



High Rate of Return to Sports and Low Recurrences With the Latarjet Procedure in High-Risk Competitive Athletes With Glenohumeral Instability and a Glenoid Bone Loss <20%

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Purpose: To analyze return to sports, functional outcomes, and complications following the Latarjet procedure in competitive athletes with anterior glenohumeral instability and glenoid bone loss <20%. **Methods:** All the included patients were operated between 2010 and 2016. The inclusion criteria were competitive athletes with anterior glenohumeral instability, a glenoid bone defect <20% who participated in contact sports, forced overhead sports, or had a previous failed Bankart repair and had a minimum 2 years' follow-up. Return to sports, range of motion (ROM), the Rowe score, and the Athletic Shoulder Outcome Scoring System score were used to assess functional outcomes. Complications and bone consolidation were also evaluated. **Results:** A total of 65 athletes were included in the study. The mean follow-up was 53 months (± 13), and the mean age was 23.9 years (range, 16-31 years). Overall, 94% were able to return to sports and 84% returned at the same level. No significant difference in shoulder ROM was found between preoperative and postoperative results. The Rowe and Athletic Shoulder Outcome Scoring System scores showed statistical improvement after operation ($P < .001$). No significant difference in shoulder ROM and functional scores was found between primary and revision cases. The total complication rate was 11% and the revision rate was 1.5%. The recurrence rate was 4.6%. The bone block healed in 95% of the cases. **Conclusions:** In high-risk competitive athletes with anterior glenohumeral instability and glenoid bone loss <20%, the Latarjet procedure resulted in excellent functional outcomes, with most of the patients returning to sports and at the same level they had before injury with a low rate of recurrences. **Level of Evidence:** Therapeutic case series; Level of evidence, IV

Glenoid bone loss is a common finding in association with anterior shoulder instability and it has been identified as a predictor of failure after capsulolabral-stabilization procedures.¹ Historically, 20% to 25% has been accepted as the "critical" cutoff value at which glenoid bone loss should be reconstructed

during surgery.^{2,3} Due to the unsatisfactory results reported with isolated capsulolabral repair in athletes with recurrent glenohumeral instability and glenoid bone deficit >20%, most authors recommend glenoid reconstruction with bone grafting in these patients.^{2,3}

However, some studies published in the last decade have shown that in some risk subgroups, the results with Bankart repair are even unfavorable when patients have a glenoid bone deficit of less than 20%.⁴⁻⁸ These risk subgroups mainly include contact and collision athletes, forced overhead athletes, and patients with previous failed Bankart repairs.⁴⁻⁸ The main problem in these high-risk patients is the high recurrence rate, which can vary between 15% and 51%.⁴⁻⁸ Furthermore, some authors have demonstrated a significant decrease in functional outcomes with isolated capsulolabral repair in athletes with only 13.5% to 20% glenoid bone deficit, even in patients who did not sustain a recurrence of their instability.^{9,10} Due to the high risk of recurrences and the possibility of obtaining

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suboptimal results with isolated Bankart repair, we have decided, since 2010, to treat high-risk patients in our institution by means of glenoid reconstruction with Latarjet surgery.

The purpose of this study was to analyze return to sports, functional outcomes, and complications following the Latarjet procedure in competitive athletes with anterior glenohumeral instability and glenoid bone loss <20%. We hypothesized that the Latarjet procedure would achieve a stable shoulder in high-risk competitive athletes with anterior glenohumeral instability and glenoid bone loss <20%, resulting in a high rate of return to play with a low rate of recurrences.

Methods

This was a retrospective comparative study. All the included patients were operated between 2010 and 2016. The inclusion criteria were competitive athletes with anterior glenohumeral instability, a glenoid bone defect <20% who participated in contact sports, forced overhead sports, or had a previous failed Bankart repair and had a minimum 2 years follow up. We excluded patients who had, other types of instability (e.g., posterior or voluntary), or in whom clinical or radiographic evaluations were absent at final follow-up. The congruent arc Latarjet¹¹ was performed early in the study period (January 2010 to June 2015), followed by a transition to classic Latarjet technique¹² later in the study period (July 2015 to December 2016). The ethics committee of our Institution approved this study (institutional review board: 00010193). The ethics committee of the Italian Hospital from Buenos Aires, Argentina, approved this study (institutional review board: 00010193, protocol number: 5395).

Evaluation

Preoperative and postoperative evaluation consisted of a patient-based questionnaire and the physical examination performed by a shoulder fellow who did not participate in the surgery. On preoperative examination, all patients had a preoperative examination consisting of apprehension and relocation testing. We also evaluated range of motion (ROM). Patients were contacted and examined at a minimum 3 years' follow-up.

All patients were studied before surgery with anteroposterior views and axillary glenohumeral views, magnetic resonance imaging, and computed tomography with 3-dimensional reconstruction (3DCT). Preoperative glenoid bone loss was measured with the glenoid index method according to Chuang et al.¹³ Patient sport level was divided into competitive and recreational sports. All included patients were competitive athletes according to Araujo et al.¹⁴

Sports were classified in an analog manner according to Allain et al.¹⁵: noncollision/nonoverhead shoulder sport (G1), high-impact/collision sport (G2), overhead

sport with hitting movements (G3), and overhead sport with hitting movements and sudden stops (G4). Patients were asked if they had been able to practice sports again and if they had been able to perform it at the same level they had before the injury. We also asked patients who did not return to sports the reasons for cessation. The Rowe score was used as a global outcome measure.¹⁶ Clinical outcome was also assessed using the minimal clinically important difference (MCID) for the Rowe score, defined as an increase from baseline in overall Rowe of at least 9.7 points.¹⁷ Shoulder-dependent sport ability was measured the Athletic Shoulder Outcome Scoring System (ASOSS).¹⁸ The ROM was objectively recorded with a goniometer. The postoperative bone block position and consolidation were assessed with 3DCT 3 months postoperatively. We considered accurate positioning of the bone block was reached when values of medialization and lateralization of the bone block were within -5 mm and +3 mm, respectively.¹⁹ Osteoarthritis was graded according to the classification of Samilson and Prieto.²⁰ All surgery-related complications and reoperations were documented. We considered patients who had a dislocation, subluxation, or who had painful apprehension after surgery as recurrences. Lesions were defined as "on track/off track" according to Di Giacomo et al.²¹

Surgical Technique

During the surgical procedure, patients received combined anesthesia (regional blockade + general anesthesia) and were placed in the beach-chair position. We used a small 5-cm deltopectoral approach. The coracoid process underwent osteotomy at the junction between the horizontal part and vertical part. In patients in whom the congruent arc was performed, in this step the coracoid graft was rotated on its longitudinal axis by 90°, such that the original medial surface was facing the glenoid neck.¹¹ The medial cortex of the graft was removed with a saw blade. Conversely, in patients where the classic Latarjet was performed, the inferior cortex of the graft was decorticated.¹² The subscapularis muscle was divided in line with the fibers at the two-thirds superior—one-third inferior junction to expose the anterior capsule that was divided in the same manner. The anterior glenoid neck was then prepared with a saw blade to be the recipient bed for the coracoid bone graft. Then the graft was temporarily stabilized with 2-mm pins. The inferior hole was drilled through the graft and through the glenoid and the coracoid was fixed with a single screw so that it lay flush with the glenoid joint line. This step was facilitated using specialized guides (South American Implants). A second screw 1 cm proximal from the inferior one was used to complete graft fixation. In all cases, 2 partially threaded cannulated cortical screws (3.5 mm diameter) were used. We did not do any attempt to

Table 1. Patients Demographics

Variable	
Sex, men/women, n	62/3
Side, right, n (%)	39 (60%)
Dominant involvement, n (%)	29 (45%)
Age at the time of surgery, y, mean (range)	23.9 (16-31)
Type of surgery	
Primary, n (%)	29 (45%)
Revision, n (%)	36 (55%)
Glenoid bone loss, % (range)	12% (0-18)
On-track/off-track lesions*	
On track, n (%)	40 (62%)
Off-track, n (%)	25 (38%)
Follow-up, mo (range)	53 (36-96)
Type of sport, [†] n	
G1	12 (18%)
G2	35 (54%)
G3	9 (14%)
G4	9 (14%)

*According to Di Giacomo et al.²¹

[†]According to Allain et al.¹⁵

repair the capsulolabral complex. We did not perform any remplissage or other procedure in the presence of a concomitant Hill–Sachs lesion.

Postoperative Rehabilitation

The arm was supported in a sling for 4 weeks. All patients followed a standard postoperative rehabilitation protocol supervised by one of the authors. After 1 week, supervised gentle physical therapy consisting of passive pendulum and gradual passive ROM was begun. Active-assisted ROM exercises were started 2 weeks after surgery. When the patient could perform active forward elevation above the shoulder level, strengthening exercises were started. Running was authorized at 8 weeks. Return to sports was allowed when the patient was pain free, full shoulder ROM had been achieved, and shoulder strength was near the same as before the injury.

Statistical Methodology

Pre- and postoperative scores were compared with the paired *t* test for independent samples. Continuous variables were presented as means \pm standard deviations, whereas categorical variables as absolute and relative frequencies. The statistical analysis was performed using the software STATA, version 13 (Stata Corporation, College Station, TX). A *P* value less than .05 was considered statistically significant.

Results

Sixty-seven athletes who met the inclusion criteria were operated during the study period. Two patients were lost to follow-up, and thus the final analysis included 65 patients. The mean follow-up was 53 months (\pm 13). The main characteristics of the involved patients and their injuries are shown in Table 1.

Return to Sports

Sixty-one (94%) patients were able to return to sports, and 84% returned at the same level they had previous to their injury (Table 2). The mean interval between surgery and return to competition was 5.6 months (range, 3-11 months). Four patients (6%) did not return to sports after the procedure. Regarding the reasons for cessation, 2 patients did not feel psychologically confident and 2 patients feared they would suffer the same injury again. No significant difference regarding return to sports was found between primary and revision cases (Table 3) and between patients operated with the classic and the congruent arc technique (Table 4).

ROM and Functional Scores

No significant difference in shoulder ROM was found between preoperative and postoperative results (Table 2). The Rowe and ASOSS scores showed statistical improvement after operation *P* < .001 (Table 2). Ninety-five percent of the athletes (62 of 65 patients) achieved a clinically significant improvement that exceeded the MCID for the Rowe score. No significant difference in shoulder ROM and functional scores was found between primary and revision cases (Table 3) and between patients operated with the classic or the congruent arc technique (Table 4). Finally, we did not find a significant difference in functional scores according to the type of sports practiced by the patients (Table 5).

Imaging Results

The bone block healed in 57 shoulders (95%). In 3 shoulders (5%), the bone block had not healed: One soccer player had pain 2 months after surgery and presented radiolucences around the inferior screw. It was interpreted as a nonunion secondary to the screw loosening. The screw was changed arthroscopically to a longer one. The graft consolidated 2 months after the reoperation and the patient returned to play soccer at the same level as before the injury. In 2 patients, no evidence of complete consolidation was observed. However, the patients were pain free, without

Table 2. Summary of Functional Outcomes and Return to Sport

Variable	Preoperative	Postoperative	<i>P</i> Value
Rowe score	51 \pm 15	95 \pm 7.5	<.01
ASOSS	29 \pm 7.9	92 \pm 15	<.01
Forward flexion	173 \pm 6.1	171 \pm 6.2	.20
ER in adduction	67 \pm 2.8	66 \pm 3.6	.99
Return to sport, n (%)	—	61/65 (94%)	—
Return to same level	—	51/61 (84%)	—

NOTE. Values are expressed as mean \pm SD unless otherwise indicated, paired rank test.

ASOSS, Athletic Shoulder Outcome Scoring System; ER, external rotation.

Table 3. Comparative Outcomes Between Primary and Revision Procedures

	Primary Procedures (n = 29)			P Value	Revision Procedures (n = 36)			P Value
	Pre	Post	Delta		Pre	Post	Delta	
Rowe	50.5 ± 2	95.9 ± 6	-45.3 ± 13	<.001	51.8 ± 17	93.7 ± 8	-41.9 ± 19	<.001
ASOSS	28.1 ± 18	89.7 ± 18	-61.6 ± 20	<.001	29.1 ± 8	94.0 ± 11	-64.9 ± 13	<.001
Forward flexion	170.76 ± 6	171.5 ± 6	-0.76 ± 5	.467	169.9 ± 6	170.3 ± 6	-0.39 ± 5	.667
ER in adduction	65.8 ± 4	65.6 ± 4	0.17 ± 4	.83	67.1 ± 1	67.1 ± 2	0.05 ± 2	.878
Return to sport, n (%)		26/29 (90%)			35/36 (97%)			.207
Return to same level		21/26 (80%)			30/35 (86%)			.395

ASOSS, Athletic Shoulder Outcome Scoring System; ER, external rotation; pre, preoperative; post, postoperative.

apprehension. Both patients were treated conservatively with no evidence of screw loosening at last follow-up, which suggested a fibrous union between the graft and the glenoid.

In the axial view, 92% (60/65 cases) were positioned within the target range (-5 to +3 mm). In contrast, 3% (2/65 cases) were considered lateralized and 5% (3/65 cases) were considered medialized. On the preoperative imaging studies, 5 shoulders (7.6%) had mild (stage 1) glenohumeral osteoarthritis. At final follow-up, 7 shoulders (10.7%) were graded as mild (stage 1) osteoarthritis. Sixty shoulders (92.4%) were free of arthritis (stage 0). No cases of moderate or severe arthritis were observed in this study. All the lesions were "on-track" in the postoperative 3DCT evaluation 3 months after surgery.

Complications and Recurrences

The total complication rate was 10.8% (7/65 patients) and the revision rate was 1.5% (1/65 patients). A summary of the complications and their general management is shown in the Table 6.

Discussion

The main findings of this study were that in high-risk competitive athletes with anterior glenohumeral instability and glenoid bone loss <20%, the Latarjet procedure resulted in excellent functional outcomes, with most of the patients returning to sports and at the same level they had before injury with a low rate of recurrences. Moreover, outcomes were equally favorable in patients undergoing a primary or a revision

procedure and in patients operated with the classic or the congruent-arc technique.

In general, the sports results reported after arthroscopic Bankart repair in athletes have been favorable.^{22,23} However, in competitive high-risk athletes (such as those included in our study), the results have not been so encouraging.^{5,6,24-26} Among these are collision athletes, those who practice forced overhead sports and athletes with a previous failed Bankart stabilization surgery.^{5-7,24-26} Trinh et al.²⁷ recently reported the clinical outcomes of 49 overhead athletes undergoing primary arthroscopic anterior shoulder stabilization. At 2-year follow-up, only 63% of athletes returned to sports and only 45% were able to return to their previous levels of competition. Buckup et al.²⁸ evaluated 20 athletes who underwent arthroscopic revision stabilization after failed primary arthroscopic Bankart repair. The authors reported that only 70% of the patients were able to return to their original sporting activities at the same level and 90% of the patients described a limitation in their shoulder when participating in their sports. Petrera et al.²⁴ compared the return to sports rate after Bankart repair in collision versus noncollision athletes and reported that only 73% of collision athletes were able to return to sports at their preinjury levels compared with 81% of noncollision athletes. Other authors also reported low rates of return to preinjury levels of competition in collision athletes after arthroscopic Bankart repair, ranging between 25% and 40%.^{5,6,24-26}

In our study, 94% of the athletes returned to sports and 84% returned at the same level they had before injury. It is important to emphasize that 68% of the

Table 4. Comparative Outcomes Between Patients Operated With the Classic and the Congruent-Arc Procedures

	Classic Latarjet (n = 26)			P Value	Congruent-Arc Latarjet (n = 39)			P Value
	Pre	Post	Delta		Pre	Post	Delta	
Rowe	50.3 ± 15	94.8 ± 7	-44.5 ± -17	<.001	52 ± 15	94.6 ± 7	-42.5 ± 16	<.001
ASOSS	29.6 ± 9	95.0 ± 9	-65.4 ± 14	<.001	27.8 ± 6	89.6 ± 18	-61.7 ± 18	<.001
Forward flexion	170.6 ± 5	170 ± 6	0.66 ± 6	.55	169.9 ± 6	171.5 ± 6	-1.6 ± 4	.05
ER in adduction	66.6 ± 2	66.6 ± 3	-0.03 ± 2	.9	66.5 ± 3	66.3 ± 3	35.22 ± 3	.73
Return to sport, n (%)		28/30 (93%)			33/35 (94%)			.87
Return to same level		23/30 (77%)			28/35 (80%)			.74

ASOSS, Athletic Shoulder Outcome Scoring System; ER, external rotation; pre, preoperative; post, postoperative.

Table 5. Results of Functional Scores by Type of Sports

		Rowe	ASOSS
G1	12 (18%)	95 ± 5	90 ± 22
G2	35 (54%)	94 ± 8	92 ± 16
G3	9 (14%)	97 ± 7	97 ± 4
G4	9 (14%)	96 ± 9	91 ± 2
P value		.55	.04

ASOSS, Athletic Shoulder Outcome Scoring System.

patients included in our series performed collision or forced overhead sports. We believe that this is a relevant finding of our study since although Latarjet surgery has shown high return to sport rates in patients with significant bone deficit,^{22,23} there is very little information in the literature addressing sports results of this technique in competitive high-risk athletes with a glenoid deficit <20%.

Another relevant finding of our study was that although 55% of patients had a previous surgery, when we compared primary and revision surgeries, we found no significant differences in the percentage of patients who returned to the same level they had before the injury (80% vs 86% respectively). In a recent systematic review, Abdul-Rassoul et al.²² evaluated the amount of time needed for athletes to return to sport after different surgical treatments for anterior shoulder instability. Return to sports occurred at a mean of 5.9 months after arthroscopic Bankart, 5 months after open Latarjet and 5.8 months after arthroscopic Latarjet. In our series, the mean interval between surgery and return to competition was 5.6 months. No significant difference regarding return to sport rates was found between primary and revision cases and between patients operated with the classic and the congruent arc technique.

Regarding functional outcomes, both open and arthroscopic Latarjet have shown excellent functional scores.^{29,30} In a recent systematic review, Hurley et al.³¹ evaluated the functional outcomes after the open Latarjet procedure at a minimum follow-up period of 10 years. The most commonly used functional outcome score was the Rowe score, with a weighted mean average of 88.5. Although this represents a very good clinical outcome, no study included patients without glenoid bone loss. In our study, the final Rowe score was 95, which is in line with the results reported in patients with severe bone deficit. Moreover, 95% of the patients achieved a clinically significant improvement that exceeded the MCID for the Rowe scores. We evaluated shoulder-dependent sport ability with the ASOSS score, which showed an excellent final performance of the patients' shoulders after returning to sports. No significant difference in shoulder ROM and functional scores was found between primary and revision cases and between patients operated with the classic and the congruent arc technique. This is an

important finding of this study, since glenoid bone loss as low as 13.5% has been associated with unacceptable clinical outcomes in a young, active population with the Bankart repair.⁹ Shaha et al.⁹ retrospectively evaluated 72 consecutive patients with anterior glenohumeral instability and glenoid bone loss <25% who underwent isolated anterior arthroscopic labral repair. The group was divided into quartiles based on bone loss. The authors reported that the mean Western Ontario Shoulder Instability Index score correlated with Single Assessment Numeric Evaluation scores and worsened as bone loss increased in each quartile. Specifically, in patients with glenoid bone loss >13.5%, the Western Ontario Shoulder Instability Index score increased to rates consistent with a poor clinical outcome.

The main problem facing competitive high-risk athletes undergoing an open or arthroscopic Bankart repair is the high recurrence rate.^{5-7,24-26} Recurrences not only generate new structural damage to the shoulder but also leave athletes between 5 and 7 months out of the competition.^{5-7,24-26} In a recent systematic review, Alkaduhimi et al.⁷ evaluated redislocation risk after the arthroscopic Bankart procedure and reported that collision athletes have an increased absolute risk of 8.0 for development of postoperative instability in comparison to noncollision athletes (*P* = .001). Specifically, the recurrence rates reported in risk athletes have been between 31% and 51% in collision sports, between 12.5% and 21.5% in forced overhead sports, and between 15% and 42% in patients with a previous failed Bankart repair.^{28,32-35}

As an alternative to reduce the rate of recurrences, some authors propose performing a remplissage in addition to the Bankart repair in patients presenting with an off-track Hill–Sachs lesion.^{36,37} Although remplissage has proven effective in the general population, there is very little information on the results of this procedure in young high-risk athletes such as those included in our study. Yang et al.³⁸ compared remplissage with modified Latarjet for off-track Hill-Sachs lesions with subcritical glenoid bone loss. An arthroscopic Bankart procedure with remplissage (group A) was performed in 98 patients, and modified Latarjet

Table 6. Summary of Complications and Their Treatment

Complications	Frequency	Management
Graft nonunion	3/65 (4.5%)	The 3 patients were asymptomatic so they were managed conservatively
Recurrence	2/65 (3%)	
Dislocations	1/65 (1.5%)	Revised with autologous iliac bone graft
Subluxations	1/65 (1.5%)	Conservative treatment
Superficial wound infection	1/65 (1.5%)	Oral antibiotics, 2 weeks
Musculocutaneous Neuropraxia	1/65 (1.5%)	Full recovery with conservative treatment

(group B) was performed in 91 patients. In a multivariate analysis, the odds of recurrence in the remplissage group were greater than in the Latarjet group in patients with previous instability surgery (3.56, $P = .006$), collision and contact athletes (2.37, $P = .02$), those with 10% to 15% glenoid bone loss (1.28, $P = .04$), and those with >15% glenoid bone loss (6.48, $P = .001$). The authors concluded that Latarjet appears to be a better choice in patients with revision instability surgery, collision and contact athletes, and those with >10% glenoid bone loss. In a recent systematic review, Paulino Pereira et al.³⁹ compared the risk of redislocation after the Latarjet procedure between collision and non-collision athletes. The pooled risk difference to develop a post-operative redislocation between collision athletes and noncollision athletes was 0.00 ($P = .370$). Although the studies included in the review evaluated patients with significant glenoid bone deficit, our study confirms that Latarjet surgery is also a highly effective procedure to prevent recurrences in competitive risk athletes with glenoid bone deficit <20%. In our study, after an average follow-up of 53 months, we had only 4.6% of recurrences (2 of 65 patients).

The rates of complications and revisions associated with the Latarjet surgery in patients with significant glenoid bone deficit vary between 7% and 30% and between 3% and 7%, respectively.⁴⁰⁻⁴² The rates of complications and revisions in our series were 11% and 1.5% respectively. These were similar to those reported in the series with patients operated with major defects.⁴⁰⁻⁴² A particular concern related to the Latarjet surgery performed in patients with glenoid bone deficit <20% is the possibility of resorption of the coracoid graft. The coracoid graft has been reported to suffer significantly more osteolysis in patients without previous minor glenoid bone defects compared to those with significant glenoid bone loss.^{43,44} One possible explanation for these findings is that according to Wolff's law, bone that is not under load is reabsorbed due to lack of mechanical stimulation.⁴⁵ However, different authors have shown that patients who presented greater resorption of the bone block did not present greater apprehension or recurrences than patients with less resorption. The authors argue that this could be due to the compensatory mechanism provided by the conjoint tendon.^{43,44} Therefore, partial lysis of the coracoid that occurs frequently only rarely leads to persistent apprehension and unsatisfactory results and is not considered a complication by most authors but an expected biological reaction of the bone consolidation process described by Wolff.^{43,44} Complete graft reabsorption is very rare and has been described in less than 1% of the cases.^{40,41} In our study, we had no resorption or fragmentation of any graft. We believe that this was due to the fact that, at the time of preparation of the anterior edge of the glenoid, we resected 2 to 4 mm of

bone until we reached the bleeding spongy bone to achieve adequate bone consolidation between the coracoid graft and the anterior face of the glenoid. As the glenoid widens from anterior to posterior surface, this allowed us to achieve a suitable support surface for the coracoid graft. Consequently, we ensured that the entire graft would be in contact with the anterior face of the glenoid surface, thus maximizing the chances of consolidation.

Limitations

The present study has some limitations that should be mentioned. In the first place, we did not have a control group operated with another technique to compare our results. Second, although for the majority of the main variables evaluated we had an adequate follow-up, for others such as osteoarthritis, the follow-up of our series was limited. Third, we used 2 types of Latarjet surgery in the series. The first group of patients were operated with the congruent arch technique and the following with the classic technique. To avoid biases associated with the interpretation of the results according to the type of Latarjet used, we presented the comparative results between both types of Latarjet procedures.

Conclusions

In high-risk competitive athletes with anterior glenohumeral instability and glenoid bone loss <20%, the Latarjet procedure resulted in excellent functional outcomes, with most of the patients returning to sports and at the same level they had before injury with a low rate of recurrences.

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