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Morphometric parameters of the glenoid labrum

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SUMMARY

The glenoid labrum has an important role in glenohumeral joint stability, yet its morphometric parameters are seldom reported. This study aimed to (i) investigate the thickness and height of the glenoid labrum, and (ii) determine whether there is any significant difference between side and sex. A total of 140 shoulders (30 male and 40 female cadavers, average age of 81.5 years) were obtained for this study. All muscles and blood vessels surrounding the glenohumeral joint, as well as the fibrous capsule, were inspected and then removed to expose the glenoid fossa with the labrum attached. Measurement of labral height and thickness at the superior (12 o'clock), anterior (3 o'clock), inferior (6 o'clock) and posterior (9 o'clock) regions were taken.

Gender, side and thickness and height measurements of the glenoid labrum were double- entered into the Statistical Package for Social Sciences. ANOVA and MANOVA tests were conducted to determine statistical significance, which was set at $P<0.05$. Significant differences in thickness (at the superior, inferior and posterior aspects) and height (at the superior and inferior aspects) of the glenoid labrum were observed between males and females, being thicker and taller in males in all regions. Based on the side of the limb, no differences in labral thickness and height were observed with respect to side. The current observations confirm that the glenoid labrum height and thickness are associated with sex, but not with side.

Key words: Glenoid labrum – Glenoid fossa – Scapula

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INTRODUCTION

The oval glenoid fossa is effectively deepened by a fibrocartilaginous rim, the glenoid labrum (Snell, 1995; Drake et al., 2005; Palastanga et al., 2006; Sinnatamby, 2006), which gives attachment to the long head of biceps and triceps tendons as well as facilitating anchoring capsuloligamentous structures to the glenoid bone (Williams, 1995; Palastanga et al., 2006; Di Giacomo et al., 2008). The labrum extends the articular surface and increases the depth of the glenoid cavity thereby protecting the articular surface and assisting in joint lubrication. The labrum readily yields to the impact and compression of the humeral head against the glenoid cavity without any restriction to free movement at the joint (Williams, 1995; Smith et al., 1983; Robinson, 1992). Howell and Galinat (1989) give one function of the glenoid labrum as enhancing glenohumeral joint stability by deepening the socket. The glenoid fossa and labrum provide a socket deeper superoinferiorly (9 mm) than anteroposteriorly (5 mm), with the labrum contributing 50% circumferentially, which could be an important factor in shoulder stability. A Bankart lesion, for example, could decrease the depth of the anterior glenoid labrum by 50%: consequently, it has been suggested that a loose glenoid labrum could cause glenohumeral instability. According to Lippitt and Masten (1993), the concavity compression stabilization of the glenohumeral joint is enhanced by increasing both the magnitude of the compressive load, as a result of dynamic muscle contraction, and glenoid cavity depth. The existence of an intact glenoid labrum is therefore important for concavity compression, as well as scapulohumeral balance, which also leads to further stabilization of the glenohumeral joint. The effect of the glenoid labrum and movement of the arm on stability of the glenohumeral joint has been quantified using a

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concavity-compression technique: the average glenoid labrum contribution to stability being 10% (Halder et al., 2001).

Although the important function of the glenoid labrum in shoulder joint stability is recognised, its morphometric parameters are seldom reported. The aim of the current study was to (i) investigate the thickness and height of the glenoid labrum, and (ii) determine whether there are differences between side and sex.

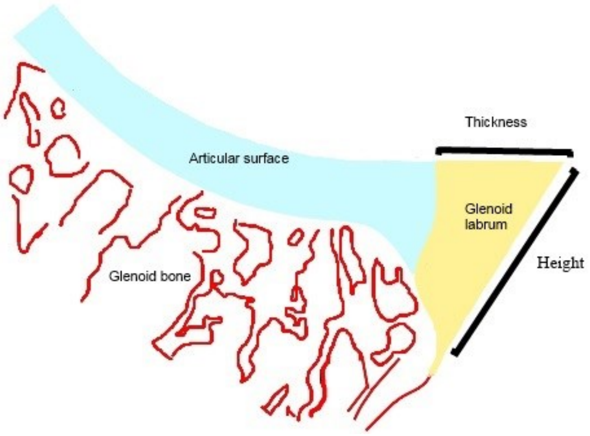

Fig 1. Measurements of glenoid labrum thickness and height.

MATERIALS AND METHODS

A total of 220 cadaveric shoulders from 58 males and 59 females, with a median age of 82 years (range, 53-102 years), were obtained from the Centre for Anatomy and Human Identification University of Dundee: they were obtained in accordance with the Human Tissue Act 2006. Macroscopically normal shoulder joints were selected for this study – i.e., shoulders from 30 male and 40 female cadavers, with an average age of 81.5 years (range, 53-101 years) with signs of previous surgery, fracture or pathology were excluded. Of the total, 140 shoulders were selected for the study.

All muscles and blood vessels surrounding the glenohumeral joint, as well as the fibrous capsule, were inspected and then carefully removed to expose the glenoid fossa with the glenoid labrum

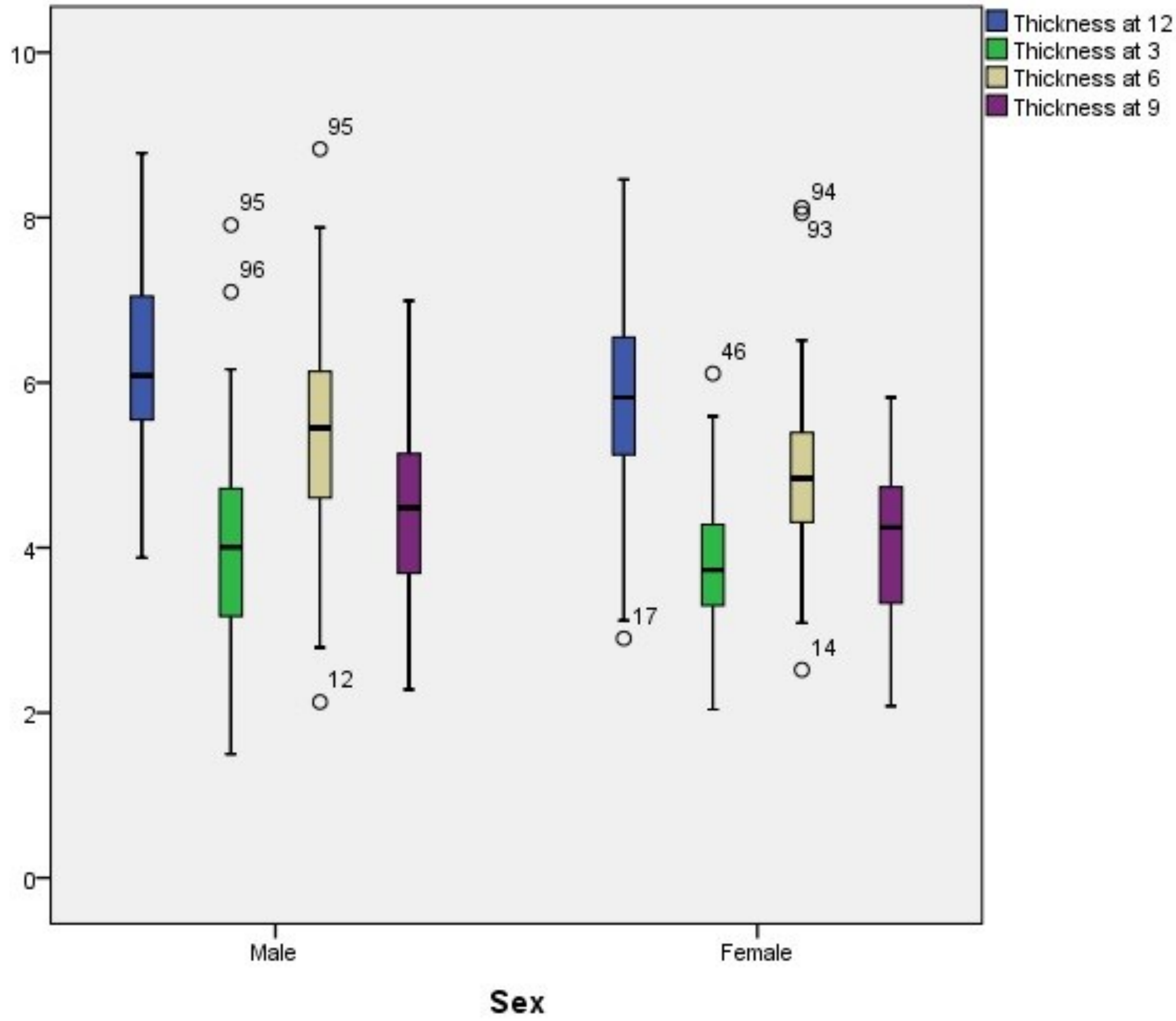

Fig 2. Distribution of glenoid labrum thickness at 12, 3, 6 and 9 o'clock in males and females.

Table 1. The thickness (mm) and height (mm) of the glenoid labrum with respect to gender.

		N	Mean	Std. Deviation	Minimum	Maximum	*P*
Thickness at 12 o'clock	Male	60	6.30	1.089	3.88	8.78	0.009
	Female	80	5.80	1.104	2.90	8.46	
	Total	140	6.02	1.121	2.90	8.78	
Thickness at 3 o'clock	Male	60	4.06	1.178	1.50	7.91	0.180
	Female	78	3.84	0.800	2.04	6.11	
	Total	138	3.94	0.985	1.50	7.91	
Thickness at 6 o'clock	Male	60	5.45	1.184	2.13	8.83	0.003
	Female	80	4.91	0.961	2.52	8.12	
	Total	140	5.14	1.092	2.13	8.83	
Thickness at 9 o'clock	Male	60	4.57	1.139	2.28	6.99	0.005
	Female	80	4.09	0.864	2.08	5.82	
	Total	140	4.29	1.015	2.08	6.99	
Height at 12 o'clock	Male	60	6.25	0.976	4.05	8.73	0.002
	Female	80	5.74	0.940	3.36	7.80	
	Total	140	5.96	0.986	3.36	8.73	
Height at 3 o'clock	Male	60	3.68	0.837	.72	5.44	0.552
	Female	78	3.60	0.613	2.23	5.51	
	Total	138	3.63	0.717	.72	5.51	
Height at 6 o'clock	Male	60	3.90	0.665	1.72	5.43	0.010
	Female	80	3.62	0.617	2.07	4.84	
	Total	140	3.74	0.651	1.72	5.43	
Height at 9 o'clock	Male	60	3.88	0.535	2.66	5.22	0.535
	Female	80	3.82	0.703	2.46	5.72	
	Total	140	3.85	0.635	2.46	5.72	

attached. The thickness and height of the glenoid labrum (Fig. 1) were measured using digital callipers at the superior (12 o'clock), anterior (3 o'clock), inferior (6 o'clock) and posterior (9 o'clock) regions.

The sex, side and both thickness and height of the glenoid labrum were double-entered into Statistical Package for Social Sciences (Version 21). ANOVA and MANOVA tests were conducted to determine statistical significance, which was set at P<0.05.

RESULTS

The total number of specimens was 140 shoulders from 30 male and 40 female cadavers with a mean age of 81.5 (standard deviation 9.81) years. Based on sex and side the thickness of the glenoid labrum varied, with the thickest part superiorly and thinnest at anteriorly. There were differences in thickness between males and females, being thicker in males in all the regions (Table 1, Fig. 2): the difference was significant superiorly (P=0.009), inferiorly (P=0.003) and posteriorly (P=0.005), but not anteriorly (P=0.180). The glenoid labrum was absent anteriorly in two female right shoulders (1.42%). Based on the side of the limb, no significant differences in labral thickness was observed with respect to side (Table 2, Fig. 3).

Based on sex and side, the height of the glenoid labrum was variable. The tallest part of the glenoid labrum was superior and the shortest anterior (Table 1). There was a difference in height between males and females, being taller in males in all regions: the differences were significant superiorly (P=0.002) and inferiorly (P=0.010), but not anteriorly or posteriorly (P=0.552 and P=0.535 respectively). Based on the side of the limb, no significant differences in labral height was observed with respect to side (Table 2).

DISCUSSION

The present study has determined the relation between the thickness and height of superior, anterior, inferior and posterior aspects of the glenoid

Table 2. The thickness (mm) and height (mm) of the glenoid labrum in relation to side.

		N	Mean	Std. Deviation	Minimum	Maximum	p
Thickness at 12 o'clock	Right	70	5.95	1.186	2.90	8.78	>0.005
	Left	70	6.09	1.055	3.12	8.53	
	Total	140	6.02	1.121	2.90	8.78	
Thickness at 3 o'clock	Right	68	3.98	0.960	1.86	7.91	>0.005
	Left	70	3.90	1.014	1.50	7.10	
	Total	138	3.94	0.985	1.50	7.91	
Thickness at 6 o'clock	Right	70	5.13	1.088	2.79	8.83	>0.005
	Left	70	5.15	1.103	2.13	8.05	
	Total	140	5.14	1.092	2.13	8.83	
Thickness at 9 o'clock	Right	70	4.29	1.052	2.28	6.99	>0.005
	Left	70	4.30	0.984	2.08	6.68	
	Total	140	4.29	1.015	2.08	6.99	
Height at 12 o'clock	Right	70	5.83	0.972	3.36	7.77	>0.005
	Left	70	6.08	0.991	4.05	8.73	
	Total	140	5.96	0.986	3.36	8.73	
Height at 3 o'clock	Right	68	3.71	0.744	.72	5.51	>0.005
	Left	70	3.56	0.687	1.89	5.11	
	Total	138	3.63	0.717	.72	5.51	
Height at 6 o'clock	Right	70	3.72	0.648	1.72	4.90	>0.005
	Left	70	3.76	0.658	2.07	5.43	
	Total	140	3.74	0.651	1.72	5.43	
Height at 9 o'clock	Right	70	3.78	0.575	2.70	5.72	>0.005
	Left	70	3.91	0.688	2.46	5.40	
	Total	140	3.85	0.635	2.46	5.72	

labrum and sex and side. The thickness and height of these four regions varied with gender, with significant differences in thickness being observed at the superior (p=0.009), inferior (p=0.003) and posterior (p=0.005) aspects between males and females, being thicker in males in all regions. The thickest part of the glenoid labrum was superior (6.01 mm) and thinnest anterior (3.93 mm). A significant difference in height superiorly and inferiorly between males and females was also observed, being taller in males in all the regions. The highest part of the glenoid labrum was superior (5.95 mm) and the shortest anterior (3.63 mm). The glenoid labrum has been reported to increase the width of the glenoid fossa by about 4 mm (12) and its depth by 4 mm (Palastanga et al., 2006; Smith et al., 1983). Howell and Galinat (1989) state that the glenoid labrum increases the depth of the glenoid fossa by 9 mm superoinferiorly and 5 mm anteroposteriorly, contributing to the overall circumferential depth by 50%. Hata et al. (1992) reported that the anterior and inferior aspects of the glenoid labrum were the largest. Despite the thicker and taller labrum in males Zacchilli and Owens (2010) reported that glenohumeral joint dislocation was more common in males.

A major advantage of the current study was the large sample size (n=140 shoulders) and the use of gross dissection: these two elements enhance the investigation by decreasing the risk of bias. The current observation shows that there was no significant difference in the labral thickness or height and side, thus supporting Chalidis et al. (2007) who, on the basis of side and dominance, reported no correlation with glenohumeral joint dislocation.

Several studies (Mallon et al., 1992; Walch et al., 1999; Churchill et al., 2001; Nyffeler et al., 2003; Kwon et al., 2005; Rouleau et al., 2010; Iannotti et al., 2012) report that glenoid fossa version is posterior (i.e. retroversion), with a mean value of between 1° and 17.9°. Thomas et al. (2012) observed that the dominant arm was significantly more retroverted than the non-dominant arm. Both Churchill et al. (2001) and De Wilde et al. (2010) reported that mean glenoid inclination for males was 4° superior (range 7° inferior to 15.8° superior) and for females was 4.5° superior (range 1.5° inferior to 15.3° superior). They also have highlighted that the angle of glenoid inclination varied significantly between race and gender. Taken together, the glenoid labrum heights and thicknesses of the current finding in which the superior glenoid labrum were greater than the inferior, and the pos-

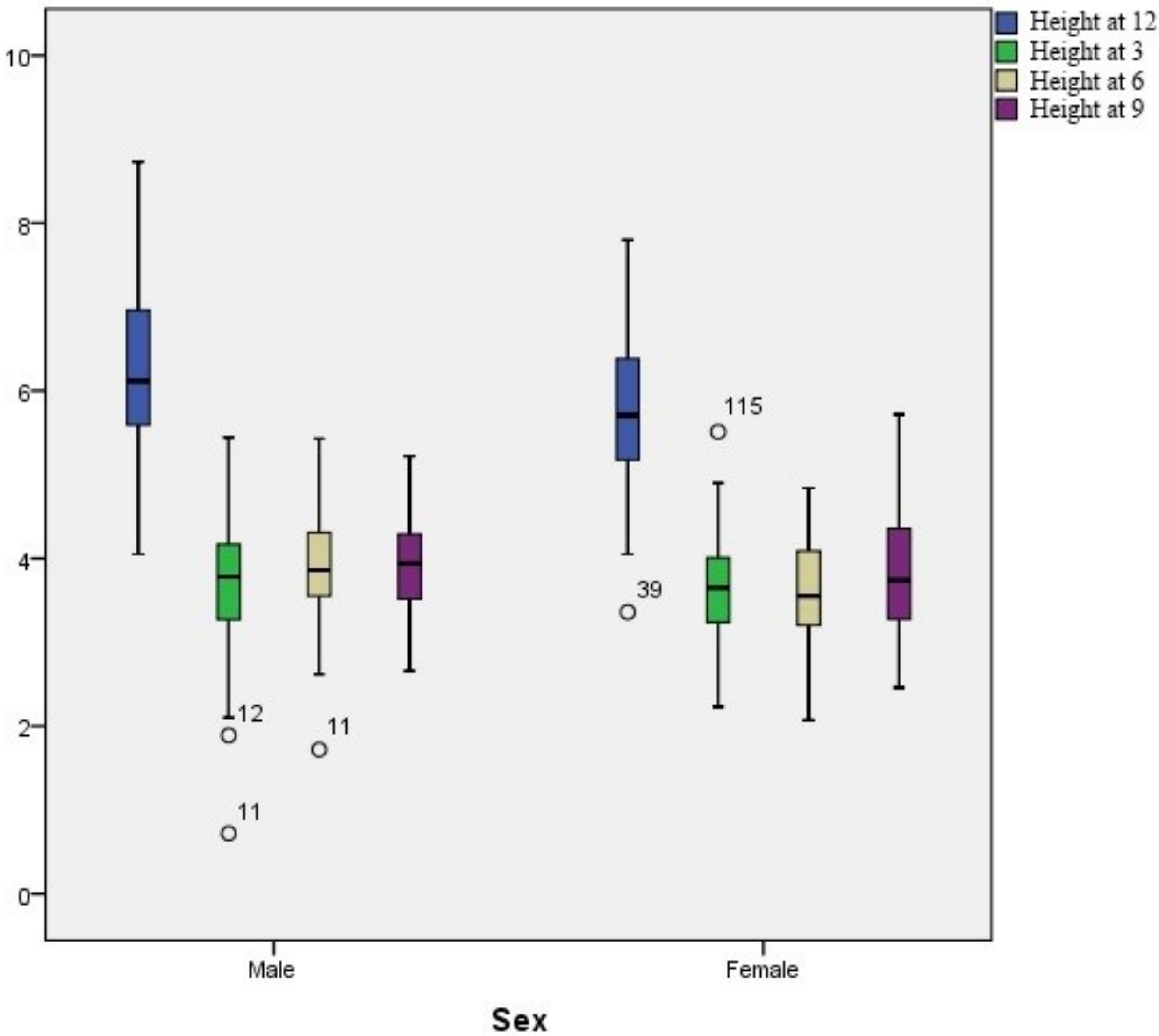

Fig 3. Distribution of glenoid labrum height at 12, 3, 6 and 9 o'clock in males and females.

terior glenoid labrum were greater than the anterior. As the glenoid is retroverted and glenoid inclination is superior, a correlation between the dimensions of the glenoid labrum and the angles of version and inclination suggests that there could be a linear relationship between them to compensate the differences observed.

From the observations of the current study with labral thickness and height being the shortest anteriorly, the reason for the high incidence of anterior glenohumeral dislocation could be explained. This supports the reports of Bankart (1923), Ufberg et al. (2004), Chechik et al. (2010) and Gutierrez et al. (2012), who all state that anterior dislocation accounts for the majority of glenohumeral dislocations. In contrast, Palastanga et al. (2006) and Sinnatamby (2006) postulate that, due to the presence of the rotator cuff muscles, the anterior dislocation is less frequent. Several studies (Wheeler et al., 1989; Bottoni et al., 2002; Te Slaa et al., 2003; Jakobsen et al., 2007; Auffarth et al., 2013; Milgrom et al., 2014) have reported that recurrence after first time traumatic anterior glenohumeral dislocation is common with a rate in young athletics of up to 92%. Kim et al. (2010) state that the incidence of anteroinferior glenoid labrum lesion in first time dislocation is 66.6% (n=22) and 98.1% (n=109) in recurrent dislocation. However, other factors could also contribute in anterior dislocation of the shoulder joint such as types of glenoid notch (Alashkham et al., 2017).

Posterior dislocation is not common, occurring in only 4% of all dislocations of the glenohumeral joint: the main underlying factor being that the glenoid fossa faces anterolaterally, and therefore counteracts any direct posterior force. In addition, infraspinatus and teres minor play a significant role in supporting the joint capsule posteriorly. Although posterior dislocation of the shoulder joint can occur if a posterior thrust along the long axis of the humerus is applied during abduction and medial rotation of the arm (Palastanga et al., 2006; Norman et al., 1963; Nobel et al., 1969; Eye-Brook, 1972; Hawkins, 1987; Cicak, 2004; Robinson, 2005; Dlimi et al., 2013), in this position the humeral head is directed more posteromedial, and is therefore more liable to dislocate by applying an external trauma to the anterior aspect of the glenohumeral joint. The current study believes that, as the glenoid fossa faces anterolaterally and the humeral head posteromedially, direct trauma could lead to dislocation of the humeral head posteriorly. Compared to the anterior aspect of the glenohumeral joint, the posterior aspect of the fibrous capsule is not supported by glenohumeral ligaments; in addition, glenoid and humeral version are anterolateral and posteromedial respectively. Nevertheless, and despite the presence of the anterior glenoid notch, the incidence of posterior dislocation is still less than that anteriorly. Furthermore, the posterior labrum is also thicker and taller than the anterior. These factors could all contribute to the decreased incidence of posterior dislocation. Due to the lack of the medical history of the specimens examined in the current study, it was not possible to correlate labral thickness and height with glenohumeral joint instability. Further study is recommended to determine if an association exists between glenoid labrum thickness and height and joint instability.

Conclusion

The current study was undertaken to investigate the relationship between the thickness and height of the superior, anterior, inferior and posterior aspects of the glenoid labrum with sex and side. Significant differences in thickness (at the superior, inferior and posterior aspects) and height (at the superior and inferior aspects) of the labrum between males and females were observed, being thicker and taller in males in all regions. No difference in labral thickness and height and side were observed. Further study is recommended to determine if there is a correlation between labral thickness and height and glenohumeral joint stability and/or dislocation.

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