IN BRIEF

Shoulder Arthroplasty in Hemophilia

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Abstract

The aim of this article is to perform a review of the literature on the current status of shoulder arthroplasty in people with hemophilia (PWH). A search was conducted in PubMed on December 8, 2024, using the keywords "hemophilia" and "shoulder arthroplasty." To date only 4 articles (84 shoulder arthroplasties) in PWH have been published. A recent study with level 3 of evidence has found that five-year implant survival was similar in PWH (97.3%) than in matched controls (95.2%) suggesting that total shoulder arthroplasty (TSA) survivorship endures lasting and might be proposed to PWH. However, the high risks of both 90-day bleeding complication and venous thromboembolism (VTE) in PWH stressed the special dares of scrupulously weighing factor replacement and VTE prophylaxis pre-, intra-, and postoperatively on an individual patient basis with cautious hematologist coordination.

Level of evidence: III

Keywords: Hemophilia, Prosthetic survival, Results, Shoulder, Shoulder arthroplasty

Introduction

Patients with hemophilia who are not adequately treated from birth from the hematological point of view (correct replacement of the deficient clotting factor) will have repeated joint bleeds (hemarthroses) in one or more of the large joints (elbows, knees and ankles, and less frequently shoulders and hips). As a consequence, between the second and third decade of life they will suffer severe degeneration of the affected joint(s) (hemophilic arthropathy). When the pain and functional disability caused by hemophilic arthropathy is very severe and has not responded to conservative treatment [analgesics, cyclooxygenase-2 inhibitors (COX-2 inhibitors), intraarticular injections of hyaluronic acid and Physical and Rehabilitation Medicine methods], the affected joint(s) will need to be treated surgically.[1-4]

Shoulder problems in people with hemophilia (PWH) have always been very rare, even when treated on demand from the hematologic point of view.[5] the objective of this article is to perform a review of the literature on the results and adverse events of shoulder arthroplasty in PWH.

Main body

We conducted a search of the literature in PubMed on December 8, 2024, using "hemophilia" and "shoulder arthroplasty" as keywords. Of the 18 articles identified, only 4 articles have been found concerning shoulder arthroplasty in PWH.

Shoulder prosthesis in hemophilia

In 1995 Phillips et al reported the first case of shoulder arthroplasty in hemophilia. The patient experienced a bio-modular (Biomet, Inc.) total shoulder replacement via an anterior approach. Both components were cemented. Preoperative pain disappeared and the result was encouraging at 3-year follow-up.[6]

In 2004 Dalzell et al reported the results of three shoulder hemiarthroplasties carried out on two men.[7] Case 1 was a 52-year-old man with mild hemophilia A (left shoulder). No intraoperative complications happened. Factor VIII (FVIII) started 1 hour before surgery, with a continuous infusion into the postoperative period. Total FVIII consumption for the intervention was estimated to be 47,250 units. The follow-up was 8 months. Right hemiarthroplasty was performed 15 months after the left hemiarthroplasty. This second procedure was similar to the first except that an interscalene block with ropivacaine hydrochloride was used for postoperative pain relief. The follow-up was 5 months. Case 2 was a 57-year-old man with severe hemophilia A. A right uncemented hemiarthroplasty was performed with

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partial resection of the subscapularis tendon, and an interscalene block was inserted. Total FVIII usage for the procedure was estimated at 79,500 units. The follow-up was 8 months. There were no surgical or postoperative adverse events. Pain diminished and range of motion (ROM) and function improved postoperatively. Pain relief was essential in allowing early postoperative rehabilitation and movement. An interscalene block was used in two of the three reported surgeries. Patient number 1 had standard patient-controlled analgesia (PCA) for the first procedure; however, an interscalene block was used for the second. Pain relief was much more effective with the interscalene block, and there was a more rapid improvement in ROM and strength following surgery. The challenge to achieve adequate pain relief in the first procedure may have been influenced by prolonged preoperative oxycontin use. Postoperative pain relief for patient number 2 was also highly effective with the interscalene block permitting early rehabilitation. Dalzell et al concluded that hemiarthroplasty could be a feasible alternative to manage severe chronic shoulder pain as a result of hemophilic arthropathy of the shoulder. These authors suggested that interscalene blocks could be an efficacious means of pain alleviation for shoulder arthroplasty.[7]

In 2011 Wendt et al reported the results of seven shoulder arthroplasties (6 men): 4 total shoulder arthroplasties, 3 humeral head replacements between 1997 and 2007.[8] Mean age 47.6 years (range, 26-70). Mean follow-up: 13.8 years (range, 33-323 months). There were 4 right and 3 left shoulders. Three patients had severe hemophilia, 1 of which had a FVIII inhibitor. Three patients had mild hemophilia A, 1 of which had a FVIII inhibitor. Two of the patients were HIV (human immunodeficiency virus) and hepatitis C positive. Two patients were hepatitis C positive only and 2 were negative for both. There were seven Cofield (Smith and Nephew, Memphis, TN, USA) bony ingrowth humeral components. There were 4 Cofield (Smith and Nephew) cemented, all polyethylene glenoid components. No patients underwent a rotator cuff repair. All patients underwent careful soft-tissue balancing. None of the shoulders required revision or reoperation. There were no postoperative hematomas and no patients required a washout. None of the operative records indicated abnormal bleeding. Average blood loss was estimated at 475 cc (200-1100 cc). Two patients required intraoperative transfusions, no patient required a postoperative transfusion. Pain alleviation was accomplished in 5 individuals (6 shoulders). ROM improved in all cases after surgery. According to the modified Neer score there were 2 excellent, 4 satisfactory, and 1 unsatisfactory outcome. One individual suffered a transient brachial plexus neuropraxia which resolved spontaneously over the course of several months. All surgeries were performed only after FVIII levels were above 75%. Two patients were pre-admitted to increase their FVIII levels. The 3 patients with severe hemophilia were treated with FVIII postoperatively to maintain levels above 75% and all were sent home with 2 weeks of FVIII home infusions. One of these patients required FEIBA (FVIII inhibiting bypassing agent) because of an inhibitor. Of the 4 surgeries performed on patients with mild hemophilia, 1 was managed with cryoprecipitate, 2 with FVIII and desmopressin, and 1 with FVIII only. All of these were managed with a postoperative goal of a FVIII level above 50%. After 3 of these surgeries the patients were sent home with infusions. The results of shoulder arthroplasty in this series were moderate with two excellent, four satisfactory and only one unsatisfactory result. ROM was functional in six of seven patients. There were no revisions or complications requiring reoperation. According to Wendt et al prosthetic arthroplasty was a reasonable surgical option for painful hemophilic arthropathy with loss of glenohumeral cartilage when performed with the support of a hematologist.[8]

In a study with level 3 of evidence published in 2024 by Gillinov et al, the 2010 to 2022 PearlDiver M161 database was utilized to identify PWH who experienced primary anatomic or reverse TSA (total shoulder arthroplasty).[9] Male individuals with hemophilia A who experienced TSA (study group, N = 73) were matched 1:10 with male individuals without hemophilia who experienced TSA (control group, N = 729) based on age and Elixhauser comorbidity index (ECI). Ninety-day complications were compared with multivariable analysis. Revision within 5 years was evaluated utilizing Kaplan-Meier analysis. Compared with the control group, PWH had greater odds of bleeding complications (anemia, hematoma, transfusion), venous thromboembolism - VTE (deep vein thrombosis - DVT and pulmonary embolism - PE), and prosthetic loosening. Five-year implant survival was similar in PWH (97.3%) than in matched controls (95.2%) suggesting that TSA survivorship endures lasting and might be proposed to PWH. The high risks of both 90-day bleeding complication and VTE in PWH stressed the special dares of scrupulously weighing factor replacement and VTE prophylaxis pre-, intra-, and postoperatively on an individual patient basis with cautious hematologist coordination.[5] Main data on shoulder arthroplasties performed in PWH are summarized in [Table 1].[6-9]

Table 1. Shoulder arthroplasties in people with hemophilia (PWH).[6-9]

AUTHORS [REFERENCE]	YEAR	METHODS	RESULTS	CONCLUSIONS
Phillips et al [6]	1995	Case report (58-year-old man with hemophilia B). Total shoulder replacement (Biomet, Inc.) was performed via an anterior approach. Both components were cemented.	Preoperative pain and hemarthroses disappeared. ROM was satisfactory.	At 3-year follow-up the result was encouraging.
Dalzell et al [7]	2004	Three shoulder uncemented hemiarthroplasties carried out on two men. Type and brand of the hemiarthroplasties were not mentioned. Follow-up between 5 and 8 months.	There were no surgical or postoperative adverse events. Pain diminished and ROM and function improved postoperatively.	Hemiarthroplasty may be a feasible alternative to manage severe chronic shoulder pain as a result of hemophilic arthropathy of the shoulder.

Table 1. Continued

Wendt et al [8]	2011	Seven shoulder arthroplasties (6 men): 4 total shoulder arthroplasties, 3 humeral head replacements between 1997 and 2007. Mean follow-up: 14 years. There were seven Cofield (Smith and Nephew, Memphis, TN, USA) bony ingrowth humeral components. There were 4 Cofield (Smith and Nephew) cemented, all polyethylene glenoid components. No patients underwent a rotator cuff repair. All individuals underwent careful soft-tissue balancing. Three of the 7 shoulders required cancellous bone grafting of the glenoid for cystic erosions.	None of the shoulders required revision or reoperation. Pain alleviation was accomplished in 5 individuals (6 shoulders). According to the modified Neer score there were 2 excellent, 4 satisfactory outcomes, and 1 unsatisfactory outcome. One individual suffered a transient brachial plexus neuropraxia which resolved spontaneously over the course of several months.	The results of shoulder arthroplasty in this series were moderate with two excellent, four satisfactory and only one unsatisfactory result. Prosthetic arthroplasty is a reasonable surgical option for painful hemophilic arthropathy with loss of glenohumeral cartilage when performed with the support of a hematologist.
Gillinov et al [9]	2024	The 2010 to 2022 PearlDiver M161 database was used to identify patients who underwent primary anatomic or reverse total shoulder arthroplasty. Male patients with hemophilia A who underwent TSA were matched 1:10 with male patients without hemophilia who underwent TSA based on age and ECI. This yielded 73 patients with hemophilia A who underwent TSA who were matched 1:10 with 729 patients without hemophilia. Ninety-day adverse events were compared with multivariable analysis. Revision within 5 years was assessed using Kaplan-Meier analysis.	Compared with the control cohort, patients with hemophilia had greater odds of bleeding issues (hematoma, anemia, transfusion), venous thromboembolic events, and prosthetic loosening. Based on available data, 5-year implant survival was not different in patients with hemophilia (97.3%) relative to matched controls (95.2%).	The elevated risks of both 90-day bleeding complications (hematoma, anemia, and transfusion) and VTE (DVT and PE) in patients with hemophilia A emphasized the special challenges of carefully balancing factor replacement and VTE prophylaxis pre-, intra-, and postoperatively on an individual patient basis with careful hematologist coordination.

ROM = range of motion; TSA = total shoulder arthroplasty; ECI = Elixhauser comorbidity index; VTE = venous thromboembolism; DVT = deep vein thrombosis; PE = pulmonary embolism.

Although our center has extensive experience in the treatment of hemophilia and the implantation of shoulder prostheses, we have not yet needed to perform this type of surgery on hemophiliac patients. It has been published that in individuals with primary glenohumeral osteoarthritis with an intact rotator cuff, the reverse total shoulder arthroplasty (RTSA) has given ROM and clinical results but lower adverse events and revision rates as compared to the total shoulder arthroplasty.[10]

According to Hays, RTSA was historically reserved for the elderly, low-demand individual with rotator cuff arthropathy (RCA) or as a salvage procedure after failed primary arthroplasty. However, surgeon expertise and the advancement of implant design has permitted RTSA to now become commonplace not only for RCA but also for glenohumeral osteoarthritis. RTSA provides a robust glenoid baseplate fixation, which permits for easier and more dependable bone grafting or augmentation when required. For individuals with severe glenoid bone loss, RTSA has been demonstrated to have superior or equivalent patient-reported outcomes and shoulder ROM when compared with TSA.[11]

Hemostatic management

Guidelines for target factor levels and duration of postoperative hemostatic support in shoulder arthroplasty surgery may be observed in [Table 2].[12,13]

Table 2. Recommendations for peak factor levels and duration of factor replacement in shoulder arthroplasty in people with hemophilia (PWH).[12,13]

	HEMOPHILIA A	HEMOPHILIA B
Preoperative peak factor activity objective	80%-100%	60%-80%
Postoperative peak factor activity objective	60%-80% (days 1-3) 40%-60% (days 4-6) 30%-50% (days 7-14)	40%-60% (days 1-3) 30%-50% (days 4-6) 20%-40% (days 7-14)

Postoperative rehabilitation

Postoperative rehabilitation programs usually consist of increasing ROM progressively, first passively and then actively, and then incorporating progressive stretching and strengthening. Post-surgical rehabilitation will preferably be done with hematologic coverage in prophylactic mode. The phases of the rehabilitation program are shown in [Table 3].[14-16] However, we should remind that most of the described steps may be not applicable to hemophilic subjects, mostly due to elbow stiffness or rotator cuff degeneration. Therefore, the general principles of postoperative rehabilitation mentioned above should be adapted to each particular case.

We think that the designs of shoulder prostheses to be used

in hemophilic shoulder arthropathy are similar to those used in shoulder osteoarthritis. Fractures of the proximal humerus have nothing to do with hemophilic arthropathy. Regarding postoperative rehabilitation, it is similar to that used in shoulder osteoarthritis, provided that hemostasis is perfectly controlled by the hematologists in charge of the patient.

In 2014 Casado-Sanz stated that when the hemophilic shoulder is severely damaged, shoulder arthroplasty may be the only alternative for treatment. Replacement of the shoulder yields to satisfactory pain alleviation, especially when a glenoid component can be implanted. In cases with glenoid bone stock deficit, it may be impossible to replace it, and hemiarthroplasty may be the only alternative.[17]

Table 3. Phases of the rehabilitation program after shoulder arthroplasty.[14-16]

INMEDIATE POSTOPERATIVE PERIOD	Immobilization is necessary to favor the union of the tuberosities and soft tissues, and to avoid the risk of dislocation. However, such immobilization is usually associated with postoperative stiffness, which is the reason why some authors support rehabilitation programs starting early, although there is currently no evidence of their benefit. In the early stages soft tissue protection is essential, which is achieved by wearing a shoulder sling for 4-6 weeks after surgery, to be removed for rehabilitation and home exercise sessions.
DURING THE FIRST 2 WEEKS	A sling will be used for the most part. Passive kinesitherapy should be started by facilitating elevation up to 90º, without rotational movements. Free exercises of the adjacent joints (cervical, elbow, wrist and hand) can also be performed.
BETWEEN WEEKS 2 AND 6	Passive mobility should continue to be worked on, expanding the ROMs. Gaining most of the ROM is essential before beginning active muscle work. We can use pulleys and advance flexion to about 140° and external rotation to about 40°. One of the fundamental principles is the recovery of the mobility of the scapulothoracic joint for anatomic arthroplasties and especially for reverse arthroplasties. In addition, the following particularities must be taken into account in this phase depending on the type of implant. In the anatomical shoulder prosthesis, protection of the subscapularis muscle is essential in these first weeks to maintain the integrity of the healing tendon, which is achieved by limiting external rotation during passive mobilization and avoiding active internal rotation. The first movements will be performed in the plane of the scapula to limit tension on the capsule, maintaining a more centered position of the humeral head on the glenoid. In the inverted shoulder prosthesis, to minimize the risk of dislocation, humeral internal rotation and adduction positions should be avoided in this early postoperative period, especially in combination with shoulder extension. The inverted prosthesis is most stable in a position of approximately 30° of external rotation. In cases of inverted arthroplasty where a tendon transfer has been performed to help restore external rotation (usually of the latissimus dorsi and teres major), the shoulder should be immobilized for about 6 weeks in 30° of abduction and 30° of external rotation to promote healing.
BETWEEN WEEKS 6 AND 12	We can begin with passive mobilization of movements restricted up to that time and extend the ranges of mobility of those already initiated. A gradual progression of strengthening can also be initiated, initially with active-assisted or active-against-gravity exercises to those performed with various levels of resistance in the neutral position. Special attention to strengthening the periscapular muscles can help facilitate the increased demands of scapular movement and avoid complications. Key muscles are the serratus anterior, lower trapezius, rotator cuff muscles (when present) and the deltoid. The deltoid is fundamental in the inverted prosthesis because it offers stability and constitutes the only motor of the glenohumeral joint. In the inverted prosthesis, strengthening exercises of the deltoid and scapula are key to the success of the rehabilitation. The introduction of loading will be done initially with isometric exercises, and gradually progress to overhead activities.
FROM WEEK 12 ONWARDS	ROMs should be maintained and strengthening should be progressed gradually, incorporating exercises against resistance in the different planes of space. We must take into account that it is common to find a later gain of strength in internal rotation after an anatomical prosthesis and of external rotation in inverted prostheses. We must add proprioceptive training exercises and encourage the gradual return to more functional activities. Progress should also be made in the home exercise program.

ROM = range of motion

Is there any difference between postoperative rehabilitation and the type of shoulder prosthesis to be used in hemophilic arthropathy and proximal humerus fracture?

Regarding the type of prosthesis, in the study of Bolam et al (2024), RTSA for proximal humeral fracture (PHF) demonstrated reliable long-run survivorship and functional results compared with elective indications. Despite lower functional results in the early postoperative period for the PHF group, implant survivorship was similar in individuals experiencing RTSA for the primary indication of acute PHF compared with RCA, osteoarthritis, and rheumatoid arthritis and superior compared to the primary indication of old traumatic sequelae.[18] As regards postoperative rehabilitation, it should be mentioned that it is basically similar in hemophilic arthropathy as in PHF.[14-16]

Conclusion

The conclusion of this paper is the result of the literature review, although some expert opinions have been included. This article has tried to provide the following new insight on the topic: it is reasonable to use the same current knowledge on shoulder arthroplasty in osteoarthritis of the general population in PWH requiring treatment of advanced hemophilic arthropathy by shoulder prostheses.

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References

1. Rodriguez-Merchan EC. The current role of ankle arthrodesis in hemophilic patients. Arch Bone Jt Surg 2022; 10(2):129-134. doi: 10.22038/abjs.2020.47865.2366.
2. Mortazavi SJ, Daneshpoor SM, Shafiei SH. Total Hip Arthroplasty in Patients with Hemophilia: What Do We know? Arch Bone Jt Surg. 2023; 11(7):434-440. doi: 10.22038/ABJS.2023.58812.291.
3. Rodriguez-Merchan EC. Total hip arthroplasty in hemophilic patients: are their results similar to those of nonhemophilic patients? Arch Bone Jt Surg. 2024; 12(5):357-360. doi: 10.22038/ABJS.2024.76984.3555.
4. Rodriguez-Merchan EC. Primary total knee arthroplasty in hemophilia and allied disorders: revision rates and their causes. Arch Bone Jt Surg. 2024; 12(6):428-432. doi: 10.22038/ABJS.2024.76697.3544.
5. Rodriguez-Merchan EC. The role of orthopaedic surgery in haemophilia: current rationale, indications and results. EFORT Open Rev 2019; 4(5):165-173. doi: 10.1302/2058-5241.4.180090.
6. Phillips AM, Ribbans WJ, Goddard NJ. Ipsilateral total shoulder and elbow prosthetic replacement in a patient with severe haemophilia B. Haemophilia 1995; 1(4):270-273. doi: 10.1111/j.1365-2516.1995.tb00088.x.
7. Dalzell R. Shoulder hemiarthroplasty to manage haemophilic arthropathy: two case studies. Haemophilia 2004; 10(5):649-654. doi: 10.1111/j.1365-2516.2004.00923.x.
8. Wendt MC, Sperling JW, Cofield RH. Shoulder arthroplasty in hemophilic arthropathy. J Shoulder Elbow Surg 2011; 20(5):783-787. doi: 10.1016/j.jse.2010.08.025.
9. Gillinov SM, Modrak M, Park N, et al. Total shoulder arthroplasty in patients with hemophilia A: greater odds of postoperative bleeding and thromboembolic events but no difference in 5-year implant survival. Clin Orthop Relat Res. 2024. doi: 10.1097/CORR.0000000000003209. Online ahead of print.
10. Vij N, Tummala S, Shahriary E, Tokish J, Martin S. Total shoulder arthroplasty versus reverse shoulder arthroplasty in primary glenohumeral osteoarthritis with intact rotator cuffs: a meta-analysis. Cureus. 2024; 16(4):e57866. doi: 10.7759/cureus.57866.
11. Hays C. Current role of reverse total shoulder arthroplasty in the management of glenohumeral osteoarthritis. Orthop Clin North Am. 2024; 55(4):489-502. doi: 10.1016/j.ocl.2024.05.001.
12. Poston JN, Kruse-Jarres R. Perioperative hemostasis for patients with hemophilia. Hematology Am Soc Hematol Educ Program. 2022; 2022(1):586-593. doi: 10.1182/hematology.2022000387.
13. Alvarez-Roman MT. Hemostatic cover in orthopedic surgery. Blood Coagul Fibrinolysis. 2023; 34(S1):S22-S25. doi:

10.1097/MBC.0000000000001201.

14. Tuphe P, Caubriere M, Hubert L, et al. Early rehabilitation after reverse total shoulder prosthesis on fracture of proximal humerus in elderly patients provides better functional outcome. Eur J Orthop Surg Traumatol 2023; 33(7):2951-2957. doi: 10.1007/s00590-023-03505-1.
15. Kirsch JM, Namdari S. Rehabilitation after anatomic and reverse total shoulder arthroplasty: a critical analysis review. JBJS Rev. 2020;8(2):e0129. doi: 10.2106/JBJS.RVW.19.00129.
16. Polio W, Brolin TJ. Postoperative rehabilitation after shoulder arthroplasty. Phys Med Rehabil Clin N Am. 2023; 34(2):469-479. doi: 10.1016/j.pmr.2022.12.010.
17. Casado-Sanz E, Barco-Laakso R, Antuña S, Rodriguez-Merchan EC. Shoulder surgery in hemophilia. In: Joint Surgery in the Adult Patient with Hemophilia. Rodriguez-Merchan EC, eds. Springer International Publishing AG, Switzerland, 2014, pp 37-42.
18. Bolam SM, Wells Z, Tay ML, Frampton CMA, Coleman B, Dalgleish A. Reverse total shoulder arthroplasty for acute proximal humeral fracture has comparable 10-year outcomes to elective indications: results from the New Zealand Joint Registry. J Shoulder Elbow Surg. 2024; 33(9):1946-1954. doi: 10.1016/j.jse.2024.01.024.