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Ninety-day complication rate based on 532 Latarjet procedures in Dutch hospitals with different operation volumes

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Background: In this study, we aimed to provide insight into the 90-day complication rates following the Latarjet procedure. Data from 2015 were collected from multiple hospitals in the Netherlands, with different volumes of Latarjet procedures. Our second aim was to examine which patient and surgical factors were associated with complications.
Methods: We conducted a retrospective chart review of 13 hospitals between 2015 and 2022. Data regarding complications within 90 days of Latarjet procedures were extracted. The effect of sex, age, body mass index (BMI), smoking, previous shoulder operations, fixation material, hospital volume, screw size, and operation time on the complication rate was assessed by multivariable logistic regression analysis.
Results: Of the 532 included patients, 58 (10.9%) had complications. The most common complications were material failure (n = 19, 3.6%) and nerve injury (n = 13, 2.4%). The risk of complications was lower for male patients than for female patients (odds ratio, 0.40; 95% confidence interval, 0.21-0.77; $P = .006$). Age, BMI, smoking, previous shoulder operations, type of fixation material, hospital volume, screw size, and operation time were not associated with complications.
Conclusion: The 90-day complication rate after the Latarjet procedure was 10.9% and was higher in female patients than in male patients. Age, BMI, smoking, previous shoulder operations, type of fixation material, hospital volume, screw size, and operation time did not affect complication rates. We advise setting up a national registry to prevent under-reporting of complications.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Latarjet; shoulder; instability; glenohumeral; complication; sequelae

For anterior shoulder instability, bony procedures (eg, the Latarjet procedure) or soft-tissue procedures (eg, Bankart repair) can be performed.[19] During Bankart repair, a torn labrum is repaired using sutures and/or anchors, whereas during the Latarjet procedure, the coracoid with its attached tendons is transferred to the anteroinferior part of the glenoid.[12] The coracoid, as such, acts as an anterior buttress, and the conjoined tendon acts as a sling to prevent the shoulder from dislocating.[3,14] In general, the Latarjet procedure results in a lower redislocation rate compared with arthroscopic Bankart repair (2.7% vs. 15.1%, $P < .001$) but a higher complication rate (9.4% vs. 0%, $P = .002$).[16] Complications such as nerve injury, infection, hematoma, screw failure (migration, bending, or breakage), and bony nonunion are frequently encountered after the Latarjet procedure.[8,13] Although the complication rate of the Latarjet procedure is higher, there are not significantly more complications requiring revision compared with arthroscopic Bankart repair (5.0% vs. 3.1%).[1] Previous reports have shown that factors associated with complications after the Latarjet procedure include smoking,[2] increased age,[7,18] workers' compensation claim,[18] surgeon experience,[5] and use of 4.0- and 4.5-mm cannulated screws instead of 3.5-mm cortical screws.[18]

Most complication rates are reported for a longer term (ie, 30 days-316 months) after the operation.[2,6,7,9-11,17,18] Regarding the short-term complication rate, the literature is scarce. We found only 4 studies evaluating a total of 914 cases assessing the complication rate 90 days after the Latarjet procedure and 1 study assessing the 30-day complication rate in 163 patients (Table I).[2,6,10,11,17] Furthermore, there is a growing trend toward centralization in orthopedic surgery resulting in high-volume hospitals. An example of a program facilitating centralization is the Getting It Right First Time (GIRFT) program in the United Kingdom. Therefore, most studies assessing complication rates include data from high-volume hospitals. In this study, we aimed to provide insight into the 90-day complication rates of Latarjet procedures performed in multiple hospitals in the Netherlands from 2015. Each hospital performed a different volume of Latarjet procedures. Our second aim was to examine which patient and surgical factors were associated with complications. Our hypothesis was that the 90-day complication rate in Dutch hospitals with different volumes would be higher than the rates reported in the literature at high-volume centers summarized in Table I (>4%-9%). Our secondary hypothesis was that several patient and surgical factors (ie, sex, age, body mass index [BMI], smoking, previous shoulder operations, fixation material, hospital volume, screw size, and operation time) might affect the risk of complications.

Methods

This was a multicenter retrospective study. This study has been reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement guidelines (Supplementary Appendix S1).

Patient selection and data acquisition

Sixteen surgeons from the Dutch Shoulder and Elbow Society were recruited to share data on Latarjet procedures and complications in their hospitals. All surgeons operating on shoulders and elbows in the Netherlands are members of the Dutch Shoulder and Elbow Society. The digital care systems of all collaborating hospitals were scanned for patients who underwent Latarjet procedures between 2015 and the time of data acquisition (Table II). We included operations performed the surgeons who participated in this study, as well as operations performed by surgeons in the same hospitals as the participating surgeons. It is mandatory to

Table I Studies assessing 30- to 90-day complication rates

Study	Study design	Patients, n	Complications, n (%)	Specification of complications	Reoperations, n (%)	Specification of reoperations
Scanlon et al[17]	Retrospective cohort	441	19 (4)	Coracoid fracture in 1 Anaphylactic reaction to vancomycin in 1 Bicipital pain requiring biceps tenodesis in 1 Hematoma in 12 Infection in 4	4 (1)	Irrigation and débridement for surgical-site infection in 2 Evacuation of hematoma in 1 Biceps tenodesis for bicipital pain in 1
Hurley et al[11]	Retrospective cohort	Open: 110 Arthroscopic: 40	Open: 4 (4) Arthroscopic: 2 (5)	Open Wound infection in 2 Graft fracture in 1 Nerve injury (axillary nerve, resolved after 3 weeks) in 1 Arthroscopic Infection in 1 Graft fracture in 1	Open: 2 (2) Arthroscopic: 1 (3)	Open Revision with distal tibial allograft due to graft fracture in 1 Irrigation and débridement for deep wound infection in 1 Arthroscopic Revision with distal tibial allograft due to graft fracture in 1
Hendy et al[10]	Retrospective case control	190	17 (9)	Graft and/or hardware failure in 9 Nerve injury in 6: combined axillary and suprascapular nerve injury in 2, musculocutaneous nerve injury in 1, brachial plexopathy in 1, peripheral sensory nerve deficit (likely axillary) in 1, and sensory plexopathy in 1 Dislocation in 2	8 (4)	Revision Latarjet procedure due to graft failure in 4 Distal tibial allograft due to graft failure in 1 Iliac crest autograft due to graft failure in 1 Iliac crest autograft due to dislocation in 1 Nicola procedure failed due to dislocation with subsequent arthrodesis in 1
Frank et al[6]	Retrospective cohort	133	10 (8)	Recurrent instability in 2 Infection in 3 Nerve injury (musculocutaneous nerve or ulnar nerve) in 2 Postoperative pain (rotator cuff tendinitis) in 1 Complex regional pain syndrome in 1 Hematoma in 1	6 (5)	Hemiarthroplasty after recurrent instability in 1 Total shoulder arthroplasty in 1 Irrigation and débridement due to infection in 2 Musculocutaneous nerve decompression in 1 Subacromial decompression in 1
Bokshan et al[2,*]	Retrospective cohort	163	9 (5.5)	Infection in 4 Deep vein thrombosis in 3 Sepsis in 2	7 (4.3)	Not specified

* The study by Bokshan et al included the 30-day complication rate but not the 90-day complication rate.

Table II Date of data acquisition per hospital

Hospital	Date of data acquisition
Deventer Hospital	April 15, 2019
Spijkenisse Medical Center	May 7, 2019
OLVG	May 28, 2019
University Medical Center Groningen	July 18, 2019
DC Clinics	July 22, 2019
Haga Hospital	January 17, 2020
Alrijne Hospital	April 17, 2020
St Antonius Hospital	September 30, 2020
Meander Medical Center	November 23, 2020
Amphia Hospital	November 23, 2020
Spaarne Gasthuis	March 12, 2021
Central Military Hospital	March 18, 2022
Flevo Hospital	June 18, 2022

have complication registries in Dutch hospitals. The complication registries of the corresponding hospitals were collected and screened for complications within 90 days of Latarjet procedures. To ensure that no complication was missed, the records of hospital visits were also screened for complications.

The Latarjet procedure was defined as a transfer of the coracoid with the conjoined tendon regardless of the fixation method. A complication was defined as any adverse event related to the Latarjet procedure requiring treatment within 90 days of the Latarjet procedure, such as nerve injury, infection, major hematoma, material failure, nonunion, or malunion. A patient with a nerve injury was defined as a patient referred to a neurologist with or without an additional electromyography and/or nerve conduction study. Graft malposition that was discovered after 90 days was also included because malpositioning occurs during the operation.

A higher-volume hospital was defined as a hospital in which >40 Latarjet procedures were performed between 2015 and 2020. Subsequently, 6 of the 13 hospitals evaluated were classified as higher-volume centers whereas the other 7 were deemed lower-volume centers.

Population characteristics

Alongside complication rates, data regarding patient characteristics and surgical characteristics were extracted. Patient characteristics included age, sex, BMI, smoking status, and previous instability surgery. Surgical characteristics included duration of operation and data regarding fixation method: screw or cortical button, number of screws or cortical buttons, and screw diameter. The exclusion criteria were patients who underwent concomitant procedures and/or were lost to follow-up.

Rehabilitation

The rehabilitation protocols were analogous in all participating hospitals. A sling was worn for 2-6 weeks postoperatively. Movement was limited to 90° of flexion and abduction and 0° of external rotation for the first 6 weeks. After 6 weeks, active and passive ranges-of-motion exercises were performed. Sport-specific exercises were performed after 3 months.

Statistical analysis

To answer our primary study question, complication rates were calculated and presented descriptively. For our secondary question, we performed a multivariable logistic regression analysis. If observations on the predictor variables were missing, these variables were not included in the multivariable logistic regression analysis. In the multivariable logistic regression analysis, screw size was divided into 2 groups: ≤3.5 mm and >3.5 mm. We also performed backward elimination for the multivariable logistic regression with a P value cutoff of .157.[15] $P < .05$ was considered significant. Statistical analysis was performed with Stata software (version 14; StataCorp, College Station, TX, USA).

Results

We identified 537 patients who underwent Latarjet procedures. Of these patients, 5 (0.93%) were excluded because no data regarding complications were reported (loss to follow-up owing to further control visits at another hospital after the surgeon left the hospital). The remaining 532 patients were included in the final analysis. Eleven patients underwent arthroscopic Latarjet procedures, whereas all other patients underwent open Latarjet procedures. Demographic characteristics and the number of complications per demographic factor are summarized in Table III. The number of Latarjet procedures performed per hospital varied from 5 to 116. The complication rate per hospital ranged from 2.7% to 25%. The average age at the time of the operation was 29.9 ± 10.1 years. A total of 94 patients (17.7%) were women and 438 (82.3%) were men. In total, 58 complications (10.9%) occurred (Table IV). Of the 8 infections, 1 was superficial, requiring antibiotics, and 7 were deep, requiring a second surgical procedure.

The average age of the patients with complications was 28.9 ± 10.6 years, and the average age of the patients without complications was 30.1 ± 10.0 years. The average BMI was 24.4 ± 5.7 kg/m^2 in patients with complications and 20.7 ± 22.4 kg/m^2 in patients without complications. The mean operation time was 81.3 ± 39.4 minutes in patients with complications and 80.5 ± 26.9 minutes in patients without complications. All patients underwent 2-screw fixation except for 3 patients who underwent fixation with 1 screw and 2 patients who received 3 screws.

Multivariable logistic regression

Because of the limited numbers of patients with diabetes (n = 3), patients receiving anticoagulants (n = 11), patients receiving cortical buttons (n = 5), patients receiving bone anchors (n = 2), and patients treated by arthroscopic Latarjet procedures (n = 11), we excluded these factors from the multivariable analysis. The remaining variables (sex, age, BMI, smoking, previous shoulder operations, fixation material, hospital volume, screw size, and operation time) were included in the multivariable analysis. A total of

Table III Demographic characteristics

Variable	Patients, n (%)	Complications, n (% of total of patients per factor)
Sex		
Male	438 (82.3)	41 (9.4)
Female	94 (17.7)	17 (18.1)
Age, yr		
Volume of center		
Lower-volume hospital	172 (32.3)	19 (11.0)
Higher-volume hospital	360 (67.7)	39 (10.8)
Diabetes		
Yes	3 (0.6)	1 (33)
No	491 (99.4)	53 (10.8)
Anticoagulant use		
Yes	11 (2.2)	1 (9.9)
No	483 (97.8)	53 (11.0)
Smoking		
Yes	162 (30.5)	18 (11.11)
No	368 (69.4)	40 (10.9)
Previous instability surgery		
Yes	197 (37.0)	23 (11.7)
No	335 (63.0)	35 (10.4)
Fixation method		
Cortical screw	140 (26.7)	14 (10)
Cannulated screw	180 (34.2)	19 (10.6)
Cortical button	5 (1.0)	0 (0)
Plate with screw	155 (29.5)	18 (11.6)
Cancellous screw not fully threaded	43 (8.2)	6 (14.0)
Bone anchor	2 (0.4)	0 (0)
Screw size		
3.0 mm	49 (9.6)	3 (6.1)
3.2 mm	31 (6.1)	4 (12.9)
3.4 mm	14 (2.7)	1 (7.1)
3.5 mm	181 (35.4)	20 (11.0)
3.6 mm	10 (2.0)	1 (10)
3.75 mm	136 (26.6)	18 (13.2)
4.0 mm	74 (14.5)	7 (9.5)
4.5 mm	16 (3.1)	3 (18.75)
Operation time, min		

508 cases were evaluated in the multivariable analysis. Sex was significantly associated with complications, with male patients having a lower risk (odds ratio, 0.40 [95% confidence interval, 0.21-0.77]; $P = .006$). The other variables did not affect complication rates. In addition, after the application of backward elimination, only sex affected complication rates (odds ratio, 0.44 [95% confidence interval, 0.24-0.83]; $P = .011$). All outcomes regarding the multivariable analysis are summarized in Table V. The complications among female patients consisted of nerve injury in 6 (6%), material failure in 5 (5%), graft malposition in 3 (3%), recurrent instability in 2 (2%), and tendon irritation in 1 (1%). The complications among male patients comprised nerve injury in 7 (2%), infection in 8 (2%), bleeding in 3 (1%), material failure in 14 (3%), graft malposition in 3 (1%), recurrent instability in 3 (1%), lung embolism in 2 (0.5%), and frozen shoulder in 1 (0.2%).

Table IV Complications

Complication	Patients with complications	
	n	%
Material failure	19	32.8
Nerve injury	10	17.2
Infection	8	13.8
Graft malposition	6	10.3
Recurrent instability	5	8.6
Bleeding	4	6.9
Frozen shoulder	3	5.2
Lung embolism	2	3.4
Tendon irritation requiring corticosteroid injection	1	1.7

Discussion

In our study population, 58 complications (10.9%) occurred within 90 days of the Latarjet procedure. The risk of complications was lower for male patients in comparison to female patients but was not significantly affected by age, BMI, smoking, previous shoulder operations, fixation material, hospital volume, screw size, and operation time.

Our results are different from those reported in the existing literature. First, our complication rate is higher than generally reported in the literature: 10.9% vs. 4%-9% (Table I).[2,6,10,11,17] We presume that this may be related to the participation of hospitals with low volumes of Latarjet surgical procedures. Furthermore, in the Netherlands, we have mandatory complication registries that are monitored yearly by the Dutch government. As a result of such complication registries, the staff of Dutch hospitals has become more focused on reporting complications. This could explain the higher complication rate in our study. However, the multivariable analysis did not reveal an association between higher and lower volumes and the complication rate. We speculate that this may be because of more complex cases being referred to higher-volume centers. These more complex cases could be more difficult to operate on and might be accompanied by more comorbidity or more bone loss, both resulting in a higher complication rate. Another explanation is that we evaluated volumes per hospital and not volumes per surgeon. We considered hospitals to be high-volume hospitals if >40 Latarjet procedures were performed over a 5-year period because surgeons achieve a level of proficiency after 22 open Latarjet procedures and most of the hospitals had 2-3 surgeons operating on shoulder instability patients.[5] Evaluating volumes per hospital could lead to an overestimation of the

Table V Results of multivariable analysis

Factor	Coefficient	95% CI for coefficient	OR	95% CI for OR	*P* value
Sex: male (reference category, female)	−0.92	−1.57 to −0.26	0.40	0.21-0.77	.006
Age	−0.02	−0.05 to 0.01	0.98	0.95-1.01	.196
BMI	0.02	−0.01 to 0.04	1.02	0.99-1.04	.267
Smoking: yes (reference category, no)	0.03	−0.56 to 0.65	1.03	0.55-1.92	.927
Previous instability surgery: yes (reference category, no)	−0.02	−0.63 to 0.59	0.99	0.53-1.81	.957
Fixation method (reference category, cortical screw)					
Cannulated screw	0.19	−0.64 to 1.02	1.21	0.53-2.79	.651
Plate with screw	0.06	−1.12 to 1.25	1.07	0.33-3.49	.913
Cancellous screw not fully threaded	0.02	−1.42 to 1.47	1.02	0.24-4.33	.976
Volume of center: higher volume (reference category, lower volume)	−0.02	−0.77 to 0.73	0.98	0.46-2.07	.953
Screw size: >3.5 mm (reference category, ≤3.5 mm)	−0.16	−0.83 to 1.15	1.17	0.44-3.15	.752
Operation time	0.001	−0.01 to 0.01	1.0	0.99-1.01	.807

CI, confidence interval; *OR*, odds ratio; *BMI*, body mass index.

volumes of Latarjet procedures that are performed per surgeon (eg, in a high-volume hospital with many surgeons performing Latarjet procedures, it could be that surgeons do not perform the Latarjet procedure that often). An alternative could be to assess the effect of the volumes of shoulder instability surgery per surgeon or volumes of shoulder surgery per hospital or surgeon on complication rates. However, we did not have access to these data. Second, in our population, only male sex was associated with a decreased risk of complications. In previous literature, relevant factors affecting complication rates were surgeon experience, smoking, increased age, workers' compensation claim, and screw type and size.[2,7,18] We do not have an explanation for this discrepancy. We speculate that the fact that male sex was less associated with complications is a result of hyperlaxity (female patients are more prone to have shoulder hyperlaxity, most likely because of higher levels of relaxin) and anatomic differences (female patients have a more oval-shaped glenoid).[4] Although the relaxin theory could explain the differences in recurrence rates, it does not provide an explanation for the other differences, (eg, nerve injury). Furthermore, the difference in the sample sizes between male patients and female patients hampers interpretation of the observed difference in complication rates. A more precise estimate of the difference between sexes requires a larger number of female patients.

These findings add relevant information to the existing literature, in which high-volume hospitals have been overrepresented. This study also includes low-volume hospitals and is the largest original study assessing 90-day complication rates after the Latarjet procedure (532 patients vs. 133-441 patients).

Our results should be interpreted in light of several limitations. First, owing to the retrospective design of this study, not all potentially relevant variables were available for analysis, such as operation indication, Instability Severity Index Score, amount of bone loss, and postoperative graft positioning. Therefore, it was not possible to explore how these variables affect the incidence and type of complications. Second, despite the substantial number of participating hospitals and patient data, only 58 complications occurred within the 90-day period assessed. This limits the statistical power to demonstrate the influence of potential prognostic variables. Nevertheless, with 58 complications, the power is considered sufficient to detect 3-6 prognostic variables. Therefore, the lack of power does not explain why no variable other than sex was associated with the risk of complications in our study. Third, the BMI of the Dutch patients included in our study is representative of a fairly normal body habitus. Therefore, we cannot draw conclusions regarding the effect of BMI on complications. Fourth, we cannot exclude the possibility that surgeons with high complication rates may have been less likely to participate. Moreover, complications were potentially missed if a patient did not go back to the same surgeon or hospital. To improve future research and the quality of health care, we are developing a nationwide registry to capture all surgical procedures and complications prospectively.

Future studies should have a prospective design to ensure that milder complications are not missed. Furthermore, blinding of assessors was not possible because of the retrospective character of our study. The lack of blinding may lead to under-reporting of complications. For example, surgeons could be less prone to report on transient neuropathy owing to its self-limiting character. This issue cannot be solved by questioning patients retrospectively because of potential recall bias. In addition, the effect of complications on patient-reported outcomes and satisfaction should be studied. A milder complication might have an impact on rehabilitation and thus may affect patient-reported outcomes and satisfaction.

Given the popularity of the Latarjet procedure and the growing need for assessment of the potential benefits and

risks of this operation, it is advisable to set up a registry database comparable to the arthroplasty registry. Registries provide a large amount of essential information regarding outcomes and can be used to adjust the tools and operative techniques needed for better outcomes. By setting up a national registry database, under-reporting of complications can be prevented by collecting data prospectively, and thus, the risks of retrospectively collecting data can be avoided. Furthermore, the long-term complication rates can be registered and analyzed in a national registry. This can improve our understanding of the clinical course after the Latarjet procedure.

Conclusion

The 90-day complication rate after the Latarjet procedure was 10.9% and was higher in female patients than in male patients. Age, BMI, smoking, previous shoulder operations, type of fixation material, hospital volume, screw size, and operation time did not affect complication rates. We advise setting up a national registry to prevent under-reporting of complications.

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