Anterior Inferior Bone Grafting Can Restore Stability In Osseous Glenoid Defects

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The glenoid fossa plays a major role in stabilizing the humeral head. Glenohumeral instability associated with a significant osseous defect of the glenoid is often treated with bone grafting to restore the glenoid concavity. The shape and positioning of the graft is critical: a graft that encroaches on the extrapolated glenoid curvature can prevent the head from seating completely in the glenoid, while a graft that is too far from the curvature does not restore the glenoid concavity. The purpose of this study is to investigate the effects on the stability provided by the glenoid of (a) a standardized anteroinferior glenoid defect and (b) different configurations of anteroinferior glenoid bone graft.

Methods

Each of four fresh cadaveric shoulders was potted in plaster in a metal frame so that the glenoid face was oriented parallel to floor facing upwards. The anteroinferior stability provided by the glenoid was quantitated by measuring the balance stability angle in that direction, that is the maximal angle that the glenoid could be tipped in the anterior inferior direction before a ball placed in the concavity dislocated over the lip. (Figure 1 A-C). The anteroinferior stability was assessed in each glenoid (1) in the unaltered state, (2) after creating a standardized defect of a magnitude reported by other investigators to be sufficient to require a bone graft, and (3) after each step of a series of procedures providing varying height and contour of bone graft.

The defect size and orientation was standardized using the parameters suggested by Itoi et al. The superior inferior glenoid length was measured for each glenoid. The length measurement was then multiplied by .21 to determine the defect size to be created along a line inclined 45 degrees from the centerline to the anteroinferior border of the glenoid with the apex at 4:30 or 7:30 depending on whether a right or left glenoid was utilized. The length of the glenoids ranged from 32 mm to 34 mm. All defects created were 7mm in maximal width (from 20.5% to 21.9% of the glenoid face length) (Figure 2 A and B).

Reconstruction of the glenoid defect with a bone block was accomplished by using a block measuring 20mm length x 25mm height x 8 mm wide. For convenience, this graft was harvested from the tip of the scapula, recognizing that in the clinical situation the graft is harvested from the iliac crest or obtained as an allograft. Each glenoid was grafted with bone harvested from its scapula. Once the stability was quantitated for the normal glenoid and for the glenoid with the standardized defect, the reconstruction was undertaken. The uncontoured bone block was secured to the defect using two 3.5mm cannulated screws placed through the graft and into the native glenoid subchondral bone (Figure 2C). The graft was initially placed at a height of 8mm above the glenoid face.

The anterior inferior balance stability angle was measured three times for each of the four glenoids for each preparation. The average of the three trials was used as the value for each specific preparation of each glenoid: native, after creation of the defect, 8 mm graft (uncontoured) (Fig 3A), 8 mm graft (contoured), 6 mm graft (contoured) (Figure 3B), 4 mm (contoured), 2 mm (contoured) and flush with the glenoid face. Contouring was performed as a surgeon would perform it in the operating room, shaping the bone graft by eye to match the curvature of the ball using

Figure 1 A, B, C: Measurement of balance stability angle. Three consecutive frames from the video recording of a glenoid being tipped at a constant rate. Note that within these three frames the ball moves from being centered (A), to moving over the lip (B), to dislocation (C). The balance stability angle is the angle of tip at which dislocation occurs.

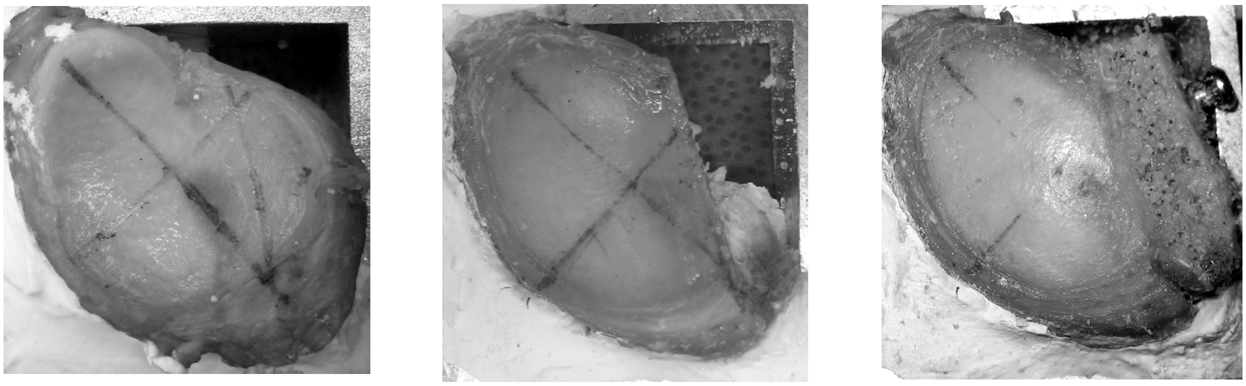

Figure 2 A, B, C: Creation of the anterior inferior glenoid defect. A. A normal glenoid. B. A glenoid with the standard defect. C. A glenoid with a graft.

a pinecone burr. The contouring of the graft was performed *in situ* without removing the screws. Physiologic saline was applied to the glenoid face between trials to prevent desiccation.

The glenoids were also observed to confirm the graft height at which contact of the ball with the graft was eliminated allowing the ball to seat in the reconstructed glenoid.

Results

The results are summarized in the Table. The balance stability angles were reproducible (within one degree) across all trials for each preparation of each glenoid. The average stability angle of the native glenoids was 26 degrees with a significant decrement to 14 degrees when the defect was created (p = .006). An uncontoured graft placed at 8mm had an average stability angle of 31 degrees which, when contoured, increased the average stability angle to 46 degrees. The increase in stability over the glenoid with the standardized defect was particularly marked for contoured graft heights of 6mm and 8mm, where the increases were 250% (p .001) and 330% (p .00025), respectively, while those with a graft height of 4mm approached significance (p .062). The average stability angle of the glenoids with the contoured graft placed at 4mm was almost 5 degrees greater than that of the native glenoid while a graft height of 2mm showed an average stability angle within .4 degrees of the native glenoid.

The ball was observed to be perched on the graft and posterior glenoid at graft heights of greater than or equal to 6mm. Contouring of the graft was helpful in minimizing the potential for unwanted contact between the ball and the graft.

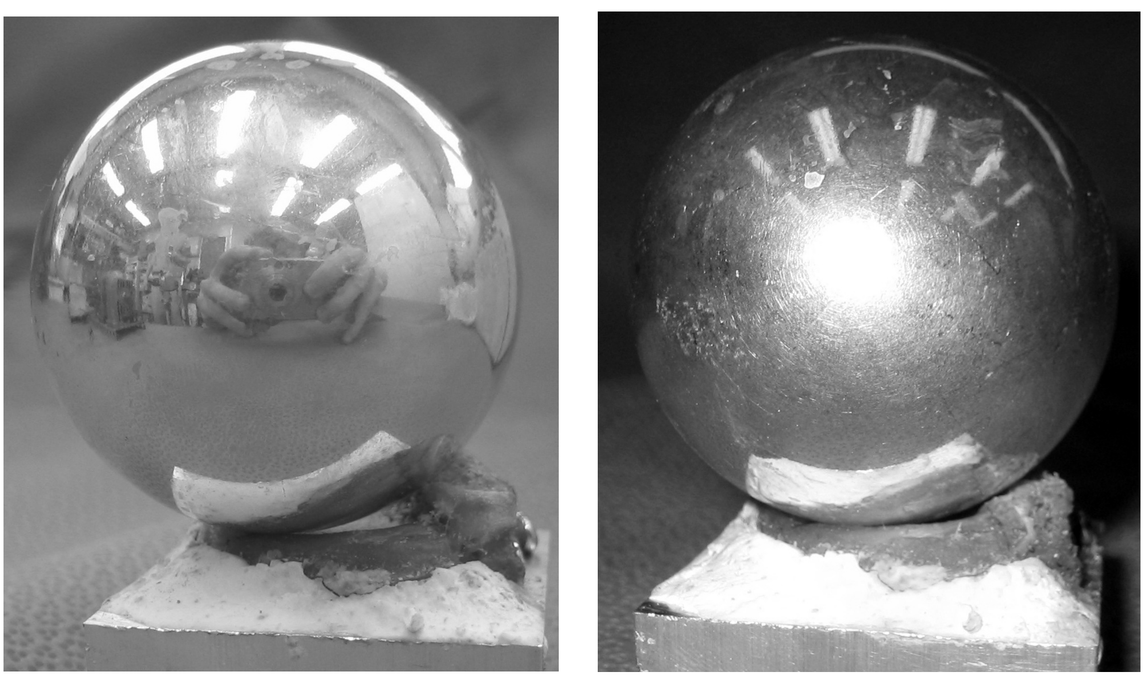

Figure 3 A, B: Relation of graft to the contour of the glenoid and the ball. A. An 8 mm uncontoured graft. B. A 6 mm contoured graft.

GLENOID #	Native	Defect	8mm Uncontoured	8mm Contoured	6mm Contoured	4mm Contoured	2mm Contoured	Flat
1	29	11	23	42	32	31	28	24
2	24	13	32	49	38	34	27	21
3	28	17	26	49	36	32	24	21
4	24	15	44	44	33	27	25	22
Ave	26	14	31	46	35	31	26	22
Std Dev	2	2	9	4	3	3	2	1
p for difference from initial		0.006	0.473	0.004	0.027	0.062	0.790	0.018
p for difference from defect			0.033	0.000	0.001	0.004	0.012	0.021

Table 1: Balance Stability Angles of Differing Glenoid States.

Conclusion

A bony defect can significantly compromise the anteroinferior instability provided by the glenoid. The lost stability can be restored by bone grafting. The effectiveness of the graft in restoring the lost stability is related to both its height and to the extent to which it is contoured as long as the graft is not so prominent that it forces the ball posteriorly from the center of the glenoid.

Recommended Reading

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