevalence of asymmetric molar and canine relationship

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SUMMARY The purpose of this study was to investigate the prevalence and severity of occlusal asymmetries in the molar and canine regions in a large population-based sample of adolescent Kuwaitis. Using a stratified cluster sampling method, 1299 Kuwaiti adolescents (674 boys mean age 13.3 years and 625 girls mean age 13.2 years), representing approximately 6.7 per cent of that age stratum in the population, were examined clinically for sagittal molar and canine relationships, with a view to recording half and full-step asymmetries. In this sample, 1244 subjects were examined clinically, while for the remaining 55, pre-treatment study models were assessed. All subjects were in the early permanent dentition stage. Descriptive statistical analyses were used to determine the proportion of different molar and canine asymmetries.

Antero-posterior asymmetries were found to be a distinctive and common feature of the dental arches, with half-step outweighing full-step asymmetries both in the anterior and posterior regions. The total prevalence of an asymmetric molar or canine relationship was 29.7 and 41.4 per cent, respectively, with more than 95 per cent falling in the mild category. Patient gender did not influence the prevalence or magnitude of asymmetry. The results showed a clinically significant prevalence of asymmetric molar and canine relationships, which were mainly in the category of half-step asymmetry. Class II half and full-step asymmetries were more prevalent than Class III asymmetries in the molar and canine regions.

Introduction

An asymmetric malocclusion may be the result of a mandibular lateral shift associated with a posterior crossbite, dental arch asymmetry due to tooth loss or tooth displacement, skeletal asymmetry within the maxillofacial skeletal complex, or any combination of these factors (Cheney, 1952; Wertz, 1975). An asymmetric malocclusion presents a challenge to orthodontic diagnosis and treatment planning (Cheney, 1952; Janson *et al.*, 2001). In such malocclusions, information regarding the aetiological factors associated with the asymmetry is required along with other diagnostic information for full orthodontic evaluation (Vig and Hewitt, 1975). Diagnostic radiographs such as submentovertex (Rose *et al.*, 1994), posteroanterior cephalographs (Alavi *et al.*, 1988), and oblique (Janson *et al.*, 2001) as well as diagnostic tools such as symmetropost (Cheney, 1952; Wertz, 1975), wax set-up, or occlusogram analyses may also be needed.

Despite the clinical significance of asymmetric malocclusions, efforts to classify asymmetric malocclusions are limited to Angle's 'subdivision', which has been shown to have major shortcomings (Siegel, 2002; Benson, 2003). A recent survey indicated that controversy exists among orthodontist when defining Angle's subdivision. The survey showed disagreement in relation to the interpretation of a Class II or Class III relationship (Siegel, 2002; Benson, 2003). Another shortcoming of Angle's (1907) classification system is rounding the half-step Class II and half-step Class III molar relationships to the nearest full-step category. Most previous epidemiological studies (Massler and Frankel, 1951; Altemus, 1959; Helm, 1968; Thilander and Myrberg, 1973; Al-Emran *et al.*, 1990; Lew *et al.*, 1993; Ng'ang'a *et al.*, 1996) followed Angle's classification and reported the molar relationship in only three full-step categories. Rounding the half-step molar relationship will minimize the ability to differentiate between mild and more severe antero-posterior discrepancies, as well as to report the full range of molar asymmetries.

Despite the shortcomings of Angle's system, many studies have followed his classification to report the prevalence of malocclusion in different populations of different age groups (Massler and Frankel, 1951; Altemus, 1959; Helm, 1968; Thilander and Myrberg, 1973; Al-Emran *et al.*, 1990; Lew *et al.*, 1993; Ng'ang'a *et al.*, 1996). However, very few attempts have been made to report the prevalence of an asymmetric malocclusion subdivision according to Angle (Wertz, 1975; Garner and Butt, 1985; El-Mangoury and Mostafa, 1990). Such a malocclusion has been found to be prevalent in 4.3–6.8 per cent of different populations (Wertz, 1975; Garner and Butt, 1985; El-Mangoury and Mostafa, 1990). Recent studies have suggested a higher range of asymmetric molar malocclusions

in more than 30 per cent of children (Keski-Nisula *et al.*, 2003) and adolescents (Smith and Bailit, 1979).

The most common reason for an asymmetric molar relationship was reported to be due to early loss of the primary second molar followed by mesial migration of the permanent first molar (Proffit *et al.*, 2007). Other factors which may lead to asymmetry are normal variations in the sequence of tooth eruption, asymmetries in eruption between the right and left sides, genetic influences, and perioral habits (Proffit *et al.*, 2007).

Few attempts have been made to determine the molar relationship in five categories, including half-cusp (half-step) relationships (Behbehani *et al.*, 2005). Also, very few attempts have been made to assess the prevalence of an asymmetric molar relationship without the effect of mesial molar migration (Behbehani *et al.*, 2005). Prevalence of precise asymmetric molar occlusion can only be achieved by reporting the full range of molar relationships, including half-step deviations, and by excluding subjects with evident mesial molar migration.

Information about the prevalence of canine asymmetries is also very limited (Keski-Nisula *et al.*, 2003; Behbehani *et al.*, 2005). Because it can be acceptable to finish in Class III or Class II molars when camouflaging a case with sagittal discrepancy, and since it is always important to finish with a Class I canine relationship, information about the canine relation may be more relevant to dictate the severity of malocclusion (Behbehani *et al.*, 2005). It is widely accepted that maxillary and mandibular canines are an integral part of facial and dental aesthetics, important for canine guidance, and essential for occlusal stability. Therefore, reports on canine asymmetries are equally or more important than those on molar asymmetries to describe the severity of malocclusion (Keski-Nisula *et al.*, 2003; Behbehani *et al.*, 2005). It may be speculated that canine asymmetry would follow molar asymmetry in a similar direction and at a similar severity level (Keski-Nisula *et al.*, 2003), but such information has not been extensively researched.

The purpose of this study was to examine a large population-based sample of adolescent Kuwaitis in the early permanent dentition to provide an accurate description of the prevalence and severity of occlusal asymmetries in the molar and canine regions.

Subjects and methods

Following approval by the ethical committee at Kuwait University, Faculty of Dentistry, the sample comprised 13- to 14-year-old Kuwaiti boys and girls according to a stratified cluster sampling method (Cochran, 1977), defining the students in the public schools of each of the six administrative areas as six different strata and the students in the different private schools as the seventh stratum. Similar to random sampling procedures in a previous report (Behbehani *et al.,* 2005), non-Kuwaitis (n = 96), Kuwaitis with a history of orthodontic treatment, whose original malocclusion could not be assessed (n = 8), and those with evidence of mesial migration of first molars (n = 180) were excluded. The remaining sample (n = 1299) divided into 674 males (mean age 13.3 years, SD 0.4) and 625 females (mean age 13.2 years, SD 0.4). In this sample, 1244 subjects were examined intraorally, while 55 subjects were assessed by evaluating their initial study models. All subjects were in the early permanent dentition stage. The molar and canine relationships were entered as missing data when these could not be scored due to missing, extracted, or impacted tooth.

The clinical examinations was performed during school hours in a well-lit room provided by the school principal, and the students were informed about their rights to refuse. All occlusal parameters were assessed when the teeth were in maximum intercuspation. Molar relationship was scored subjectively in five half-step units (Table 1). Angle's definitions were used to score full-step Class III, Class I, and Class II (Angle, 1907). Half-step Class II was scored if the mesial aspect of the maxillary first molar was flush with the mesial aspect of mandibular first molar (Figure 1a) and Half-step Class III was scored if the mesiobuccal step of the maxillary first molar occluded with distobuccal groove or distal cusp of the mandibular first molar (Figure 1b). As in the previous report (Behbehani *et al.*, 2005), between category relationships were scored according to the closest category and scored as the respective half-step Class II or Class III when in doubt. Similar criteria were used for scoring the canine relationship (Table 2), with full step Class II and Class III denoting occlusion of the maxillary canine cusp at the mesial aspect of the mandibular canine and distal aspect of the mandibular first premolar respectively (Behbehani *et al.,* 2005). A half-step Class II canine was recorded when the upper canine occluded at the cusp of the lower canine (Figure 1c) and half-step Class III when the upper canine occluded at the cusp of the lower first premolar (Figure 1d). Similar methods were used as in Behbehani *et al.* (2005) to score mesial molar migration and almost ideal occlusion. A total of four orthodontists (Faraj Behbehani, Badria Al Jame, Jon Årtun and Heidi Kerousuo) did the intraoral examinations. Each orthodontist evaluated about 300 to 400 subjects. Only one orthodontist (Faraj Behbehani) evaluated the pre-treatment study models for those who had orthodontic treatment.

Method error

To assure consistency in scoring the occlusal parameters within each examiner and among the four examiners, two sets of calibration were performed prior to the actual examination and data collection. Acceptable intra and interclass correlation coefficients were reached similar to what was reported earlier (Behbehani *et al.*, 2005). The mean intraclass correlation coefficient of all examiners was

Table 1 Prevalence of all possible molar relationship scores in subjects judged to have a malocclusion without mesial molar migration ($N = 1119$).

Left/right quadrant	Left molar relationship (%)						Classification of asymmetries	Prevalence (%)
Right molar relationship	Molar classification	Class I	Half-step Class II	Full-step Class II	Half-step Class III	Full-step Class III	*Half-step asymmetries	26.0
	Class I	60.0	8.6*	1.4**	2.8*	0.4**	**Full-step asymmetries	3.6
	Half-step Class II	8.4*	8.4	0.9 *	0.2**	0***	***One and one half-step asymmetries	0.1
	Full-step Class II	1.0**	1.0*	2.1	0.1***	0****	****Two full-step asymmetries	None
	Half-step Class III	3.2*	0.2**	0***	2.4	0.5*	Total asymmetries	29.7
	Full-step Class III	0.4**	0***	0****	0.6*	0.4	Total symmetrical relationship	70.3
							Total	100.0

*Half-step asymmetries, **Full-step asymmetries, ***One and one half-step asymmetries and ****Two full-step asymmetries.

0.80 and the mean for interclass correlation among the four examiners was 0.89. The error margins were acceptable.

Data analyses

Prevalence of occlusal asymmetries was determined in the molar and canine areas by calculating the number and percentage of males and females with asymmetric molar and canine relationships according to the following morphological criteria:

I Half-step asymmetries:
1. Half-step Class II on one side
   a) Full-step Class II on the other
   b) Class I on the other
2. Half-step Class III on one side
   c) Full-step Class III on the other
   d) Class I on the other

II Full-step asymmetries:
1. Class I on one side
   a) Full-step Class II on the other
   b) Full-step Class III on the other
2. Half-step Class II on one side and half-step Class III on the other

III One and half-step asymmetries:
1. Half-step Class II on one side and Class III on the other
2. Half-step Class III on one side and Class II on the other

IV Two full-step asymmetries:
1. Full-step Class II on one side and full-step Class III on the other

The severity of occlusal asymmetries was calculated by classifying the asymmetric molar and canine relationships as mild in subjects with half-step asymmetries, moderate in those with full-step asymmetry, and severe in cases with more than one full-step asymmetries. Chi-square tests were performed to test for gender differences in the prevalence and severity of occlusal asymmetries.

Results

Among the 1299 subjects examined, 178 (13.7 per cent) had an almost ideal occlusion. For the remaining 1121 (86.3 per cent) subjects with a malocclusion, the molar relationship could be scored in 1119 subject and the canine relationship in 1081 subject. The total prevalence of an asymmetric molar relationship was 29.7 per cent with only 3.7 per cent of the cases falling in the moderate to severe occlusal asymmetry category (Table 1). The total prevalence of an asymmetric canine relationship was 41.4 per cent with only 4.2 per cent of the cases falling in the moderate to severe occlusal asymmetry category (Table 2). No subjects were found to have two full-step asymmetry in the molar or canine areas (Tables 1 and 2).

In the molar region, half-step asymmetries were found in 18.9 per cent as half-step Class II and in 7.1 per cent as

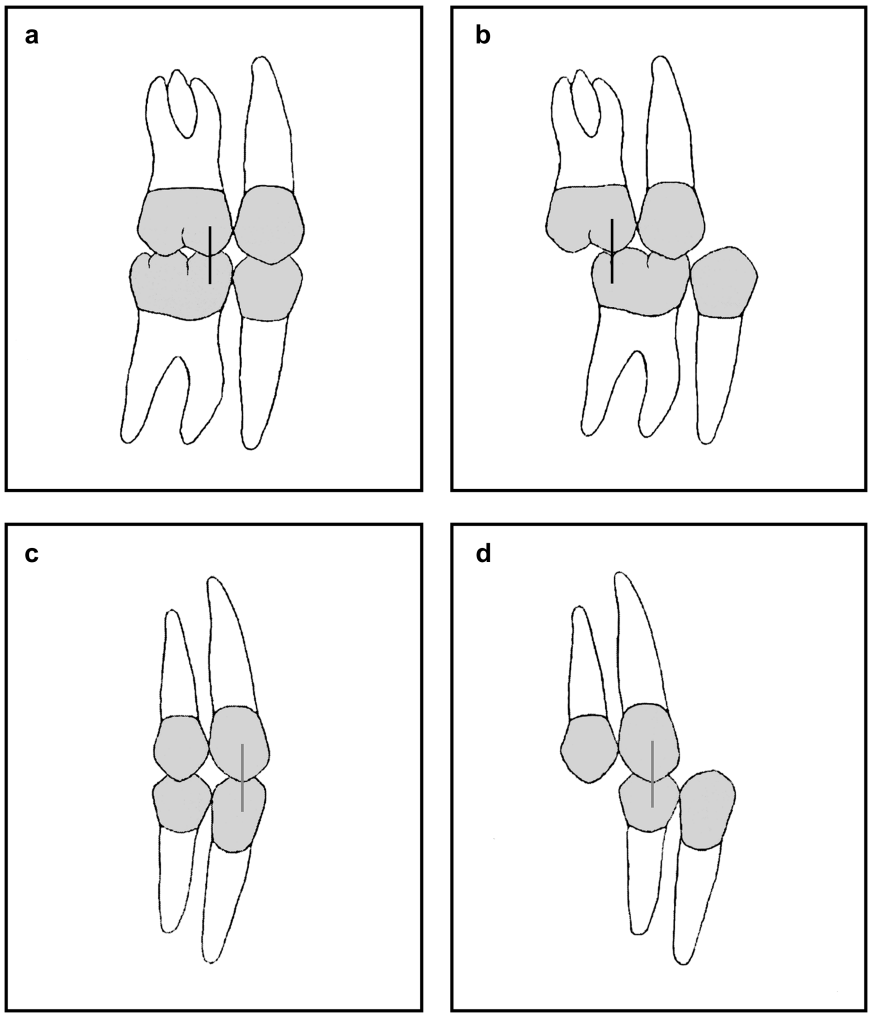

Figure 1 Classification of half-step molar and canine relationships. (a) Half-step Class II molar relationship, (b) half-step Class III molar relationship, (c) half-step Class II canine relationship, and (d) half-step Class III canine relationship.

half-step Class III (Figure 2a). Full-step asymmetries were prevalent in 2.4 per cent as Class II, 0.8 per cent as Class III, and 0.4 per cent as a combination of half-step Class II on one side and a half-step Class III on the other (Figure 2b). One and half-step asymmetry was found only in one subject (0.1 per cent) who had a half-step Class III on one side and full-step Class II on the other (Table 1). When comparing the Class II molar asymmetry (Figure 2a and 2b), it was found that the half-step Class II asymmetry was more than full-step asymmetry by a ratio of approximately 8:1.

In the canine region, half-step asymmetries were found in 33.4 per cent as half-step Class II and in 3.8 per cent as half-step Class III (Figure 2c). Full-step asymmetries were prevalent in 1.8 per cent as Class II, 1.2 per cent as Class III, and 1.0 per cent as a combination of half-step Class II one side and half-step Class III on the other (Figure 2d). One and half-step asymmetry was found only in two cases (0.2 per cent) which were found to have half-step Class II on one side and a full-step Class III on the other (Table 2). When comparing the Class II canine asymmetry (Figure 2c and 2d), it was found that the asymmetry of a half-step Class II was more than full-step by a ratio of about 18:1.

No gender differences were detected in prevalence or severity of occlusal asymmetries ($P > 0.05$).

Discussion

Asymmetric molar and canine relationships have caused a great deal of debate and differences in diagnostic interpretation in orthodontics (Siegel, 2002; Benson, 2003). These subdivision discrepancies provided the impetus to conduct this research on the existence, prevalence, and severity of molar and canine asymmetrical occlusions. The findings on the prevalence of different types of canine relationships may be considered of greater clinical

Table 2 Prevalence of all possible canine relationship scores in subjects judged to have a malocclusion without mesial molar migration (N = 1081).

Left/right quadrant	Left canine relationship (%)						Classification of asymmetries	Prevalence (%)
Right canine relationship	Canine classification	Class I	Half-step Class II	Full-step Class II	Half-step Class III	Full-step Class III	*Half-step asymmetries	37.2
	Class I	34.0	14.8*	1.2**	1.7*	0.4**	**Full-step asymmetries	4.0
	Half-step Class II	15.5*	21.2	1.6*	0.3**	0***	***One and one half-step asymmetries	0.2
	Full-step Class II	0.6**	1.5*	1.7	0***	0****	****Two full-step asymmetries	None
	Half-step Class III	1.6*	0.7**	0***	1.2	0.1*	Total asymmetries	41.4
	Full-step Class III	0.8**	0.2***	0****	0.4*	0.5	Total symmetrical relationship	58.6
							Total	100.0

*Half-step asymmetries, **Full-step asymmetries, ***One and one half-step asymmetries and ****Two full-step asymmetries.

significance than molar relationship. Canine relationships provide more relevant information on the severity of the malocculsion since the aim of everyday clinical practice is to achieve a stable and ideal Class I canine relationship.

To avoid bias due to the effects of untreated caries, subjects with mesial migration were eliminated from the sample. This made the findings on asymmetry independent of the effect of molar mesial migration. Exclusion of such cases could lead to underestimation of the total asymmetries relative to other reports. However, the findings on molar and canine asymmetry (29.7 and 41.4 per cent, respectively) are still higher than previously reported (Gábris *et al.*, 2006; Lux *et al.*, 2009).

This study on the full range of molar and canine relationship in five half-step categories allowed distinction between cases with mild, moderate, and severe occlusal asymmetries, unlike previous research where half-step molar relationship was rounded to the nearest full-step category according to Angle. Following this method, it was found that most of the asymmetries were within the range of mild (half-step asymmetries). In the canine region, half-step asymmetries were found to be approximately nine times more than canine full-step asymmeties (Table 2). For molar relationships, the total half-step asymmetries were about seven times more than molar full-step asymmetries (Table 1). A similar trend has been reported (Gábris *et al.*, 2006; Lux *et al.*, 2009). Those authors found half-cusp asymmetries to be more common than full-step asymmetries. Gábris *et al.* (2006) reported that a half-step anomaly in the antero-posterior molar relationship was more prevalent than a full-step anomaly (26.9 and 20.3 per cent, respectively) in an Hungarian population using the World Health Organization questionnaire. Similarly, Lux *et al.* (2009) reported a half-step malocclusion to be more common than a full-step malocclusion in 494 German school children. Harris and Bodford (2007) derived from their study that bilateral asymmetry is widespread in orthodontic patients; magnitudes of most asymmetries were found in all three categories of Angle's classification and asymmetries were greatest in subjects with severe Class II malocclusions.

A further important observation of the present study was that a combination of a full-step Class II on one side with a full-step Class III on the other, which was defined as a two full-step asymmetry, was not found in the molar region. However, five subjects (0.5 per cent) presented with a half- or full-step Class II molar relationship on one side combined with a half-step Class III on the other. These cases are indefinable according the current use of Angle's classification system. Similarly, a combination of a full-step Class II on one side with a full-step Class III on the other in the canine region was not found. However, 14 cases (1.2 per cent) had a half- or full-step Class III canine relationship on one side combined with a half-step Class II on the other.

In agreement with other related reports (Katz, 1992; Siegel, 2002; Benson, 2003; Snyder and Jerrold, 2007; Staudt and Kiliaridis, 2009), the relevant findings of this

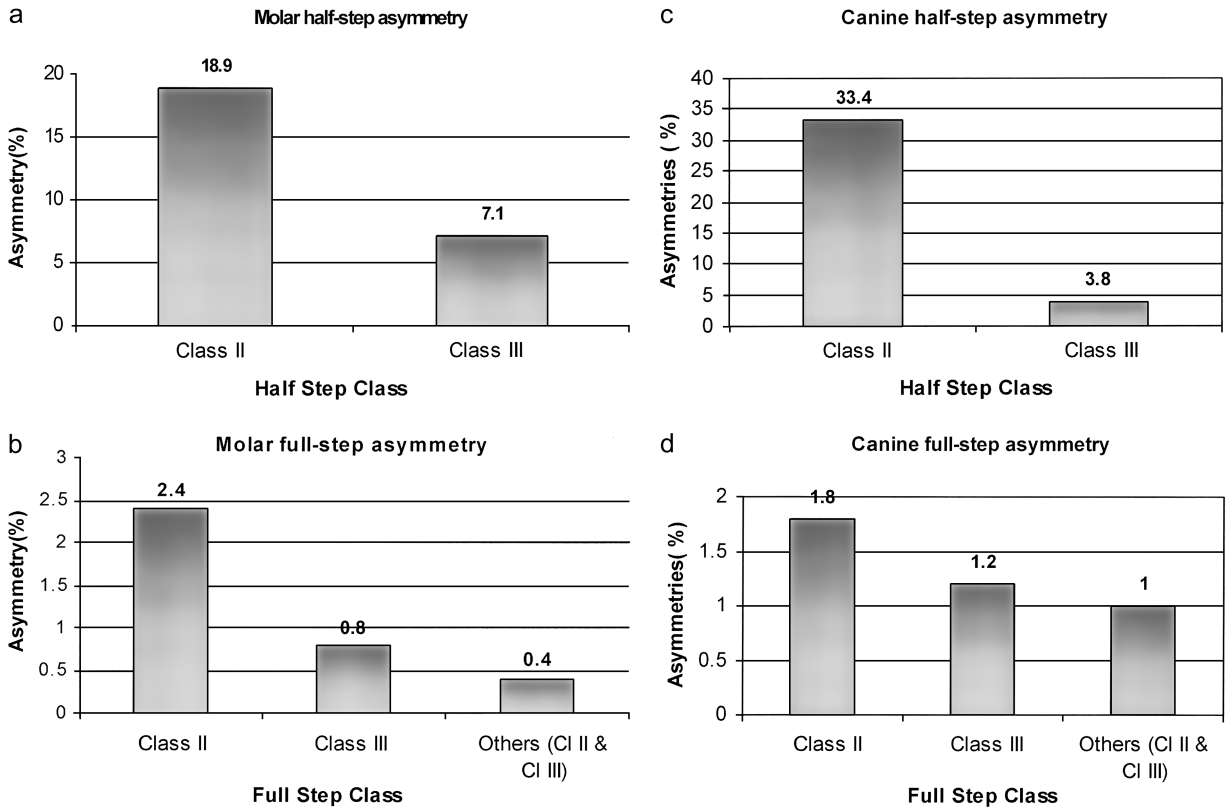

Figure 2 Prevalence of (a) Class II and Class III half-step molar asymmetries, (b) Class II and Class III full-step and one and a half-step molar asymmetries, (c) Class II and Class III half-step canine asymmetries, and (d) Class II and Class III full-step and one and a half-step canine asymmetries.

study suggest the need for a more precise classification system which could incorporate the canine relationship, half-step molar relationship, and moderate to severe asymmetric malocclusions.

The present study did not focus on the complex relationship between treatment need and various aspects of malocclusion but aimed to provide a detailed insight into the distribution of clinically relevant dental asymmetric traits, particularly in the sagittal relationship. It also did not focus on the complex relationship of facial, skeletal, and dentoalveolar asymmetries but the prevalence of occlusal sagittal asymmetries.

Conclusions

The results of this research indicate that the total asymmetric relationships were 29.7 and 41.4 per cent in the molar and canine areas, respectively. Mild asymmetric molar and canine relationships are significantly more common than the moderate and severe deviations. For molar relationships, total half-step asymmetries were approximately seven times more frequent than molar full-step asymmetries. In the canine region, half-step asymmetries were about nine times more prevalent than canine full-step occlusions. A half-step Class II canine asymmetry outweighed a full-step anomaly by a ratio of approximately 18:1. A Class II half-step molar asymmetry was a more frequent finding than a full-step by a ratio of about 8:1. Class II half and full-step asymmetries are more prevalent than Class III asymmetries in the molar and canine regions. No cases were found to have two full-step asymmetry in the molar or canine areas.

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