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Original article

Return to sports after glenoid reconstruction using an implant-free iliac crest bone graft

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ABSTRACT

Purpose: The purpose of this study was to evaluate sports ability and the rate of return to sports after implant-free iliac bone graft for recurrent, anterior shoulder instability and anterior glenoid bone loss. Subgroups of younger and older patients and patients who had previous arthroscopic Bankart surgery and those who did not have such surgery before implant-free iliac bone graft were formed and compared.
Methods: We retrospectively analyzed 34 patients; 14 patients had previous arthroscopic Bankart surgery, and 20 patients did not have the surgery; The median age at the time of iliac bone graft was 35.3 years (range, 23 to 75), 17 patients were over the age of 35, and 17 patients were under the age of 35. The mean follow-up was 40 months (range: 25 to 56).
Results: All the 34 patients were engaged in pre- and post-operative sport, which represents a return to sport rate of 100%. Although the number of sport disciplines decreased significantly from 6 before the operation to 4.8 after the operation ($p = 0.002$), the number of sports sessions per week did not change significantly, and the duration per session did not change significantly. More than two-thirds of all patients returned to sports within 6 months. Overall, 41% of patients changed sport disciplines, 15% of whom cited shoulder-related causes; however, all patients returned to the same sport level.
Conclusions: Overall and within the subgroups, the return to sport rate after implant-free iliac bone grafting was high, with a high sense of well-being. The number of sport disciplines decreased significantly and more than one-third of the patients changed disciplines, of which 15% percent changed due to shoulder-related causes. The sport level remained equal, and no other parameters changed significantly compared with the time before the onset of restrictive shoulder symptoms.

1. Introduction

Shoulder dislocation is the most frequent joint dislocation, with a reported incidence between 23 and 56 per 100,000 person-years [1–3]. Risk factors for high recurrence rates are young age, male gender, postoperative participation in high-risk sports, shoulder hyperlaxity, glenoid bone loss and large Hill-Sachs lesions [1,4–9].

Surgical treatments for recurrent dislocation comprise soft tissue repair such as open or arthroscopic Bankart repair, bone block procedures or coracoid transfer [10–12]. In the presence of anterior-inferior bone loss, soft tissue repair alone is associated with high recurrence rates; therefore, bony glenoid augmentation procedures such as iliac crest bone block or Latarjet are recommended [10,11].

Both iliac crest bone block such as the J-bone graft and the Latarjet have shown excellent clinical and radiological results [10,13–15].

However, information about sports ability and return to sport rates after the J-bone graft are sparse [10]. Knowledge of sports

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Table 1
Patient demographics, ± indicates standard deviation.

	Overall	Surgical groups		*p*-value	Age groups		*p*-value
		Previous surgery	No previous surgery		≤35	>35	
Participants	34	20	14		17	17	
Age (years, mean)	26.9 ± 12.3	44.1 ± 14.1	34.1 ± 11.2	0.04			
Sex (m, f)	29; 5	15; 5	14; 0	0.056	15; 2	14; 3	0.500
BMI kg/m^2	24.5 ± 3.3	24.7 ± 4.0	24.2 ± 2.1	0.656	24.1 ± 2.7	24.9 ± 3.8	0.494
Bone defect %	17.9 ± 2.6	17.5 ± 3.0	18.4 ± 2.0	0.288	17.1 ± 3.0	18.7 ± 2.0	0.075

ability and return to sport rates after surgical treatment of shoulder instability are important factors for surgical success in this often highly active population. Moreover, preoperatively, patients may be more adequately informed about their expected sports ability after surgery.

We therefore designed a study to evaluate sports activity after the use of an implant-free iliac crest bone graft, the so-called J-bone graft, for recurrent anterior shoulder dislocation with concomitant glenoid bone loss. The hypothesis was that the majority of patients that have been involved in sport activity preoperatively are involved in sport activity postoperatively, after implant-free iliac crest bone block.

2. Materials and methods

2.1. Study design

All patient charts between 01/2012 and 12/2014 were reviewed for patients who, after traumatic anterior shoulder dislocation with concomitant anterior glenoid bone loss, underwent shoulder stabilization for recurrent anterior shoulder instability using an implant-free iliac crest bone graft technique. The minimum follow-up for this study was 24 months. Sports activity was surveyed preoperatively and postoperatively using a questionnaire used previously in several studies [16–19]. Additionally, the postoperative Constant-Murley-Score (CMS), Rowe score and the preoperative ISIS score were assessed [20–22]. Bone loss was evaluated preoperatively using 3D CT images assessing the best-fit circle, according to the Pico method [23].

We included all patients who underwent J-bone grafting to treat recurrent instability and concomitant anterior glenoid bone deficiency after traumatic anterior shoulder dislocation.

The exclusion criteria were patients under the age of 18 years, patients with neurological diseases, patient who underwent prior surgical procedures to the affected shoulder except arthroscopic Bankart repair and patients who underwent glenoid bone grafting for any other indication such as posterior instability.

Overall, 44 patients received bone block during the time period, and 38 patients fulfilled the inclusion criteria and were contacted.

Additionally, the patients were divided into age groups (younger: age ≤ median age; older: age > median age) and surgical groups of patients who underwent arthroscopic Bankart repair elsewhere before bone block and patients who had no arthroscopic Bankart surgery prior to J-bone grafting (previous surgery/no previous surgery). Ethical approval was obtained for this study (415-EP/73/520-2015).

2.2. Demographics

For this study, we contacted 38 patients, 34 of whom participated (follow-up rate of 89%). Two patients could not be contacted and 2 declined to participate. The mean follow-up time was 39.5 ± 9.6 months (range, 25 to 56). Table 1 shows patient demographics.

Overall, the first traumatic dislocation occurred 7.4 ± 5.8 years (range: 1 to 32) before bone block surgery. The patients sustained a mean of 15.9 ± 19.8 dislocations (range: 1 to > 100) until the index surgery was performed. Fourteen patients underwent arthroscopic Bankart repair before bone block surgery. Thirteen sustained a mean of 5.4 ± 4.3 dislocations (range: 1 to 15) and one patient sustained multiple subluxations between arthroscopic repair and bone block. The mean time between arthroscopic repair and recurrent dislocation was 4 ± 1.9 months, (range: 0 to 6). The reasons for first-time dislocation and recurrent dislocation were traumatic sports injuries in every case. The mean amount of bone loss before surgery was 17.9% ± 2.6% (range: 14 to 23) with no differences within and between the groups.

The overall mean ISIS score was 5.7 ± 1.2 (range: 4 to 8) Fig. 1. The ISIS score was significantly higher in the younger age group compared to the older age group (6.3 ± 1.2 vs. 5.1 ± 0.9; $p = 0.004$). In the surgical groups (no previous surgery vs. previous surgery) there were no significant difference in the ISIS score (5.5 ± 1.2 vs. 6.1 ± 1.3; $p = 0.155$).

2.3. Surgical technique

Once under general anesthesia, the patient is placed in the beach chair position. A deltopectoral incision of approximately 5 cm is made. The subscapularis muscle is then horizontally split between the upper two-thirds. A 15-mm osteotome is used to create an osteotomy medial to the glenoid surface. Then, a bicortical iliac bone graft is harvested and prepared until it resembles the shape of the letter J. The graft is inserted in the osteotomy in press-fit fashion. The fascia, which has been horizontally split and separated from the subscapularis muscle, is then closed, without attaching it to the iliac crest bone graft. Then the subscapularis muscle is closed. After closing the wound, the arm is placed in a sling for approximately 3 weeks. Fig. 2 shows a typical example of pre- and post-operative 3D CT reconstruction after J-bone graft.

2.4. Sports and activity questionnaire

The questionnaire used for this study evaluated the pre- and post-operative engagement in 28 different sport disciplines, of which the patients were able to chose between 14 highly demanding shoulder sport disciplines, like boxing, swimming and tennis and 14 intermediate shoulder-demanding sport disciplines, like running, cycling or skiing. Additionally, patients had the opportunity to name other sport disciplines in a free text session. Preoperative activity was determined as activity before the "onset of restrictive symptoms". In all patients, pre- and post-operative sports session length, sport frequency per week and level of sport, as well as time to return to sport after surgery was determined. If patients changed sport disciplines, they were able to provide the reason for changing their sport habits in a free text session.

For all patients, the pre- and post-operative well-being before, during and after sports was evaluated. Subjective feelings of well-being were evaluated on a VAS scale (0–10), with 0 representing the best rating and 10 representing the worst rating.

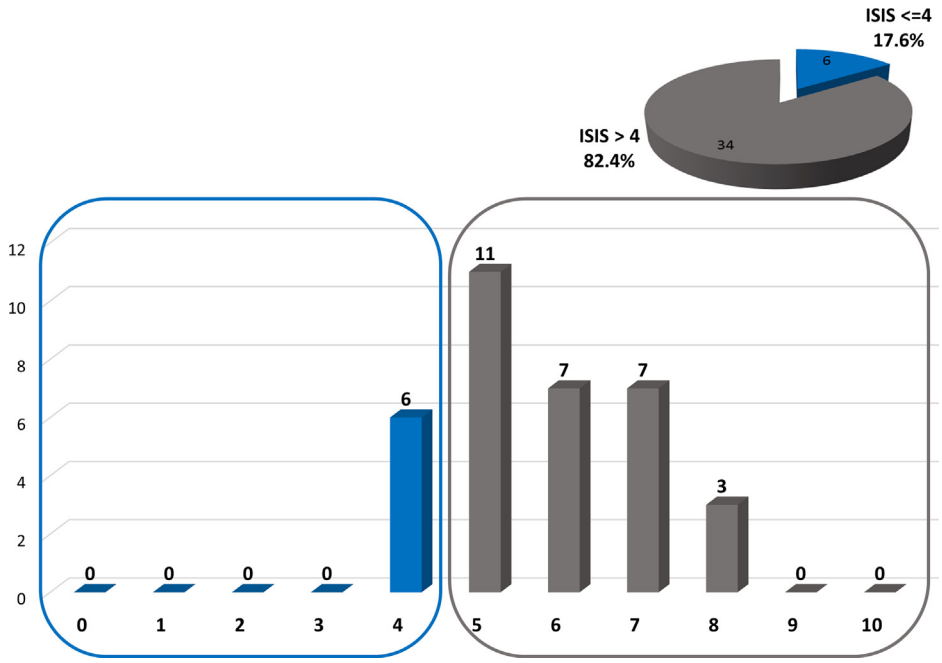

Fig. 1. ISIS (The instability severety index score) distribution among the 34 patients. In all, 17.4% had ISIS score ≤ 4 and 82.4% had ISIS score > 4.

Fig. 2. Left preoperative glenoid with antero-inferior bone loss middle postoperative glenoid after J-bone graft right glenoid after bone remodeling of the bone graft after 12 months.

Additionally, the use of pre- and post-operative pain medications and satisfaction with the final outcome was queried.

2.5. Clinical and radiological assessment

For all patients, the postoperative CMS score and Rowe score were assessed at the final follow-up. Radiological follow-up comprised a 3D CT scan before surgery to assess amount of bone loss according to the Pico method [23].

2.6. Statistical methods

In order to show the observed frequency of dichotomous variables, contingency tables were created. Chi^2 tests were used to determine whether there are significant differences between the expected and the observed frequencies. In the case of dependent samples, we will fall back on the McNemar's test respectively on the Cochran's Q test. For metric variables, a one-way respectively a repeated measure Anova was used to determine whether there are any statistically significant differences between the means of two or more independent or dependent groups.

All statistical tests are two-tailed. The significance level for the error of the type one error is 5%. All evaluations were performed with IBM SPSS in the version 20.

3. Results

3.1. Sports participation and activity

Before the onset of restricting symptoms, 34 patients (100%) were engaged in sports and 34 were also engaged at the final follow-up, which represents a return to sport rate of 100%.

Overall the number of sport disciplines decreased significantly from 6 ± 2.6 (range, 1 to 10), to 4.8 ± 3 (range, 0 to 10); ($p = 0.002$). Additionally, the number of disciplines in the subgroups decreased. In the surgical groups (previous surgery and no previous surgery), the number of disciplines decreased from 6.6 ± 2.99 (range, 3 to 15) to 5.6 ± 3.93 (range, 1 to 16); ($p = 0.003$) and from 5.6 ± 2.37 (range, 1 to 10) to 4.3 ± 2.36 (range, 0 to 8); ($p = 0.003$), respectively. In the age groups (≤35 and > 35 years), the number of disciplines decreased from 6.8 ± 2.77 (range, 3 to 15) to 5.9 ± 3.26 (range, 1 to 16); ($p = 0.002$) and from 5.2 ± 2.33 (range, 1 to 10) to 3.8 ± 2.68 (range, 0 to 8); ($p = 0.002$), respectively. Patients who had undergone previous arthroscopic surgery and younger patients were engaged in significantly more pre- and post-operative disciplines than patients without previous arthroscopy and older age. The types of pre-and post-operative disciplines are shown in Fig. 3.

The top 5 shoulder-demanding sport disciplines for the subgroups are shown in Table 2.

Fourteen patients (41%) changed disciplines from pre- to post-operatively. Five patients (15%) cited shoulder-related causes such

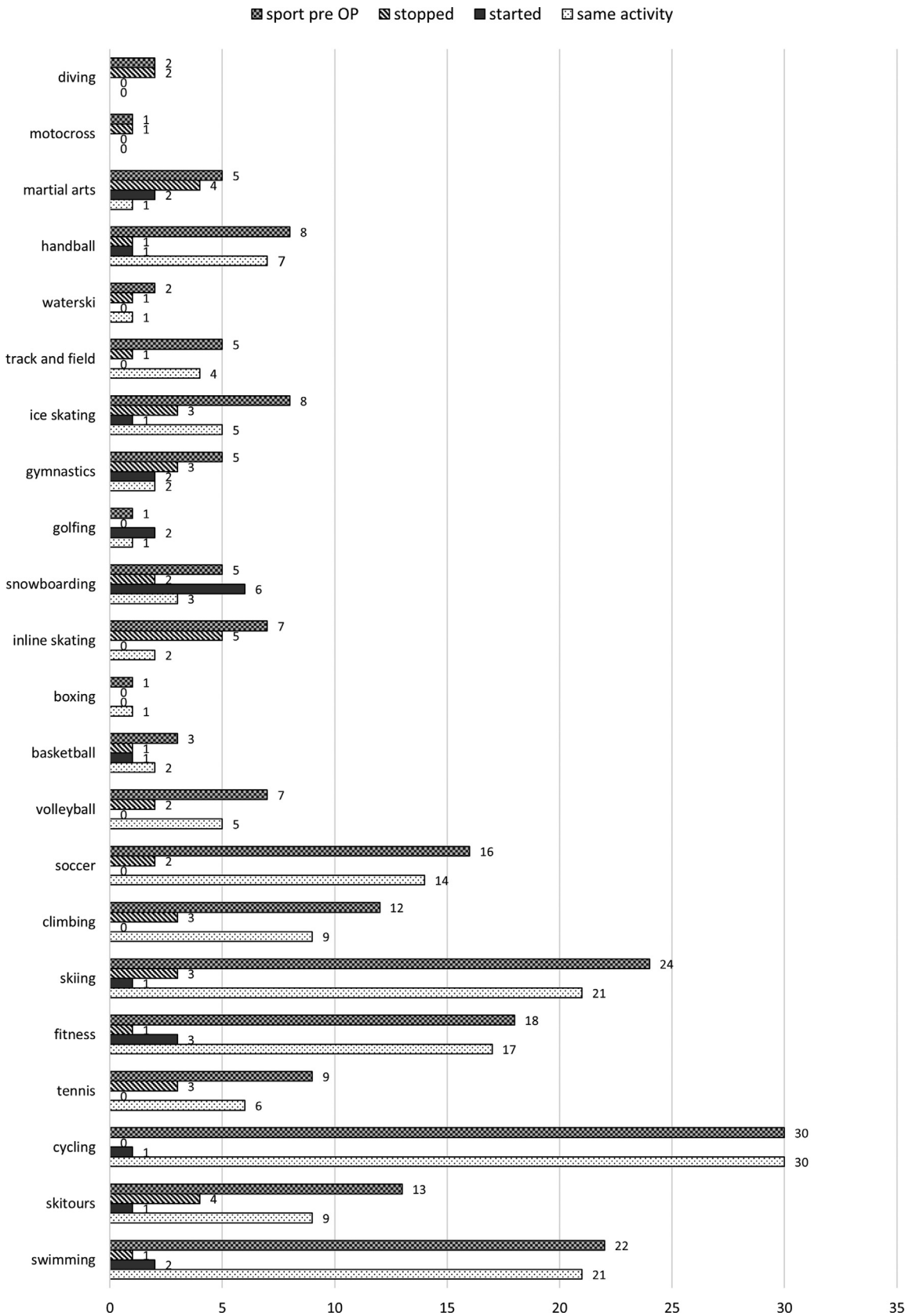

Fig. 3. Types of disciplines pre- and post-operatively. Sport preop: number of patients that were engaged in particular discipline preoperatively; stopped: number of patients that were engaged in particular discipline that was stopped after surgery; started: number of patients that were engaged in particular discipline that were started after surgery; same activity: number of patients that were engaged in particular discipline that was performed preoperatively and postoperatively.

Table 2
Top 5 sport disciplines for age and surgical groups.

	Preoperative percent of patients(%)	Postoperative percent of patients(%)	Change[a]
Top 5 demanding shoulder sports, (patients ≤ 34)			
Climbing	56	46	−10
Swimming	39	33	−6
Tennis	32	31	−1
Handball/volleyball	44	29	−15
Martial arts	17	4	−13
Top 5 demanding shoulder sports, (patients > 34)			
Climbing	66	65	−1
Swimming	55	54	−1
Tennis	43	45	+2
Handball/volleyball	31	29	−2
Martial arts	40	25	−15
Top 5 demanding shoulder sports, (patients with previous surgery)			
Climbing	55	48	−7
Swimming	40	32	−8
Tennis	45	28	−17
Handball/volleyball	24	24	0
Martial arts	17	4	−13
Top 5 demanding shoulder sports, (Patients without previous surgery)			
Climbing	68	62	−6
Swimming	56	56	0
Tennis	41	46	+5
Handball/volleyball	40	37	−3
Martial arts	40	25	−15

[a] Change in percentage from pre- to post-operatively.

as insecurity and 9 patients (26%) cited shoulder-unrelated reasons for changing disciplines.

Thirteen patients (38%) returned to sports within 3 months and 13 patients (38%) returned within the first 6 months after surgery. The remaining 8 patients (24%) returned to sports between 7 and 12 months. No significant differences regarding time to return to sports were observed within the age and surgical groups.

3.2. Sports extent

Overall, the number of sessions per week did not differ significantly from pre- to post-operatively Fig. 4. The number of sessions within and between the age and surgical subgroups did not differ significantly pre- and post-operatively.

The duration per session for all patients did not differ significantly from pre- to post-operatively and is shown in Fig. 4. The duration per session within and between the age and surgical subgroups did not differ significantly pre- and post-operatively.

No differences in the preoperative and postoperative sport level were observed within and between the age and previous surgery subgroups. Fig. 5 shows the sport level.

3.3. Clinical results

The overall mean postoperative CMS was 96.8 ± 3.50 (range, 90 to 100) and the mean Rowe score was 94.1 ± 11.80 (range, 50 to 100). No significant differences in the mean postoperative CMS were observed between the age and surgical groups (≤35 years: 96.6 vs. > 35 years: 97.4, $p = 0.53$; no previous surgery: 97.5 vs. previous surgery: 96.2, $p = 0.3$, respectively). The mean postoperative Rowe score did not differ significantly between the age and the surgical subgroups (≤35 years: 94.1 vs. > 35 years: 94.1, $p = 1$; no previous surgery: 95 vs. previous surgery: 93.2, $p = 0.71$, respectively).

The mean overall postoperative abduction was 178° ± 7.40 (range, 150 to 180) and the mean postoperative anterior flexion was 178° ± 5.53 (range, 140 to 180). The mean postoperative external rotation in 0° abduction with the arm at the side in the neutral position was 57° ± 2.09 (range, 54 to 60).

3.4. Complications

No intraoperative or perioperative complications occurred. Redislocation occurred in 2 patients after 8 and 48 months. One patient had prior Bankart repair and the other patient had no previous surgery. The preoperative ISIS score was 6 and 7 points, respectively. Both patients fell during sports and dislocated the shoulder after sufficient trauma. After closed reduction, both patients were treated conservatively by sling use for 2 weeks. Both patients did not report instability or insecurity at the final follow-up. The Rowe score and the CMS score were 50 and 98 and 50 and 96, respectively, and both patients were satisfied at the final follow-up.

3.5. Subjective rating and sense of well-being

Details for subjective rating and sense of well-being are illustrated in Table 3.

In total, 96% of patients rated their shoulder pain during sport as very low (VAS 0–3) and 6% as intermediate (VAS 4–6), without significant differences in the subgroups.

Shoulder pain (VAS 0–10) after sports was very low (VAS 0–3) in 97% and in 3% of patients intermediate (VAS 4–6).

In all, 91% of the patients reported almost no insecurity (VAS 0–3), 6% reported intermediate insecurity (VAS 4–6) and 3% severe insecurity during sport (VAS 7–10).

The sensation of instability was very low (VAS 0–3) in 97% and in 3% intermediate (VAS 4–6).

The sport ability was rated excellent (VAS 0–3) in 82% and intermediate (VAS 4–6) in 12% and low in (VAS 7–10) 6%.

Overall, 82% of the patients rated their fitness level as excellent (VAS 0–3), 15% as intermediate (VAS 4–6) and 3% reported a low fitness level (VAS 7–10).

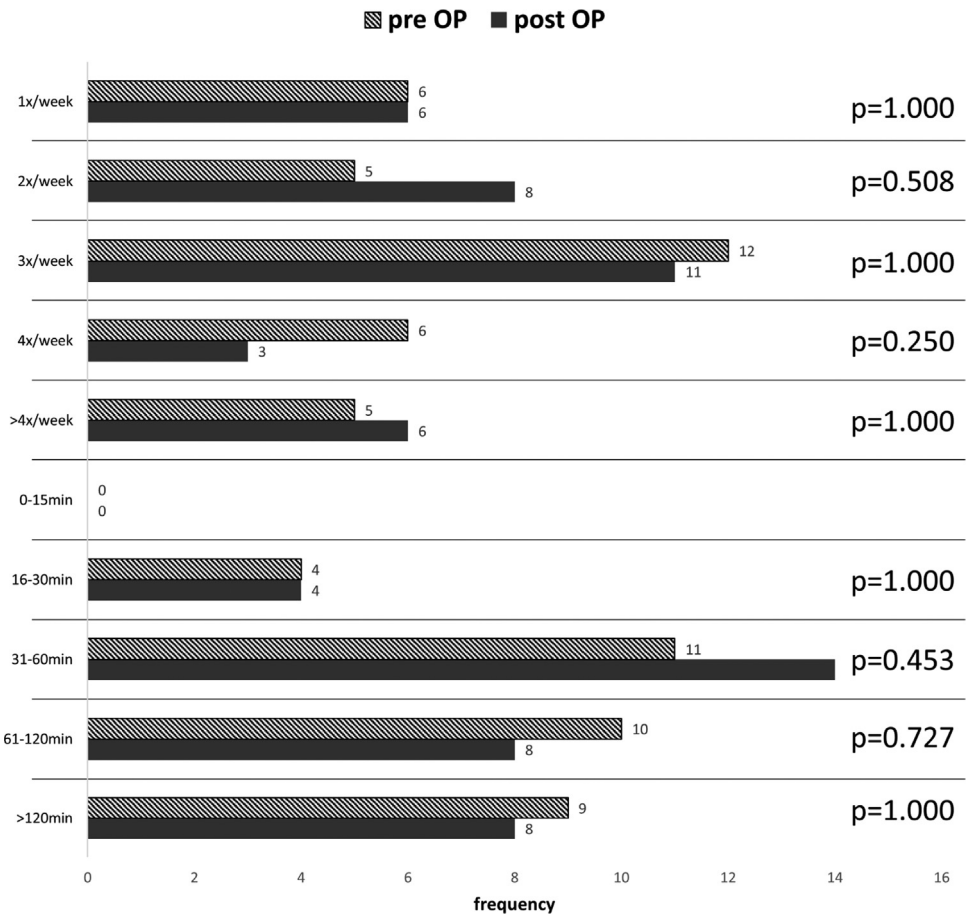

Fig. 4. Number of session per week and session length (all patients – two-tailed test/McNemar Test).

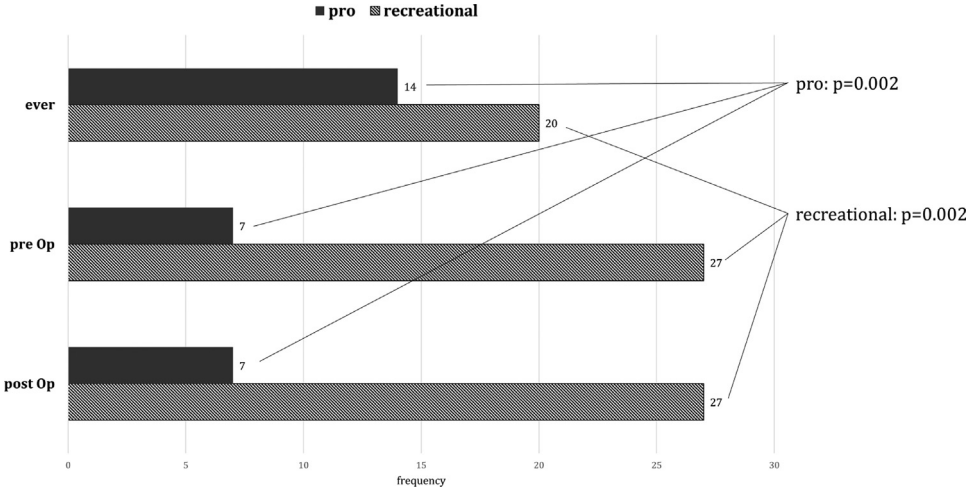

Fig. 5. Sport level ever in life, pre- and post-operatively (overall – Cochran Q Test).

4. Discussion

The J-bone graft is a highly successful procedure to treat recurrent anterior shoulder dislocation and concomitant anterior-inferior glenoid bone loss. This technique was shown to provide good clinical and radiological results and low redislocation rates. Therefore, it is an alternative to the widely used Latarjet procedure and other bone block procedures [10,14,15,24–26]. However, information about sports activity after J-bone graft is scarce; therefore, the purpose of this study was to determine the sports ability and return to sport rate after implant-free iliac crest bone block with a special interest in the comparison of age and surgical subgroups. In this study, all the patients participated in sports before the onset of restrictive symptoms preoperatively and after surgery, including at the final follow-up, which represents a return to sport rate of 100%. Although the overall number of sport disciplines declined and 41% of the patients changed some sport disciplines, only 15% of those cited shoulder-related causes as the reasons for changing or quitting. All patients, regardless of whether they changed disciplines, reached the same sport level after surgery as

Table 3
Subjective rating and sense of well-being ± indicates standard deviation.

Overall (n = 34)	VAS (0–10)		
	Preoperative	Postoperative	p-value
Shoulder pain during sport	1.7 ± 2	0.7 ± 1	0.003
Pain in other joints during sport	0.8 ± 1.6	0.5 ± 1.1	0.65
Shoulder pain after sport	2 ± 1.5	0.7 ± 1.1	<0.001
Insecurity/Anxiety during sport	5.7 ± 3	1.5 ± 1.7	<0.001
Sensation of instability	5.2 ± 3	0.9 ± 1.2	<0.001
Sport ability	3.4 ± 2.4	1.4 ± 2	0.002
Subjective fitness level	2.6 ± 2	2.0 ± 1.5	0.29
Subjective shoulder mobility	2.7 ± 2.3	1.5 ± 1.6	0.035
Satisfaction		0.6 ± 1.4	

before the onset of restrictive shoulder symptoms preoperatively. This study shows a typical cross section of the athletic population, and most of the patients in this study were recreational athletes; therefore, two-thirds of the patients rated their sport level as leisure sports and 21% as competitive/professional, both pre- and post-operatively with no differences between the age and surgical groups.

In a study by Auffarth et al. [10] reporting on sports ability after J-bone graft, the authors reported a return to sport rate of 94% with approximately 20% of patients changing disciplines, and an increase of patients performing overhead activities from 9% to 13%. The percentage of patients performing sports on a professional level decreased from 9% to 4% and those who performed hobby sports increased from 70% to 76%. In a study by Anderl et al. [27] investigating clinical and radiological results after a minimum of 2 years after arthroscopic J-bone grafting, all patients returned to full athletic activity. In a study by Taverna et al. [28] investigating the clinical and radiological results and the sport ability after arthroscopic iliac crest bone block, the authors found a 67% return to sports rate to the same level and three out of five patients returning to competitive sports.

When considering the Latarjet procedure, the reported return to sport rates at the same preoperative level are between approximately 63% and 96% [29–31]. In a study by Beranger et al. [29], the authors investigated 47 sports-participating patients after Latarjet procedures and found an overall return to sport rate of 100%; however, 79% of these patients returned to the same sport level and 21% of patients changed disciplines due to shoulder-related causes. In another study investigating the return to sport ability in collision and non-collision athletes after Latarjet, the authors found an overall return to sport rate of 96%. However, only 16% of all patients returned to the same preoperative level of sports, a rate that was even lower in collision athletes with only 3% of patients returning to the same level compared to the 30% of non-collision athletes who return to the same level [32]. In a study by Camus et al. [33] the authors compared and isolated bankart procedure to an bankart procedure and remplissage and found no significant differences in the return to sport rate. The return to sport rate after arthroscopic Bankart surgery varies from 48% to 100% [34] and is comparable to the rates described for the Latarjet procedure [35].

In this study, one-third of all patients returned to sports within 3 months and two-thirds returned to sports within 6 months postoperatively, with no differences in the age or surgical groups. In the study by Auffarth et al. [10], although the authors did not provide the time to return to sports, they stated that patients who performed manual labor returned to work after a mean of 3.7 months and patients in non-manual professions returned after a mean of 2.7 months. In a study by Anderl et al. [27] in which the authors investigated the clinical and radiological outcome after arthroscopic J-bone graft, all patients returned to athletic activity after 6 months. In a study by Beranger et al. [29], 78% of the patients returned to the same sport level after 6 months after the Latarjet procedure. In a study by Kee at al. [32], the authors found all patients returned to sports within 1 year after the Latarjet procedure and Labattut et al. [36] found that all patients returned to sport after arthroscopic assisted Trillat procedure after a mean of 4.5 months postoperatively.

In the present study, complications comprised redislocation in 2 patients after falls during sports, which represents a complication rate and a recurrence rate of 4.5%. Other previously described complications for J-bone grafting are graft fracture, hematoma, infection and iliac crest-related problems such as nerve palsies and postoperative hematoma [10,27].

In a recent systemic review of complications and re-operation after the Bristow-Latarjet procedure, the authors found a total complication rate of 30% and a re-operation rate of 7% along with an overall redislocation rate of 2.9% and a subluxation rate of 5.8% [37].

In another review comparing different stabilization methods, the authors found similar redislocation rates with the lowest incidence for the Latarjet procedure (3.5%) compared with open and arthroscopic Bankart repair (6.7% and 6.6%). However, athletic patients appear to have a higher incidence of recurrence after arthroscopic Bankart surgery, which is higher still in the presence of glenoid bone loss [38]. Therefore, for those patients, bone block or Latarjet appear to be superior options.

The most shoulder-demanding pre- and post-operative sport disciplines in which the patients were engaged were climbing, swimming, tennis, handball, volleyball and martial arts. Participation in most of these disciplines declined slightly, although for some patients, it remained the same and for some it even increased. However, we cannot draw definitive conclusions as both decreases and increases were observed for some of the shoulder-demanding sports in the different age and surgical groups.

Although some patients changed sport disciplines, they changed from one shoulder-demanding sport to another, such as from climbing to swimming. Only patients who cited shoulder-related causes for changing switched from high to lower shoulder-demanding sports.

The sports extent, the number of sessions per week and the duration per session were similar pre- and post-operatively and did not change significantly.

The clinical outcome was excellent with a CMS of 96.8 and a Rowe score of 94.1 and almost unimpeded range of motion. These findings are consistent with the reported results after J-bone grafting in the literature [10,27].

The subjective sense of well-being during and after sports was excellent with a very low pain level during and after sports, a very low sensation of insecurity, almost no dislocation apprehension during sports and a high sense of ability to perform the actual sports activity.

The main limitations of this study are the retrospective design, the small number of patients and the lack of a control group of a different surgical intervention, such as Latarjet or other bone block procedures. Another limitation is that the patients reported on sports activities they performed several years ago, which might not be accurately recalled. Preoperatively 21% of the patients performed sport at competitive level and 79% at recreational level. The more demanding patients could probably criticize more the final results or do more efforts in returning to sports, which may lead to potential bias.

5. Conclusion

In this retrospective study we found that all patients participated in sports before and after J-bone grafting. However, a decline

in the number of sport disciplines was observed and some patients changed disciplines due to shoulder-related cause. The number of sessions per week and the duration per session did not change significantly. Moreover, most of the patients reported a substantial sense of well-being during and after sports, and their subjective feelings regarding their ability to perform a certain sport activity was very high with a low dislocation apprehension and a low sensation of insecurity or instability.

Ethical approval

All procedures performed in this study involving human participants were in accordance with ethical standards, and ethical approval was obtained from the Ethikkommission Land Salzburg (415-EP/73/520-2015). Informed consent was obtained from all study patients.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Disclosure of interest

The authors declare that they have no competing interest.

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There was no funding for this study.

Contributions

RO conceived and designed the study. MG, PF, MM and MG were responsible for acquisition, analysis and interpretation of data. GM was responsible for participant recruitment and contributed to analysis and interpretation of data and correction of the manuscript. PF, MM, MG was involved in patient management. HK was responsible for statistical analysis and revision of the manuscript and drafting of the manuscript. FC, SW, HJ, RH performed critical revision of the manuscript regarding important intellectual content and were responsible for data analysis and drafting the manuscript. All authors read and approved the final manuscript.

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