JSES International 7 (2023) 121–125

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Anterior glenoid rim erosion in the early stage after arthroscopic Bankart repair affects postoperative recurrence

Takehito Hirose, MD, PhD[a,*], Shigeto Nakagawa, MD, PhD[b], Hiroto Hanai, MD, PhD[c], Ryuji Nishimoto, MD[d], Naoko Mizuno, MD[e], Makoto Tanaka, MD, PhD[f]

[a]Department of Orthopaedic Surgery, Daini Osaka Police Hospital, Osaka, Osaka, Japan
[b]Department of Orthopaedic Sports Medicine, Yukioka Hospital, Osaka, Osaka, Japan
[c]Department of Orthopaedic Surgery, Graduate School of Medicine, Osaka University, Suita, Osaka, Japan
[d]Department of Orthopaedic Surgery, JCHO Osaka Hospital, Osaka, Osaka, Japan
[e]Department of Orthopaedic Surgery, Toyonaka Municipal Hospital, Toyonaka, Osaka, Japan
[f]Center for Sports Medicine, Daini Osaka Police Hospital, Osaka, Osaka, Japan

ARTICLE INFO

Keywords:
Glenoid rim erosion
Glenoid rim resorption
Anterior shoulder instability
Bankart repair
Recurrence
Risk factor
Computed tomography

Level of evidence: Level III; Retrospective Case Control Design; Prognosis Study

Background: Recent studies reported that anterior glenoid rim erosion can occur in the early period after arthroscopic Bankart repair (ABR) for traumatic anterior shoulder instability. However, it is unknown whether such erosion is a risk factor for postoperative recurrence. This study evaluated risk factors for postoperative recurrence after ABR, specifically aiming to elucidate whether reduction of postoperative glenoid width due to anterior glenoid rim erosion is one of such factors.
Methods: A total of 220 shoulders that underwent ABR alone between 2013 and 2020 were retrospectively investigated. Patient age at surgery, whether the patient was a collision/contact athlete, anchor placement, preoperative glenoid bone defect (%), localization of the Hill-Sachs lesion, and change of glenoid width (%) in the 6 months after surgery were investigated for their statistical relation to recurrence by univariate and multiple logistic regression analysis.
Results: Postoperative recurrence occurred in 32 of 220 shoulders (14.5%). In univariate analysis, being a collision/contact athlete was the only variable with a significant effect on recurrence (odds ratio [OR], 2.555; 95% confidence interval [CI], 1.123-5.814; $P = .03$). Change of glenoid width reduction was larger in those with recurrence than without recurrence, but the difference was not statistically significant ($-7.0 \pm 6.6\%$ vs. $-5.0 \pm 9.3\%$; $P = .14$). However, in multivariate logistic analysis, preoperative glenoid bone defect (%) (adjusted unit OR, 1.076; 95% CI, 1.018-1.137; $P = .010$) and postoperative change of glenoid width (%) (adjusted unit OR, 0.946; 95% CI, 0.900-0.994; $P = .028$) had a significant influence on postoperative recurrence.
Conclusion: Glenoid width reduction due to anterior glenoid rim erosion after ABR is a risk factor for recurrence.

Various factors have been reported to be associated with recurrence after arthroscopic Bankart repair (ABR) for traumatic anterior shoulder instability, including younger age,[21,26,31] sports with collision or contact,[3,8,16,21] preoperative glenoid defect size[1-3,21,27,31] and localization of bone defect of the humeral head (ie; Hill-Sachs lesion (HSL)).[1,15,28,31] Of these factors, preoperative glenoid bone defect size may be the most relevant, with biomechanical studies demonstrating that a defect of over 20% significantly decreases anterior stability.[12,27,29] Accordingly, depending on the extent of anterior glenoid bone loss, surgeons may need to change the surgical procedure from ABR alone to performing coracoid transfer or some augmentation techniques.[6,13] Thus, quantitative preoperative morphological evaluation of bone loss in the affected shoulders by imaging modalities such as computed tomography (CT) or magnetic resonance imaging is an essential step in the current treatment strategy for traumatic anterior shoulder instability.[17,19,25]

However, recent studies have raised new concerns that may affect the outcome after ABR.[9,10] An earlier study indicated that glenoid bone loss can occur not only preoperatively but also

This study was approved by the Institutional Review Board of the Academic Clinical Research Center of Yukioka Hospital (ID number of the approval 13 – 006) and all subjects provided written informed consent.

*Corresponding author: Takehito Hirose, MD, PhD, Department of Orthopaedic Surgery, Daini Osaka Police Hospital, 2-6-40 Karasugatsuji, Tennoji-ku, Osaka-shi, Osaka 543-8922, Japan.
E-mail address: hiroset511@gmail.com (T. Hirose).

https://doi.org/10.1016/j.jseint.2022.10.005
2666-6383/

postoperatively. In other words, the authors revealed that anterior glenoid rim erosion can progress within 6 months after ABR. Postoperative glenoid rim erosion has been shown to occur in up to 54% of patients without a preoperative bony Bankart lesion. On the other hand, another study conversely advocated no erosive change after ABR, suggesting still controversial over this morphological change.[18] If this negative morphological change actually does occur, there is some concern whether it affects postoperative recurrence.[9] However, to date, no studies have specifically evaluated whether postoperative bone loss may be a risk factor for recurrence after ABR. Therefore, the purpose of this study was to elucidate the risk factors for recurrence after ABR alone, including anterior glenoid rim erosion in the early period after surgery. Our hypothesis was that glenoid rim erosion after ABR has a significant negative influence on postoperative recurrence.

Methods

The study population consisted of consecutive patients who underwent ABR for traumatic anterior shoulder instability between January 2013 and July 2020 and had a minimum follow-up of 2 years. The study exclusion criteria were as follows: ABR combined with the open Bristow procedure (mainly for collision/contact athletes with a large glenoid defect); combined posterior labrum repair for posterior instability or multi-directional instability; isolated capsular repair or humeral avulsion of the glenohumeral ligament repair; ABR performed with anchors other than JuggerKnot (Zimmer-Biomet Corporation, Warsaw, IN, USA); and revision surgery for recurrence. Patients who missed either the preoperative and postoperative CT scan of the glenoid and the humeral head or who underwent the first postoperative CT more than 6 months after surgery were also excluded. The study was approved by our institutional review board and ethics committee, and written informed consent was obtained from all participants before treatment.

Surgical procedure and postoperative rehabilitation

The same orthopedic surgeon performed all surgical procedures in this series. Labral repair was finished by the single-row suture anchor technique with at least five 1.4-mm JuggerKnot anchors (single loaded) in simple suture manner. Sutures were passed through the capsule-labral complex and tied with sufficient tension so that the complex was reattached at least 1 hour above its detached position. In patients with a relatively large bony Bankart lesion, the bone fragment was reduced by passing sutures through it, but in patients with a small bone fragment, the fragment was carefully preserved and sutured together with the capsule-labral complex. In this study series, 2 different anchor placements were applied at the time of suture anchor insertion; on-the-face anchoring was used until the end of March 2018, and on-the-edge anchoring thereafter. In patients with on-the-face anchoring, articular cartilage around the anterior glenoid rim was carefully removed with a radiofrequency device, and a 3- to 4-mm-wide trough was created. Then, anchors were inserted into the glenoid just posterior to the trough. This technique was used to encourage bleeding from the subchondral bone and allow the repaired soft tissue to heal sufficiently to the bone.[4] In addition, this approach also has the advantage that it increases the height of the repaired labrum.[24] On the other hand, in patients with on-the-edge anchoring, anchors were inserted as anteriorly as possible on the glenoid edge, and the minimum amount of anterior cartilage was removed to expose the bone edge of the anchor insertion site. This technique was adopted because of findings that it may protect against postoperative erosive change of the glenoid rim by reducing stress shielding around the rim.[11] We did not use the remplissage technique in any patients. After surgery, shoulders were immobilized in the internal rotation position with a brace. Motion exercises were permitted from 2 weeks postoperatively, and patients removed the brace 4 weeks after surgery. A return to full athletic activity 6 months after surgery was permitted in all athletes except collision/contact athletes, who were allowed to return to full competitive activity after 8 months.

CT scan

All patients underwent a preoperative CT; the first postoperative CT was performed between 4 and 6 months. The CT was performed with an Aquilion scanner (Canon Medical Systems Corporation, Tochigi, Japan) at a slice thickness of 0.50 mm, and the obtained Digital Imaging and Communications in Medicine data of bilateral shoulders of each patient were then reconstructed into 3-dimensional (3D) bone models to evaluate the en face view of the glenoid and posterior side of the humeral head.

Imaging analysis

Preoperative glenoid bone defect

The percentage of preoperative glenoid bone defect was measured in the preoperative en face glenoid 3D bone model by using the assumed circle method described in the report by Nakagawa et al.[20]

Glenoid track and HSL

Localization of the HSL was also measured in the preoperative 3D bone model of the humeral head on the affected side.[7] In cases with unilateral involvement, the distance between the medial margin of the HSL and rotator cuff attachment was compared with the distance of the glenoid track determined from the unaffected glenoid width; in cases with bilateral involvement, the assumed diameter of the affected glenoid was used as the reference. Then, in each case, the HSL was classified as an on-track HSL other than a peripheral-track one, peripheral-track HSL, or off-track HSL.[5,30]

Change of glenoid width

The percentage change in glenoid width as a result of anterior glenoid rim erosion was assessed in accordance with the report by Hirose et al.[10] The percent change in the maximum glenoid width diameter perpendicular to the long axis of the glenoid was calculated. The authors reported that this is a reliable method for measuring glenoid width and has a low inter-examiner error. The percentage change of glenoid width (Δ) was calculated relative to the preoperative glenoid width, with increases shown as positive values and decreases shown as negative values. At the time of assessment of shoulders with a bony Bankart lesion, the additional glenoid surface obtained by the postoperative union of the bone fragment was included in the glenoid width if the additional surface was within 3.0 mm of the original one.

Statistical analysis

Statistical analysis was performed with JMP software (Version 16.0.0; SAS Institute Inc., Cary, NC, USA). Postoperative recurrence was defined as any report of dislocation or subluxation, and subluxation was defined as an episode of shoulder instability that did not require manual reduction by a health care provider.[23] For 2-group comparison by univariate analysis, the Wilcoxon test and chi-square test were used. Then, multivariate logistic regression analysis of the following variables was performed to determine the risk factors for recurrence: (1) age at surgery, (2) type of athlete (collision/contact athlete or not), (3) anchor placement (on-the-

Table I
Patient demographics.

N	220
Age at surgery (y)*	21.7 ± 10.3 [20.3-23.1]
Sport category	
Collision/contact	117
Noncollision/contact	103
Preoperative glenoid structure	
Normal	58
Erosion	56
bony Bankart	106
Glenoid bone defect (%)*	7.7 ± 7.2 [6.7-8.6]
Hill-Sachs lesion	
On-track other than peripheral-track	171
Peripheral-track	43
Off-track	6
Postoperative 1st CT (mo)*	4.5 ± 0.7 [4.4-4.6]
Change of glenoid width (%)*	−5.3 ± 9.0 [−6.5 to −4.1]

CI, confidence interval; *CT*, computed tomography.
Values within square brackets are 95% CI.
*Data were reported as means ± standard deviations.

face or on-the-edge anchoring), (4) preoperative glenoid bone defect (%), (5) localization of the HSL (on-track other than peripheral-track HSL or off-/peripheral-track HSL), and (6) change of glenoid width (%) within 6 months after surgery. These variables were selected from those that were found or suspected to be the risk factors in previous studies on recurrence after ABR or that were the target of this study. Then, the adjusted odds ratio (OR) and statistical significance were calculated. The statistical significance was assumed at a *P* value of less than .05.

Results

Among 520 shoulders that underwent ABR for traumatic anterior shoulder instability, 300 shoulders were excluded because of missing optimal CT scan data, use of anchors other than the JuggerKnot, concomitant coracoid transfer surgery, or lack of a follow-up of at least 2 years. Thus, a total of 220 shoulders met the study criteria. Patient demographics are shown in Table I. The mean age at surgery was 21.7 years, and about half of the patients were collision/contact athletes. The first postoperative CT evaluation was performed at 4.5 months, and the mean decrease in glenoid width was more than 5%. According to preoperative glenoid structure, change of glenoid width in normal, erosion, and bony Bankart type was −9.6 ± 6.2%, −5.2 ± 6.2%, and −3.1 ± 10.6%, respectively. The rate in normal glenoid type was higher than those in erosion and bony Bankart type (*P* = .001 and .0004).

Univariate analysis

Postoperative recurrence occurred in 32 of 220 shoulders (14.5%). Table II shows each parameter according to the presence or absence of postoperative recurrence. In univariate analyses, the only variable that significantly affected recurrence was being a collision/contact athlete (OR, 2.555; 95% confidence interval, 1.123-5.814; *P* = .03). Regarding the change of glenoid width, shoulders with recurrence were revealed to have 7.0 ± 6.6% reduction while those without recurrence were 5.0 ± 9.3% reduction, but the difference was not statistically significant. Additionally, among 106 shoulders with bony Bankart type glenoid, 55 shoulders achieved bone fragment healing while 14 were nonunion, and 37 shoulders showed resorption of bone fragment. Recurrence rate was higher in those without union than with union (7/55 (12.7%) vs. 13/51 (25.5%), *P* = .09). The glenoid width decreased in fragment nonunion (−11.2 ± 5.5%) or resorption (−9.2 ± 6.0%) but increased in fragment union (3.1 ± 10.3%).

Multivariate logistic regression analysis

In multivariate logistic regression analysis, the extent of the preoperative glenoid bone defect and the change of glenoid width on the first postoperative CT were identified as risk factors for recurrence after ABR alone. The OR of recurrence was 1.08 for every 1% increase in the extent of the preoperative glenoid bone defect and 1.06 (1/0.946) for every 1% decrease in the postoperative change of glenoid width. Although being a collision/contact athlete and being younger at surgery tended to be risk factors for postoperative recurrence, the differences were not statistically significant. The localization of the HSL was not associated with postoperative recurrence (Table III).

Discussion

The key finding of this study was that postoperative anterior glenoid rim erosion was found to be a risk factor for recurrence after ABR alone by multivariate analysis. As in previous reports, the extent of the glenoid bone defect before surgery was confirmed to have a critical influence on postoperative recurrence; the second most important factor was the reduction of glenoid width due to anterior glenoid rim erosion after surgery.

Before the present study, postoperative bone resorption could be interpreted as having a limited impact on recurrence because the resorptive change that occurs after surgery has achieved adequate soft tissue repair. However, this study showed that postoperative bone resorption has a significant effect on recurrence and therefore must be recognized as a risk factor for postoperative recurrence after ABR. As the previous study showed that patients especially with a preoperative erosive-type glenoid or without union of a bony Bankart lesion show additional postoperative reduction of the glenoid width,[9] we considered that this 2-step bone defect (ie, before and after surgery) may represent a strong possibility for postoperative recurrence. We also noted postoperative changes in shoulders with bone fragments, suggesting that the outcome can vary greatly depending on the presence or absence of fragment union. Our data suggested that fragment union results in a larger glenoid, while healing failure of fragment may result in a smaller glenoid and recurrence.

We found no effect of anchor placement on postoperative recurrence. Hirose et al advocated that on-the-edge anchor placement was more protective against anterior glenoid rim erosion than on-the-face placement, but they also concluded that the postoperative recurrence rates of both methods were almost equivalent.[10] Consistent with this conclusion, in the present study, we found no significant difference between the influences of both placements on postoperative recurrence. This lack of a difference might be because on-the-edge anchoring may compromise the height of the repaired labrum compared with on-the-face anchoring, rather than protecting against glenoid rim erosion. In other words, both techniques have their weakness that may contribute to postoperative recurrence in different ways. However, we believe that on-the-edge anchoring is superior because it preserves bone volume and morphology so that, in case of recurrence, more options are available at the time of revision surgery.

Similar to previous reports,[3,8,16,21,26,31] we found that younger age at surgery and being a collision/contact athlete tended to influence recurrence. However, the effects did not reach statistical significance, perhaps because the patient population at our institution is younger and has a much larger proportion of collision/contact athletes. Consequently, we believe that these factors should

Table II
Parameters depending on postoperative recurrence.

	No recurrence	Recurrence	*P* value
N	188	32	
Age at surgery (y)*	22.3 ± 10.9 [20.7-23.8]	18.4 ± 5.0 [16.6-20.2]	.06
Sport category			.03
Collision/contact	94	23	
Non collision/contact	94	9	
Preoperative glenoid structure			.12
Normal	54	4	
Erosion	48	8	
bony Bankart	86	20	
Anchor placement			.76
On-the-face	124	22	
On-the-edge	64	10	
Preoperative glenoid bone defect (%)*	7.3 ± 6.7 [6.3-8.3]	9.8 ± 9.5 [6.4-13.2]	.20
Hill-Sachs lesion			.64
On-track other than peripheral track	144	27	
Peripheral-track	38	5	
Off-track	6	0	
Change of glenoid width (%)*	−5.0 ± 9.3 [−6.4 to −3.7]	−7.0 ± 6.6 [−9.3 to −4.6]	.14

CI, confidence interval. Values within square brackets are 95% CI.
*Data were reported as means ± standard deviations.

Table III
Multivariate logistic regression analysis for postoperative recurrence.

	Adjusted odds ratio*	95% CI	*P* value†
Preoperative glenoid bone defect (%)	1.076	1.018-1.137	**.010**
Change of glenoid width (%)	0.946	0.900-0.994	**.028**
Collision/contact athlete	2.154	0.898-5.170	.086
Age at surgery (y)	0.937	0.868-1.011	.093
On-the-edge anchor placement	1.332	0.528-3.363	.544
Off-/peripheral-track HSL	0.715	0.236-2.168	.553

CI, confidence interval; *HSL*, Hill-Sachs lesion.
*Odds ratio; unit odds ratio for glenoid bone defect (%) and change of glenoid width (%).
†Bold; statistical significance.

continue to be considered as possible risks for recurrence after ABR alone.

In this study, the preoperative localization of HSL had no statistically significant effect on postoperative recurrence. As mentioned above, previous risk analyses did not consider the effect of postoperative glenoid rim erosion. Postoperative glenoid bone may increase in size in cases with healed bony Bankart lesions[14,22] but decrease in other cases because of rim erosion. Therefore, a HSL may change from a preoperative on-track lesion to a postoperative off-track lesion or vice versa. Consequently, we considered that the change in the localization of the HSL resulting from a postoperative change in glenoid width is more relevant than the preoperative localization of the HSL.

The results of this study indicate that surgeons should pay attention to resorptive bone morphological changes after ABR and control activity in patients with a glenoid width reduction. In addition, future research is required to elucidate the causes of this pathology and establish preventive approaches. We believe that such research will lead to more sophisticated surgical interventions for anterior shoulder instability.

Limitation

This study has a few limitations. First, because it targeted postoperative recurrence, the effect of postoperative glenoid width reduction on comprehensive shoulder function, including range of motion, pain, and muscle strength, remains unknown. Further investigation is needed to determine whether residual minor instability, although it does not lead to recurrence, is responsible for patients' postoperative symptoms. Second, postoperative subluxation was defined as an episode of shoulder instability that did not require manual reduction, meaning that it was a subjective, self-reported outcome. Unlike complete dislocation, which requires manual reduction, the occurrence of subluxation may depend on a patient's perception and therefore may have affected the recurrence rate. Last, the majority of the study population were younger patients and collision/contact athletes. Even though we adjusted for this fact in the multivariate analysis, the uneven distribution compared with the general hospital patient population should be considered when interpreting the results.

Conclusion

Glenoid width reduction due to anterior glenoid rim erosion after ABR is a risk factor for recurrence.

Acknowledgments

The authors would like to thank Yamada Translation Bureau, Inc. (https://www.ytrans.com/index.html) for the English language review.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: All authors and their immediate family have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

Reference

1. Arciero RA, Parrino A, Bernhardson AS, Diaz-Doran V, Obopilwe E, Cote MP, et al. The effect of a combined glenoid and Hill-Sachs defect on glenohumeral stability: a biomechanical cadaveric study using 3-dimensional modeling of 142 patients. Am J Sports Med 2015;43:1422-9. https://doi.org/10.1177/0363546515574677.
2. Boileau P, Villalba M, Héry JY, Balg F, Ahrens P, Neyton L. Risk factors for recurrence of shoulder instability after arthroscopic Bankart repair. J Bone Joint Surg Am 2006;88:1755-63. https://doi.org/10.2106/jbjs.E.00817.
3. Burkhart SS, De Beer JF. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs: significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. Arthroscopy 2000;16:677-94.
4. Burkhart SS, Lo IKY, Brady PC. Burkhart's view of the shoulder: a cowboy's guide to advanced shoulder arthroscopy. Philadelphia: Lippincott Williams & Wilkins; 2006.
5. Di Giacomo G, Itoi E, Burkhart SS. Evolving concept of bipolar bone loss and the Hill-Sachs lesion: from "engaging/non-engaging" lesion to "on-track/off-track" lesion. Arthroscopy 2014;30:90-8. https://doi.org/10.1016/j.arthro.2013.10.004.
6. Di Giacomo G, Piscitelli L, Pugliese M. The role of bone in glenohumeral stability. EFORT Open Rev 2018;3:632-40. https://doi.org/10.1302/2058-5241.3.180028.
7. Funakoshi T, Hartzler RU, Stewien E, Burkhart SS. Hill-Sachs lesion classification by the glenoid track paradigm in shoulder instability: poor agreement between 3-dimensional computed tomographic and arthroscopic methods. Arthroscopy 2019;35:1743-9. https://doi.org/10.1016/j.arthro.2018.12.005.
8. Hayashida K, Yoneda M, Nakagawa S, Okamura K, Fukushima S. Arthroscopic Bankart suture repair for traumatic anterior shoulder instability: analysis of the causes of a recurrence. Arthroscopy 1998;14:295-301.
9. Hirose T, Nakagawa S, Iuchi R, Mae T, Hayashida K. Progression of erosive changes of glenoid rim after arthroscopic Bankart repair. Arthroscopy 2020;36:44-53. https://doi.org/10.1016/j.arthro.2019.07.019.
10. Hirose T, Nakagawa S, Uchida R, Yokoi H, Ohori T, Tanaka M, et al. On-the-edge anchor placement may be protective against glenoid rim erosion after arthroscopic Bankart repair compared to on-the-face anchor placement. Arthroscopy 2022;38:1099-107. https://doi.org/10.1016/j.arthro.2021.10.013.
11. Inoue K, Suenaga N, Oizumi N, Yamaguchi H, Miyoshi N, Taniguchi N, et al. Glenoid bone resorption after Bankart repair: finite element analysis of post-operative stress distribution of the glenoid. J Shoulder Elbow Surg 2021;30:188-93. https://doi.org/10.1016/j.jse.2020.04.023.
12. Itoi E, Lee SB, Berglund LJ, Berge LL, An KN. The effect of a glenoid defect on anteroinferior stability of the shoulder after Bankart repair: a cadaveric study. J Bone Joint Surg Am 2000;82:35-46.
13. Itoi E, Yamamoto N, Kurokawa D, Sano H. Bone loss in anterior instability. Curr Rev Musculoskelet Med 2013;6:88-94. https://doi.org/10.1007/s12178-012-9154-7.
14. Kitayama S, Sugaya H, Takahashi N, Matsuki K, Kawai N, Tokai M, et al. Clinical outcome and glenoid morphology after arthroscopic repair of chronic osseous Bankart lesions: a five to eight-year follow-up study. J Bone Joint Surg Am 2015;97:1833-43. https://doi.org/10.2106/jbjs.N.01033.
15. Locher J, Wilken F, Beitzel K, Buchmann S, Longo UG, Denaro V, et al. Hill-Sachs off-track lesions as risk factor for recurrence of instability after arthroscopic Bankart repair. Arthroscopy 2016;32:1993-9. https://doi.org/10.1016/j.arthro.2016.03.005.
16. Loppini M, Delle Rose G, Borroni M, Morenghi E, Pitino D, Dominguez Zamora C, et al. Is the instability severity index score a valid tool for predicting failure after primary arthroscopic stabilization for anterior glenohumeral instability? Arthroscopy 2019;35:361-6. https://doi.org/10.1016/j.arthro.2018.09.027.
17. Lubowitz JH, Brand JC, Rossi MJ. Proper evaluation of bone loss determines shoulder instability indications and outcomes. Arthroscopy 2021;37:785-6. https://doi.org/10.1016/j.arthro.2021.01.004.
18. Nagaya LH, Yamamoto N, Shinagawa K, Hatta T, Itoi E. Does glenoid remodeling occur with an erosion-type bone loss after arthroscopic Bankart repair? JSES Int 2020;4:814-7. https://doi.org/10.1016/j.jseint.2020.06.002.
19. Nakagawa S, Hanai H, Mae T, Hayashida K, Yoneda M. Bipolar bone loss in male athletes with traumatic anterior shoulder instability: an evaluation using a new scoring system. Orthop J Sports Med 2018;6:2325967118782420. https://doi.org/10.1177/2325967118782420.
20. Nakagawa S, Hirose T, Uchida R, Yokoi H, Ohori T, Sahara W, et al. A glenoid defect of 13.5% or larger is not always critical in male competitive rugby and American football players undergoing arthroscopic bony Bankart epair: contribution of resultant large bone fragment. Arthroscopy 2021;38:673-81. https://doi.org/10.1016/j.arthro.2021.07.033.
21. Nakagawa S, Mae T, Sato S, Okimura S, Kuroda M. Risk factors for the post-operative recurrence of instability after arthroscopic Bankart repair in athletes. Orthop J Sports Med 2017;5:2325967117726494. https://doi.org/10.1177/2325967117726494.
22. Nakagawa S, Ozaki R, Take Y, Mae T, Hayashida K. Bone fragment union and remodeling after arthroscopic bony Bankart repair for traumatic anterior shoulder instability with a glenoid defect: influence on postoperative recurrence of instability. Am J Sports Med 2015;43:1438-47. https://doi.org/10.1177/0363546515571555.
23. Nakagawa S, Sahara W, Kinugasa K, Uchida R, Mae T. Bipolar bone defects in shoulders with primary instability: dislocation versus subluxation. Orthop J Sports Med 2021;9:23259671211003553. https://doi.org/10.1177/23259671211003553.
24. Park JY, Lee JH, Chung SW, Oh KS, Noh YM, Kim SJ. Does anchor placement on the glenoid affect functional outcome after arthroscopic Bankart repair? Am J Sports Med 2018;46:2466-71. https://doi.org/10.1177/0363546518785968.
25. Shaha JS, Cook JB, Rowles DJ, Bottoni CR, Shaha SH, Tokish JM. Clinical validation of the glenoid track concept in anterior glenohumeral instability. J Bone Joint Surg Am 2016;98:1918-23. https://doi.org/10.2106/JBJS.15.01099.
26. Verweij LPE, van Spanning SH, Grillo A, Kerkhoffs G, Priester-Vink S, van Deurzen DFP, et al. Age, participation in competitive sports, bony lesions, ALPSA lesions, >1 preoperative dislocations, surgical delay and ISIS score >3 are risk factors for recurrence following arthroscopic Bankart repair: a systematic review and meta-analysis of 4584 shoulders. Knee Surg Sports Traumatol Arthrosc 2021;29:4004-14. https://doi.org/10.1007/s00167-021-06704-7.
27. Yamamoto N, Itoi E, Abe H, Kikuchi K, Seki N, Minagawa H, et al. Effect of an anterior glenoid defect on anterior shoulder stability: a cadaveric study. Am J Sports Med 2009;37:949-54. https://doi.org/10.1177/0363546508330139.
28. Yamamoto N, Itoi E, Abe H, Minagawa H, Seki N, Shimada Y, et al. Contact between the glenoid and the humeral head in abduction, external rotation, and horizontal extension: a new concept of glenoid track. J Shoulder Elbow Surg 2007;16:649-56. https://doi.org/10.1016/j.jse.2006.12.012.
29. Yamamoto N, Muraki T, Sperling JW, Steinmann SP, Cofield RH, Itoi E, et al. Stabilizing mechanism in bone-grafting of a large glenoid defect. J Bone Joint Surg Am 2010;92:2059-66. https://doi.org/10.2106/JBJS.I.00261.
30. Yamamoto N, Shinagawa K, Hatta T, Itoi E. Peripheral-track and central-track Hill-Sachs lesions: a new concept of assessing an on-track lesion. Am J Sports Med 2020;48:33-8. https://doi.org/10.1177/0363546519886319.
31. Yian EH, Weathers M, Knott JR, Sodl JF, Spencer HT. Predicting failure after primary arthroscopic Bankart repair: analysis of a statistical model using anatomic risk factors. Arthroscopy 2020;36:964-70. https://doi.org/10.1016/j.arthro.2019.11.109.