The shoulder

- Arthritis in one or more joints in the shoulder is a common disorder, but often goes unnoticed for an extended period due to increased compensatory mobility in the other joints of the shoulder.
- Synovectomy in the glenohumeral joint has a good potential for providing pain relief and improving mobility if performed before joint deterioration has become too extensive.
- Lateral clavicle resection should probably be considered more often than is currently the case. The procedure is relatively minor and may possibly replace prosthetic surgery in some patients where the shape of the clavicular head of the humerus is retained and the articular cartilage of the glenohumeral joint is somewhat preserved.
- The results of prosthetic surgery are highly favorable, particularly concerning pain relief, and are improving as the procedure becomes increasingly more common and as more types of prostheses become available. The effect on mobility is determined more by the condition of the soft tissues than by the type of prosthesis.
- Secure fixation of a glenoid component is difficult to achieve with the prostheses and fixation methods currently available. Glenoid replacement, however, does not seem to be required to achieve good pain relief and mobility.

Good, pain-free mobility of the shoulder is decisive to the function of the upper extremity. It pays poorly to reconstruct a rheumatically deformed hand if the patient cannot move it freely due to limited mobility in the shoulder and elbow. The shoulder and elbow should therefore be assessed at an early stage concerning the possibility of surgical intervention.

To date, surgery in the shoulder joint has been used relatively sparingly, most likely due to the good chances of compensatory mobility in other joints of the shoulder region, but also due to limited surgical alternatives.

When considering surgical treatment of a shoulder problem, it must be remembered that all tissues are affected by inflammation. The pathological soft tissue changes revealed at the time of surgery are extremely variable and difficult to predict, as opposed to the conditions in arthritic patients.

Scope of the problem

Symptoms from the shoulder are common. Between 80% and 90% of hospitalized rheumatic patients or patients with more than 15 years of illness, have been reported to have radiological changes and more or less severe symptoms from the shoulder [7,14,27,36]. Arthritis in the glenohumeral (GH) joint and the acromioclavicular (AC) joint is most common. Radiographic deterioration of the GH joint progresses as mobility is lost, with increasing duration of rheumatoid arthritis. Disease in the AC joint is probably often overlooked as a cause of pain in the shoulder [17]. Clinical signs of AC joint arthritis have been reported in 34% and radiographic changes in 85% of rheumatics with a painful shoulder [29]. Arthritis in the sternoclavicular joint is more unusual and seldom requires surgical intervention.

In Lund, approximately 20 prosthetic shoulder joint operations are performed yearly, which would correspond to a nationwide need of approximately 200 prosthetic operations/year.

Indications and surgical methods

The shoulder belongs to the joint systems which can be favorably treated by local steroids. Thorough pain analysis should proceed such injection treatment. The cause of the shoulder pain may be localized elsewhere, even in patients with consid-

erable radiographic destruction of the GH joint. Intraarticular injection into the GH joint and/or the AC joint and intrabursal administration usually result in good and more-or-less extended relief of problems, despite approximately 60% of the injections being incorrectly placed [8]. Patients who received correctly placed injections reported greater gains in mobility.

Therapy-resistant swelling of the subacromial bursa, which is seen in approximately 20% of rheumatics with shoulder pain [27], may indicate a bursectomy [35]. Often there is concurrent AC joint arthritis and the procedure can then be combined with a lateral clavicle resection. Isolated painful AC joint arthritis can be treated by clavicle resection, possibly in combination with anterior acromioplasty, a procedure which can provide good pain relief in patients with massive rotator cuff rupture [35].

Synovectomy in the GH joint is seldom relevant, because when the patient starts to develop significant shoulder problems and is hence referred for assessment, there is usually pronounced joint destruction. Whether or not a surgeon specialized in rheumatic diseases will see the patient early enough for a synovectomy to be meaningful, is determined by the patient's problems and by the referring physician being familiar with the procedure. Otherwise, a patient with pain at rest, somewhat well preserved joint surfaces, and a productive synovitis is appropriate for synovectomy. It appears to be advantageous to perform synovectomy in the GH joint arthroscopically, but the literature is lacking in data to support this.

Resection-interposition arthroplasty involves the joint surfaces being evened out and a membrane (usually Lyodura®) being interposed between the head of the humerus and the glenoid. The method has been used much in Germany, but rarely in Scandinavia, probably due to the postoperative course often being long and troublesome and the risk of instability. A prosthesis is most likely the superior material for interposition.

Lately, arthroplasty by endoprosthesis, either as a hemiprosthesis or as a total prosthesis with a glenoid component, has become an increasingly common procedure on the indication of mobility pain in shoulders with destruction of the glenohumeral joint. Restoring the center of mobility in the GH joint is important for achieving good leverage for the deltoid muscle and the rotator cuff, and normal tension in other soft tissue parts. The outcome of prosthetic surgery, apart from the correct positioning of the prosthesis, is determined by the quality of the soft tissue parts, not least the rotator cuff [9,33].

The first, and probably still most used, humerus prosthesis is the Neer prosthesis. Many types of prosthetic devices have been both introduced and taken off the market during the past 15–20 years. Recent trends have favored modular humeral prostheses, of various styles, with a conical connection between the humerus component's shaft and articular head. It is too early to determine the durability of these prostheses. The glenoid prosthesis was introduced much later, but the hemiprosthesis is still widely used, while waiting for better methods for the fixation of a glenoid component.

Although there is consensus that arthroplasty with a prosthesis to a high extent provides reliable pain relief and functional gain in rheumatics, there has often been different opinions on the necessity to replace the glenoid. Both pain relief and mobility have been reported to improve more following a total arthroplasty compared to a hemiarthroplasty [2]. Similar results concerning both pain relief and gain in mobility have also been found [20]. In a study comparing total arthroplasty and hemiarthroplasty in rheumatics, no difference in pain relief was found, but the hemiarthroplasties achieved a better ability for active elevation [31]. Greater gains in mobility after hemiarthroplasty were also shown in another study [16]. In a recently published review article concerning the necessity of replacing the glenoid, it is noted that a review of the literature gives more support for hemiarthroplasty than for total arthroplasty both in patients with inflammatory disease of the GH joint and in patients with an injured rotator cuff [32].

An argument against hemiarthroplasty is that bone loss in the glenoid accelerates, which may make reoperation difficult [34]. However, the bone quality of patients with extensive preoperative bone loss is such that safe fixation of a glenoid component is nearly impossible. This is reflected by the rather high frequency of development of a radiographic zone (probably a pro-stage

to loosening) in most studies [1,9,11,19,22,37,41], and high frequencies of prosthetic loosening on the glenoid side [1,11,19]. Preservation of the original glenoid also excludes that plastic wear products would cause or accelerate prosthetic loosening.

Arthrodesis in the shoulder very rarely is a reasonable alternative to prosthesis in patients with polyarticular joint disease. The procedure may be considered in younger patients with somewhat preserved bone quality, but arthrodesis places excessively great demands on the patient during the healing period, and also involves a risk for stiffness in the elbow and hand during the fixation period.

Rehabilitation

The postoperative course after prosthetic surgery is usually uncomplicated. Rehabilitation, however, often takes a long time compared to corresponding time after hip and knee surgery, mostly due to the substantial preoperative muscular atrophy which commonly affects most patients. A carefully designed individual program for gradually increasing training of mobility and muscular strength based on surgical findings is important for achieving optimal results.

Surgical treatment results

Synovectomy

Experience from synovectomy in the shoulder is limited. The only large patient material reported after 1985 is one from Norway [26]. Fifty-four synovectomied shoulders were followed for 5.3 (1–16) years. At the time of followup, 6 had been converted to a prosthesis and 10 continued to have pain, however not extensive enough to make them desire a reoperation to implant a prosthesis. No patient showed swelling as a sign of resynovitis and on average they gained little in mobility, mostly in flexion. 75% showed no radiographic changes, while the remainder showed progressive radiographic changes. It appears from this study that prosthetic surgery could be avoided, or at least be postponed, by performing a synovectomy before the radiographic changes become too extensive. However, the procedure, as opposed to prosthetic surgery, requires extensive input from both the physical therapist and the patient during rehabilitation.

In a German study, 75 shoulders were reported, followed for 6 (1–13) years [40]. 80% of shoulders operated at an early stage were free from pain, but only 60% of those at later stages. 70% could manage their personal hygiene postoperatively, compared to 33% preoperatively, probably due to improved ability for inward rotation.

In a study from Malmö of 15 patients, 12 were free from pain and satisfied with treatment 2 years after surgery, while two had been reoperated with a prosthesis [28]. A comparison was made with 18 prostheses operated during the same time period. Seven out of eleven hemiarthroplasties and 2/7 total shoulder arthroplasties still reported pain. The conclusion was that synovectomy, if performed early in the course, can alleviate pain just as well as a prosthesis. Making meaningful comparisons between study data and methods requires precise classification systems for defining the preoperative condition of the joint. Arthroscopic examination of the joint ought to prove useful for this purpose.

Resection–interposition arthroplasty

In a database of 22 operated shoulders followed for 3 (1–5) years, one became infected and one unstable, significant pain relief was reported in the remaining shoulders and most had made functional gains [39]. Another study followed 29 shoulders for 2 (1–5) years; 20 shoulders were pain free, while three developed problems of instability [23]. In Sweden, there is some experience from Uppsala [24]. Initially, good pain relief and mobility gains were reported in 13 operated patients. Long-term rehabilitation was required for restoring muscular strength, but long-term results are unknown. The method may be considered as an alternative after unsuccessful prosthetic surgery or arthrodesis.

Prosthetic surgery

Patients with inflammatory joint disease usually have osteopenia, weak muscles, and a thin or ruptured rotator cuff, which makes it important to an-

Table 1. Clinical and radiological results of prosthetic surgery in the shoulder

Author	No. shoulders	Followup years	Prosthetic type[a]	Pain-relief %	Radiographic zon (%) Hum	Glen	Lossening (%) Hum	Glen	Compl (%)
Cofield (1984)	24	3 (1–6)	T	92	–	–	0	4	–
Pahle&Kvarnes (1985)	64	6 (1–12)	T	80		–	6 (totalt)		22
Figgie et al. (1988)	50	5 (2–9)	T	80	8	36	0	6	0
Barrett et al. (1989)	140	5 (2–11)	T	93	12	82	5	10	7
Hawkins et al. (1989)	34	4 (2–9)	T	91	–	–	0	6	9
McCoy et al. (1989)	29	3 (1–8)	T	–	31	86	0	0	24
Friedman et al. (1989)	24	5 (2–10)	T	92	0	42	0	8	–
Swanson (1989)	10	4 (1–6)	BP	100	0	–	0	–	10
Thomas et al. (1990)	30	4 (2–10)	T	–	13	33	0	7	7
Rydholm&Sjögren (1993)	72	4 (2–10)	H	94	–	–	25	–	0
Kelly et al. (1987,1994)	36	10 (7–13)	T	88	56	67	25	25	6
Lee&Niemann (1994)	7	3 (2–4)	BP	86	–	–	14	–	14
vanCappelle&Visser (1994)	38	4 (1–10)	H	78	0	–	3	–	8

[a] T = total arthroplasty, H = hemiarthroplasty, BP = bipolar prosthesis
- = data missing

alyze the outcomes of prosthetic surgery in the shoulder of these patients, apart from those in arthritic patients. It is also important to remember that shoulder function free from pain depends not only on the condition of the GH joint, but also on the soft tissues surrounding the joint and other joints in the shoulder. Especially important is an AC joint free from pain, a intact rotator cuff, and good deltoid function.

Shoulder prostheses of various styles have now been used to treat rheumatic patients for several decades. Nevertheless, long-term followup is lacking. It is difficult to extract reliable data from the literature since different authors mix both diagnoses and prosthetic types in their studies. The majority of such mixed studies have follow-up periods of 3–4 years and show little gain in abduction and elevation, but often the largest gain is in rotation. Since it is difficult to measure isolated mobility of the GH joint, usually total shoulder mobility is reported, which is dependent also on the condition in the other joints included in the shoulder, and hence it is sometimes difficult to define how much of the effect on shoulder mobility that can be ascribed the prosthetic operation. Pain relief is always good, and approximately 90% outcome of "good-excellent" is standard [43].

Table 1 shows achieved pain relief and radiographic findings in pure rheumatic studies with a followup period exceeding 3 years [1,4,9,11,12, 18,19,21,22,25,34,37,38,42]. Of 558 operated shoulders, 89 (78–100)% were relieved from pain, 6 (0–25)% showed radiological loosening of the humerus component, 8 (0–25)% of the glenoid component, and the frequency of complications (infection, fracture, nerve damage, instability) was 10 (0–24)% in the eleven studies reporting complications.

Pain relief after joint replacement appears to be safer than the prosthetic fixation, at least on the glenoid side. It appears as if radiographic loosening of the glenoid component is common, but causes insignificant symptoms. An association between loosening of glenoid components and concurrent occurrence of rotator cuff injury [10] has been shown, and it has also been suggested that proximal migration of the humerus, which is common, changes the kinetics of the shoulder so that the risk of prosthetic loosening increases [1]. There is however no relationship between the clinical outcome and the degree of progressive proximal migration of humerus [20,31,34]. Nor does prosthetic loosening appear to have any significance for the clinical result [34].

Only a few studies have analyzed survivorship. With the endpoint defined as need for revision, or that the patient has either unchanged or more severe pain than he/she did preoperatively, 92% survival was found after 11 years for 25 prostheses in rheumatics compared to 74% in the total patient material of 53 shoulders [3].

Serious complications are uncommon. In an American study, the total risk for complications after 1459 prosthetic operations, performed on

different indications and reported in the literature between 1982–1992, is reported to be 14% [43]. This number includes instability, rotator cuff injury, ectopic ossification, prosthetic loosening, fracture, nerve damage, and infection. The only severe complications are fracture, the incidence of which is less than 2%, nerve damage with an incidence of less than 1%, and infection with a risk of approximately 0.5%. Use of a glenoid component is likely to increase the risk for complications, and an American review study reports 12% of complications after total shoulder arthroplasty, compared to 5% after hemiarthroplasty [6].

Modular and uncemented prostheses have recently become popular. The former provide better possibilities for achieving an optimal tension in soft tissues and restoring the center of mobility, but they also involve a risk for dislocations between the components and corrosion of the conical connection. There are no long-term results yet. Uncemented glenoid components have shown promising short-term results, but have the disadvantage of potentially causing more plastic wear and hence particle-induced prosthetic loosening [5]. Bipolar prostheses have also been introduced, a concept which has been used for decades in the hip and has now been reported in the shoulder in two small patient materials having short followup times [21,37].

The results of prosthetic surgery in the shoulder can be evaluated in terms of pain relief, improved mobility, functional improvement in the upper extremity, radiographic results, and complication frequency. There are several scoring systems ("scores") for evaluating shoulder function, but no consensus on which is best suited for patients with chronic inflammatory joint disease. Mobility in the shoulder emanates from four joints, and it is difficult to measure the mobility in a prosthetic GH joint alone. It appears more reasonable to evaluate the outcome based on postoperative function. Examples from four studies concerning functional gain are shown in Table 2 [4,19,34,42].

There are no long-term results published from revision surgery.

Finally, it should be emphasized that prosthetic surgery in the shoulder, besides providing pain relief in the shoulder, may also reduce problems in the neck and elbow [30].

Table 2. Functional gain after shoulder prosthesis. Percent of operated shoulder joints preoperatively and on followup

Author	n	Can manage personal hygiene (%)		Can use a comb (%)	
		Pre	FU	Pre	FU
Kelly (1987)	41	41	83	12	54
Barrett et al . (1989)	134	46	84	28	66
Rydholm&Sjögren (1993)	71	30	78	6	56
van Cappelle&Visser (1994)	41	39	71	29	61

Arthrodesis

Positioning of an arthrodesis for optimal function is very important and should be 20°–30° abduction, 20°–30° flexion, and 20°–30° inward rotation [13,15]. Arthrodesis may be considered in very young patients with severe bone destruction which almost makes secure prosthetic fixation impossible, or in the few who have severe pain despite having spontaneously developed, and become used to, very pronounced stiffness. Long-term postoperative immobilization is required, with the risks involved of stiffening of the other joints in the arm.

Only one report was found in the literature concerning rheumatics [13]. Of 25 operated shoulders followed during 0.5-6 years, 16 showed healing, and only four were said to have achieved "excellent" results concerning pain relief and function. In a comparison between prosthetic surgery and arthrodesis, Jonsson et al. could observe that both methods provide effective pain relief, while function after prosthetic surgery was superior to that after arthrodesis [15].

Other surgery

Isolated AC joint arthritis is uncommon, it generally occurs in combination with GH joint arthritis [30]. The natural course is known [29]. In the typical case, bone loss mainly occurs on the clavicular side, so that the lateral clavicle is gradually replaced by fibrous tissue. Obviously, it is doubtful whether it is necessary to surgically anticipate the natural course by performing a lateral clavicular resection. At earlier stages, however, this operation seems to provide significant pain relief. In shoulders with concurrent arthritis of the GH joint

and AC joint, but with maintained spherical shape of the humeral head, lateral clavicular resection should be considered as a first procedure [35]. In a Swedish study covering 13 AC joint resections, all but one of the patients were satisfied with their pain relief on examination 3.5 years after the operation [29]. In prosthetic surgery, the AC joint may be swollen, which is an early sign of arthritis, so that it limits the subacromial space and hence may jeopardize prosthetic function. In these cases it is probably of value to perform a resection. A combination of acromioplasty and lateral clavicular resection has also shown good results concerning pain relief and functional gain in shoulders with well preserved spherical shape of the humeral head [35].

References

1. Barrett WP, Thornhill TS, Thomas WH, Gebhart EM, Sledge CB. Nonconstrained total shoulder arthroplasty in patients with polyarticular rheumatoid arthritis. J Arthroplasty 1989: 4: 91-6.
2. Boyd AD, Thomas WH, Scott RD, Sledge CB, Thornhill TS. Total shoulder arthroplasty versus hemiarthroplasty. Indications for glenoid resurfacing. J Arthroplasty 1990; 5: 329-36.
3. Brenner BC, Ferlic DC, Clayton ML, Dennis DA. Survivorship of unconstrained total shoulder arthroplasty. J Bone Joint Surg 1989; 71-A: 1289-96.
4. Cofield RH. Total shoulder arthroplasty with the Neer prosthesis. J Bone Joint Surg 1984; 66-A: 899-906.
5. Cofield RH. Uncemented total shoulder arthroplasty. A review. Clin Orthop 1994; 307: 86-93.
6. Cofield RH, Bradley CE. Total shoulder athroplasty: complications and revision surgery. Instr Course Lectures 1990;39:449-62.
7. Crossan JF, Vallance R. Clinical and radiological features of the shoulder joint in rheumatoid arthritis. J Bone Joint Surg 1980; 62-B: 116.
8. Eustace J, Brophy D, Gibney R, Bresnihan B, Fitzgerald O. Comparison of the accuracy of steroid placement with clinical outcome in patients with shoulder symptoms. Ann Rheum Dis 1997; 56(1): 59-63.
9. Figgie HE III, Inglis AE, Goldberg VM. An analysis of factors affecting the long-term results of total shoulder arthroplasty in inflammatory arthritis. J Arthroplasty 1988; 3: 123-30.
10. Franklin JL, Barrett WP, Jackins SE, Matsen FA III. Glenoid loosening in total shoulder arthroplasty. J Arthroplasty 1988; 1: 39-46.
11. Friedman RJ, Thornhill TS, Thomas WH. Non-constrained total shoulder replacement in patients who have rheumatoid arthritis and classs-IV function. J Bone Joint Surg 1989; 71-A: 494-8.
12. Hawkins RJ, Bell RH, Jallay B. Total shoulder arthroplasty. Clin Orthop 1989; 242 :188-94.
13. Hämälainen, M. Arthrodesis of the shoulder joint in rheumatoid arthritis. Rheumatology 1989; 12: 127-35.
14. Hämälainen M. Epidemiology of upper limb joint affections in rheumatoid arthritis. In: Rheumatoid arthritis. Current trends in diagnostics, conservative treatment, and surgical reconstruction (Eds. Baumgartner H, Dvorak J, Grob D, Munzinger U, Simmen BR). Stuttgart: George Thieme Verlag, 1995: 158-61.
15. Jonsson E, Brattström M, Lidgren L. Evaluation of the rheumatoid shoulder function after hemiarthroplasty and arthrodesis. Scand J Rheumatol 1988; 17: 17-26.
16. Kechele P, Bamania C, Wirth MA, Seltzer DG, Rockwood CA. Rheumatoid shoulder: hemiarthroplasty vs total shoulder arthroplasty. J Shoulder Elbow Surg 1995; 4: 13.
17. Kelly IG. The source of shoulder pain in rheumatoid arthritis–usefulness of local anaesthetic injections. J Shoulder Elbow Surg 1994; 3: 62-5.
18. Kelly IG. Unconstrained shoulder arthroplasty in rheumatoid arthrits. Clin Orthop 1994; 307: 94-102
19. Kelly IG, Foster RS, Fisher WD. Neer total shoulder replacement in rheumatoid arthritis. J Bone Joint Surg 1987; 69-B723-6.
20. Kelly IG, Husain M, Stewart MPM. Hemiarthroplasty of the rheumatoid shoulder. 1995, 6th International Congress on Surgery of the Shoulder (ICSS) FS 042.
21. Lee DH, Niemann KMW. Bipolar shoulder arthroplasty. Clin Orthop 1994; 304: 97-107.
22. Mc Coy SR, Warren RF, Bade HA, Ranawat CS, Inglis AE. Total shoulder arthroplasty in rheumatoid arthritis. J Arthroplasty 1989; 4: 105-13.
23. Miehlke RK, Thabe H. Resection interposition arthroplasty of the rheumatoid shoulder. Rheumatology 1989; 12: 73-6.
24. Milbrink J, Wigren A. Resection arthoplasty of the shoulder in rheumatoid arthritis. A follow-up study. J Orthop Rheumatol 1990; 19: 432-436.
25. Pahle JA, Kvarnes L. Shoulder replacement arthroplasty. Ann Chir Gyn 1985; Suppl 198: 85-9.
26. Pahle JA. Experiences with synovectomy of the shoulder. Rheumatology 1988; 12: 31-9.
27. Petersson CJ. Painful shoulders in patients with rheumatoid arthritis. Scand J Rheumatology 1986; 15: 275-9.
28. Petersson CJ. Shoulder surgery in rheumatoid arthritis. Acta Orthop Scand 1986; 57: 222-6.
29. Petersson CJ. The acromioclavicular joint in rheumatoid arthritis. Clin Orthop 1987; 223: 86-93.
30. Plant MJ, Underhill A, Cliffe JE, Leach Am, Jones PW, et al. Rehabilitation and outcome after total shoulder replacement in rheumatic disease. J Orthop Rheumatol 1995; 8: 12-9.
31. Pollock RG, Deliz ED, McIlveen SJ, Flatow EL, Bigliani LU. Prosthetic replacement in rotator cuffdeficient shoulders. J Shoulder Elbow Surg 1992; 1: 173-86.
32. Rodosky MW, Bigliani U. Indications for glenoid resurfacing in shoulder arthroplasty. J Shoulder Elbow Surg 1996; 5: 231-248.

33. Rozing PM, Brand R. The influence of the preoperative status of the shoulder in shoulder arthroplasty. Rheumatology in Europe 1995; 24 suppl 3: 293.
34. Rydholm U, Sjögren S. Resurfacing of the humeral head in rheumatoid arthritis. J Shoulder Elbow Surg 1993; 2: 286-95.
35. Simpson NS, Kelly IG. Extra-glenohumeral joint shoulder surgery in rheumatoid arthritis: The role of bursectomy, acromioplasty, and distal clavicle excision. J Shoulder Elbow Surg 1994; 3: 66-9.
36. Stegers M, Tahira S, Miehlke RK. Involvement of the shoulder in rheumatoid arthritis. Rheumatology 1989: 12: 24-30.
37. Swanson AB. Bipolar implant shoulder arthroplasty. Rheumatology 1989; 12: 103-23.
38. Thomas BJ, Amstutz HC, Cracchiolo A. Shoulder atrhroplasty for rheumatoid arthritis. Clin Orthop 1991; 265: 125-8
39. Tillman K, Braatz D. Resection interposition arthroplasty of the shoulder in rheumatoid arthritis. Rheumatology 1989; 12: 68-72.
40. Tressel W, Köhler G, Mohing W. Synovectomy of the shoulder joint in rheumatoid arthritis. Rheumatology 1988; 12: 40-5.
41. Vahvanen V, Hämälainen M, Paavolainen P. The Neer II replacement for rheumatoid arthritis of the shoulder. Int Orthop 1989; 13: 57-60.
42. vanCappelle HGJ, Visser JD. Hemiarthroplasty of the shoulder in rheumatoid arthritis. J Orthop Rheumatol 1994; 7: 43-7.
43. Wirth MA, Rockwood CA. Complications of shoulder arthroplasty. Clin Orthop 1994; 307: 47-69.
44. Wirth MA, Rockwood CA. Complications of total shoulder-replacement arthroplasty J Bone Joint Surg 1996; 78-A: 603-16.