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Original article

Osteoarthritis of the shoulder in under-50 year-olds: A multicenter retrospective study of 273 shoulders by the French Society for Shoulder and Elbow (SOFEC)

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ABSTRACT

Introduction: Osteoarthritis (OA) of the shoulder in under-50 year-olds is rare, and treatment is delicate. Shoulder replacement incurs frequent long-term risk of progression and a high revision rate, making it unsuited to young active patients. The aim of the present study was to determine the epidemiology of shoulder OA in under-50 year-olds and to assess the clinical results of the various treatment options.
Hypothesis: The main study hypothesis was that well-conducted non-operative treatment can allow shoulder replacement to be postponed. The secondary hypothesis was that anatomic total shoulder arthroplasty (TSA) is the treatment of choice when other options fail.
Materials and methods: A multicenter retrospective study included primary (POA) and post-instability osteoarthritis (PIOA) in patients aged ≤ 50 years at symptom onset. Exclusion criteria comprised post-traumatic OA, rheumatoid arthritis and necrosis. Two hundred and sixty-six patients for 273 shoulders were included from 13 shoulder surgery centers: 2 types of non-operative treatment (28 by platelet-rich plasma [PRP] and 88 by viscosupplementation), 73 arthroscopies, and 150 implantations (62 humeral hemiarthroplasties [HA], comprising 10 hemi-metal, 24 hemi-pyrocarbon and 28 hemi-resurfacing; 77 anatomic total prostheses, and 11 reverse prostheses). Minimum follow-up was 12 months for non-operative treatment and 24 months for arthroplasty (some patients having both). Endpoints comprised Constant score, Subjective Shoulder Value (SSV) and number of complications/revision procedures.
Results: Mean age at treatment was 43 years (range, 23–65 years), with 75% male predominance. Symptom onset was earlier in PIOA than in POA: 36 vs. 39 years (range, 20–50 years). PRP and viscosupplementation postponed implantation by a mean 3.5 years in 86% of cases, as did arthroscopy in 56%. ER1 restriction was the most negative factor. At 74 months' follow-up for HA and 95 months for TSA, mean Constant score was significantly lower for HA (56 vs. 67; $p = 0.004$), with higher rates of complications (31% vs. 11%) and implant exchange (13% vs. 9%).

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Discussion/conclusion: PRP, viscosupplementation and arthroscopy allow implantation to be postponed until the shoulder becomes stiff and painful. In case of failure, TSA is the most effective solution in the medium-term.
Level of evidence: IV a; therapeutic study – investigating the results of treatment.

1. Introduction

Osteoarthritis (OA) of the shoulder in young subjects is problematic for 2 reasons: pathophysiology is poorly understood, and there is no consensus on treatment. Onset can be at less than 50 years, accounting for 5–10% of shoulder replacements [1–3].

It is disabling for the patient and a challenge for the surgeon. Anatomic total shoulder arthroplasty (TSA) is standardly recommended for centered osteoarthritis in young subjects [1–4], but long-term revision risk casts doubt on indications in a presumably active, potentially athletic and functionally demanding population. Complications rates are 12–15% at less than 5 years [5–7]: 5–6% horizontal instability or cuff tear [5,6,8], and 4% infection [9,10]. Long-term glenoid component loosening is also a major concern, with implant revision rates up to 70% at 15 years [11–14]. Some authors therefore manage young patients by a simple humeral implant. Hemiarthroplasty (HA), however, entails a risk of painful glenoid wear, with implant revision rates higher than for TSA [1]. It was recently recommended to replace chromium-cobalt (CrCo) humeral heads by pyrocarbon (PYC), with elasticity modulus close to that of bone, to reduce the risk of glenoid wear, with encouraging preliminary results [15].

It seems advisable, for young subjects, to be able to offer an alternative to implantation, such as platelet-rich plasma (PRP), hyaluronic acid or arthroscopy; however, no consensus exists.

The aim of the present study was to determine etiology in shoulder OA in under-50 year-olds and assess the clinical results of the various treatment options. The main study hypothesis was that well-conducted non-arthroplastic treatment provides clinical improvement allowing arthroplasty to be postponed. The secondary hypothesis was that, when arthroplasty is indicated, TSA is the most reliable option in the medium-term.

2. Material and method

2.1. Study protocol

A multicenter retrospective study was conducted by the French Society for Shoulder and Elbow (SOFEC), in 13 specialized shoulder centers. Patients signed their consent for use of clinical and radiological data.

Inclusion criteria comprised: age $\leq$ 50 years at diagnosis, treated for primary osteoarthritis of the shoulder (POA), post-instability osteoarthritis (PIOA), operated on or not, or other cause of OA (osteochondromatosis, chondrodysplasia, and collagenosis), with $\geq$ 12 months' follow-up in non-arthroplastic treatment and $\geq$ 24 months in arthroplasty.

Exclusion criteria comprised: post-traumatic OA (fracture sequalae) or OA following rotator cuff tear, systemic arthropathy (rheumatoid arthritis), osteonecrosis or tumor.

2.2. Techniques

Treatment option was at the surgeon's discretion, without preestablished criteria or randomization. Study treatments comprised 2 non-operative modalities (intra-articular PRP or viscosupplementation), 1 arthroscopic procedure and 5 types of arthroplasty:

- PRP: three 4cc intra-articular injections of pure PRP without leukocytes (ACP kit, Arthrex) under ultrasound control;
- hyaluronic acid: ultrasound or radioscopy-guided viscosupplementation with three 2 mL injections in our early experience, or 6 mL reticulated hyaluronic acid (Synvisc, Sanofi, Paris, France) later;
- arthroscopy: articular debridement/lavage with foreign body removal, with or without long head of the biceps tenotomy, anterior arthrolysis by capsulotomy and cuff interval opening in case of stiffness [16]. The axillary nerve was not explored or released;
- arthroplasty, with implant choice at the surgeon's discretion:
  - 3 types of humeral hemiarthroplasty (HA) without glenoid component: stem with metal head (HA-CrCo), stem with pyrocarbon head (HA-PYC) or stemless humeral head resurfacing (HHR) without stem,
  - anatomic TSA with cemented polyethylene (PE) or metal-back glenoid,
  - reverse shoulder arthroplasty (RSA).

2.3. Clinical and radiographic assessment criteria

Clinical assessment was based on Constant score [17] and Subjective Shoulder Value (SSV) [18] pre-treatment and at last follow-up in each treatment option. In case of failure of non-arthroplastic treatment (PRP, viscosupplementation, arthroscopy), the date of subsequent arthroplasty was recorded. Failure was defined by:

- arthroplasty after non-arthroplastic treatment;
- revision surgery after primary arthroplasty.

Preoperative OA stage was graded on AP radiographs following Samilson and Prieto [19] as 0: normal; 1: osteophyte < 3 mm; 2: osteophyte 3–7 mm; 3: osteophyte > 7 mm or joint incongruence. Glenoid morphology was graded A, B or C following Walch [20].

At last follow-up, AP view in neutral rotation assessed, depending on treatment option:

- HA: joint line loss by glenoid wear with or without humeral implant medialization;
- TSA: glenoid loosening with implant mobilization or continuous peripheral radiolucency;
- RSA: notch, according to Sirveaux et al. [21].

2.4. Statistics

Continuous variables were reported as mean (range) and categoric variables as number (percentage). The Student test for matched data was used for pre- to post-operative comparisons. Groups were compared on Mann-Whitney or Fisher exact test. Data collection and statistical testing used EasyMedStat (www.easymedstat.com; Neuilly-sur-Seine, France) and R software version 3.4.2 (The R Foundation). The significance threshold was set at $p < 0.05$.

3. Results

One hundred and nine patients were treated after failure, in several groups.

3.1. Demographics and epidemiology

Two hundred sixty-six patients (273 shoulders) were included: mean age 38 years (range, 20–50 years) at symptom onset and 43 years (23–65) at treatment; 68 females, 198 (74%) males (Table 1). OA was primary (POA, $n = 147$; 55%), post-instability (PIOA, $n = 111$; 42%) (6-fold more often anterior than posterior), or other ($n = 8$; osteochondromatosis, collagenosis, and chondrodysplasia).

There were no significant pre-treatment differences between POA and PIOA on SSV or Constant score (except for greater Strength in POA: $p = 0.004$), dominant side function or occupation. Symptom onset and treatment initiation were earlier in PIOA (36 vs. 39 years and 41 vs. 44 years respectively; $p = 0.002$). Type B glenoid was more frequent in POA (41%) than PIOA (22%) ($p = 0.001$).

3.2. PRP

Twenty-eight patients (10%) received PRP injection under ultrasound control, mainly in PIOA (57%) (Table 2). OA stage was Samilson 1 or 2 in 50% of cases; mean pre-treatment Constant score was 64 points and SSV 62%. At a mean 44 months, scores increased by 9 points and 11%, respectively. Pre-injection arthroscopy was performed in 11 patients (39%). Secondary arthroplasty was performed in 4 patients (14%); 86% of patients had no arthroplasty at a mean 3 years (range, 12–130 months).

3.3. Hyaluronic acid viscosupplementation

Eighty-eight patients received ultrasound or radioscopy-guided viscosupplementation by reticulated hyaluronic acid, mainly in POA (56%) (Table 2). Samilson stage was 1 or 2 in 56% of cases; mean pre-treatment Constant score was 50 and SSV 51%. At a mean 96 months' follow-up, scores increased by 12 points and 14%, respectively. Twenty-seven arthroscopies were performed (31%). Twenty-five arthroplasties were finally performed, but 86% of patients had no arthroscopy at a minimum 4 years' follow-up (range, 12–321 months).

3.4. Arthroscopy

Arthroscopy was performed in 73 shoulders in 66 patients, equally for POA and PIOA (Table 2). Samilson stage was 1 or 2 in 75% of cases; mean pre-treatment Constant score was 51 and SSV 51%. At a mean 62 months, scores improved by 13 points and 16%, respectively. Good results were associated with significantly better preoperative ER1 than poor results: $46^\circ \pm 28.3$ vs. $25^\circ \pm 24.3$ ($p = 0.003$). Thirty-two shoulders (44%) required arthroplasty, at a mean 46 months.

3.5. Metal and pyrocarbon stemmed hemiarthroplasty

There were 10 metal head (HA-CrCo) and 24 pyrocarbon head (HA-PYC) hemiarthroplasties. Samilson stage was 3 in 50% of cases (Table 3). The 2 groups were comparable preoperatively, but with significantly longer follow-up in HA-CrCo (92 vs. 36 months; $p = 0.03$). In HA-CrCo and HA-PYC, mean preoperative Constant score was 38 and 46 respectively and SSV 36% and 41%, with no difference according to type of implant or prior surgery. At last follow-up, mean Constant score had increased by 13 points in HA-CrCo and 24 points in HA-PYC, and SSV by 19% and 34%. There were 5 cases of painful glenoid wear: 2 in HA-CrCo (20%) and 3 in HA-PYC (13%). In HA-CrCo, there were 3 revision procedures (30%), all for implant exchange: 2 cases of painful glenoid wear and 1 cuff tear (Fig. 1a and b). In HA-PYC, there were 4 revision procedures (17%): 2 exchanges due to painful glenoid wear (Fig. 2a and b), and 1 lavage for deep infection with instability testing.

3.6. Humeral resurfacing (without stem)

Twenty-eight patients had HHR. Samilson stage was 3 in 42% of cases; mean preoperative Constant score was 44 and SSV 40%. At a mean 78 months, scores had improved by 14 points and 21%, respectively, with no difference according to make of implant or prior surgery. There were 6 cases of radiologic glenoid wear (22%), and 5 revision surgeries: 1 early cutibacterium acnes infection treated by lavage without exchange, 1 subscapularis tear treated by anterior latissimus dorsi transfer and arthrolysis, and 3 of the 6 cases of glenoid wear requiring implant exchange (Fig. 3). There were no differences in any Constant score components or SSV between the 34 HAs (CrCo and PYC) and 28 HHRs.

3.7. Anatomic total shoulder arthroplasty

Seventy-seven patients had anatomic TSA. Samilson stage was 3 in 69% of cases. Twenty-six stemless and 51 classic prostheses were used, with 10 metal-back and 67 cemented polyethylene (PE) glenoids. At a mean 95 months, mean Constant score improved by 34 points and SSV by 43%, with no difference according to type of implant or prior surgery. There were 7 implant exchanges (9%): 2 secondary cuff tears, 4 cases of PE glenoid loosening, and 1 case of PE wear on a metal-back glenoid.

Compared to the 62 non-resurfaced glenoids (HA-CrCo, HA-PYC and HHR), the 77 TSAs had lower preoperative mean Constant score (32 vs. 41 points; $p = 0.003$) and SSV (30% vs. 40%) and more cases of Samilson stage 3 (69% vs. 49%; $p = 0.02$). With longer follow-up (94 vs. 71 months), TSA showed higher mean Constant score (67 vs. 56; $p = 0.004$), and complications and exchange rates were lower than for HA: 11% vs. 31% ($p = 0.04$) and 9% vs. 13% ($p = 0.10$) respectively.

3.8. Reverse shoulder arthroplasty

Eleven patients had RSA: 5 for type B2 severe dysplastic glenoid, 4 for iterative full-thickness cuff tear, and 2 for implant exchange (1 HA, and 1 TSA). Mean preoperative Constant score was 30 and SSV 31%. At a mean 53 months, scores had improved by 32 points and 39%. There were no complications, revision surgeries or exchanges, but an 18% rate of grade 1 or 2 radiologic notching at last follow-up.

3.9. Analysis of complications

There were no complications in non-operative treatments (Table 4). Nineteen of the 150 prostheses 19 (14%) had complications requiring revision surgery and 9 (6%) had complications without need for revision.

In 13 of the 19 prostheses requiring revision (62%) there was history of surgery ($p = 0.13$). Fifteen (79%) required implant exchange, and 4 (21%) required revision without exchange. Painful glenoid wear was the main reason for exchange (7 patients: 37%), followed by glenoid loosening (4 patients: 21%) and cuff tear (3 patients: 16%). Cuff tear occurred twice in the 77 TSAs (2%) and twice in the 62 HAs (3%). Revision of TSA and RSA significantly improved all components of the Constant score, for a 17-point gain.

The 9 cases of complication without revision comprised 4 cases of glenoid wear, 2 complex regional pain syndromes, 1 axillary palsy, 1 infection and 1 dislocation.

Table 1
Demographic's and epidemiology.

Etiology	Total	POA	PIOA	*p*-value
	n = 273	*n* = 147 (55%)	*n* = 111 (42%)	AP vs. API
Male	198 (74%)	108 (73%)	86 (77%)	>0.05
Age at onset (years)	38 (20–50)	39 (20–50)	36 (20–50)	0.0002
Age at treatment (years)	43 (23–65)	44 (23–65)	41 (23–61)	0.0002
Dominant side involvement (%)	147 (54%)	79 (54%)	57 (51%)	>0.05
Manual worker (%)	172 (63%)	95 (65%)	69 (62%)	>0.05
Occupational context	39 (15%)	21 (15%)	16 (15%)	>0.05
Sport (%)	158 (58%)	35 (24%)	80 (72%)	<0.0001
History of surgery				
Ant. stabilization	71 (26%)	0	71 (64%)	–
Post. stabilization	11 (4%)	0	11 (10%)	–
Other	28 (10%)	22 (15%)	6 (5%)	–
Initial Constant score				
Pain	5 (0–15)	5 (0–11)	5 (0–15)	>0.05
Activity	10 (2–20)	10 (2–20)	10 (2–20)	>0.05
Mobility	24 (4–40)	24 (4–40)	25 (4–40)	>0.05
Strength	7 (0–25)	8 (0–25)	6 (0–20)	0.004
Total	46 (5–92)	47 (7–89)	46 (6–87)	>0.05
Initial SSV (%)	48 (20–100)	47 (20–85)	49 (10–90)	>0.05
Samilson				
1	76 (28%)	45 (31%)	29 (26%)	>0.05
2	79 (29%)	37 (25%)	38 (34%)	>0.05
3	118 (43%)	65 (44%)	44 (40%)	>0.05
Glenloid				
A	169 (62%)	78 (53%)	81 (73%)	0.001
B	90 (33%)	60 (41%)	24 (22%)	0.001
C	14 (5%)	9 (6%)	6 (5%)	>0.05

POA: primary osteoarthritis; PIOA: post-instability osteoarthritis; Ant: anterior; Post: posterior.

Table 2
Comparison of non-arthroplastic treatments.

Treatments	PRP	Viscosupplementation	Arthroscopy
Number of shoulders (%)	28 (10%)	88 (32%)	73 (27%)
Male	22 (79%)	72 (82%)	52 (71%)
Age at treatment (years)	40 (24–49)	40 (20–65)	42 (26–55)
Dominant side involvement	15 (54%)	50 (57%)	42 (57%)
Manual worker	16 (57%)	57 (65%)	45 (62%)
Occupational context	1 (4%)	15 (17%)	15 (20%)
Sport	21 (75%)	59 (67%)	29 (40%)
Etiology			
POA	11 (40%)	49 (56%)	32 (44%)
PIOA	16 (57%)	39 (44%)	30 (41%)
Other	1 (3%)	0	11 (15%)
History of surgery			
Stabilization	10 (35%)	35 (39%)	18 (25%)
Other	5 (18%)	5 (6%)	20 (27%)
Samilson (%)			
1	5 (19%)	27 (30%)	32 (44%)
2	9 (31%)	31 (36%)	23 (31%)
3	14 (50%)	30 (34%)	18 (25%)
Glenoid (%)			
A	20 (69%)	46 (52%)	53 (72%)
B	6 (27%)	37 (42%)	18 (25%)
C	2 (4%)	5 (6%)	2 (3%)
Initial Constant score			
Pain	7 (5–12)	5 (0–12)	5 (0–12)
Activity	13 (6–17)	11 (2–18)	10 (2–20)
Mobility	29 (20–40)	27 (8–40)	29 (4–40)
Strength	15 (5–19)	7 (0–19)	7 (0–19)
Total	64 (44–78)	50 (20–76)	51 (20–76)
Follow-up Constant score			
Pain	10 (0–15)	9 (0–15)	10 (0–15)
Activity	15 (7–20)	14 (6–20)	15 (3–20)
Mobility	32 (20–40)	30 (18–38)	31 (8–40)
Strength	16 (4–20)	9 (0–10)	8 (0–19)
Total	73 (42–92)	62 (25–95)	64 (18–92)
Follow-up (months)	44 (24–130)	61 (12–182)	62 (12–321)
Initial SSV	62 (20–80)	51 (20–80)	51 (20–80)
Follow-up SSV	73 (40–95)	65 (20–100)	67 (25–100)
Arthroplasty at last follow-up (%)	4 (14%)	35 (40%)	32 (44%)

POA: primary osteoarthritis; PIOA: post-instability osteoarthritis.

Table 3
Comparison of arthroplastic treatments.

Treatments (150 prostheses/273 shoulders = 54%)	HA-CrCo	HA-PYC	HHR	TSA	RSA
Number of shoulders (%)	10 (4%)	24 (8%)	28 (10%)	77 (28%)	11 (4%)
Male	7 (70%)	16 (68%)	22 (79%)	58 (75%)	7 (64)
Age at treatment (years)	43 (29–47)	44 (35–50)	44 (30–45)	44 (31–50)	45 (40–50)
Dominant side involvement	6 (60%)	12 (55%)	17 (61%)	45 (58%)	9 (82%)
Manual worker	4 (40%)	15 (64%)	18 (64%)	57 (74%)	9 (82%)
Occupational context	2 (20%)	2 (10%)	4 (14%)	14 (18%)	1 (9%)
Sport	3 (30%)	3 (14%)	14 (50%)	38 (49%)	3 (30%)
Etiology					
POA	4 (40%)	12 (50%)	11 (39%)	45 (58%)	5 (27%)
PIOA	3 (30%)	10 (41%)	17 (61%)	32 (42%)	2 (18%)
Other	3 (30%)	2 (9%)	0	0	6 (52%)
History of surgery					
Stabilization (%)	2 (20%)	5 (21%)	18 (64%)	29 (38%)	2 (18%)
Other (%)	2 (20%)	0	2 (7%)	7 (9%)	6 (55%)
Samilson (%)					
1	1 (10%)	4 (17%)	6 (23%)	4 (5%)	6 (50%)
2	4 (40%)	9 (37%)	10 (35%)	20 (26%)	3 (27%)
3	5 (50%)	11 (46%)	12 (42%)	53 (69%)	2 (23%)
Glenoid (%)					
A	5 (50%)	14 (59%)	17 (61%)	51 (66%)	6 (55%)
B	4 (40%)	8 (33%)	9 (32%)	20 (26%)	4 (36%)
C	1 (10%)	2 (8%)	2 (7%)	6 (8%)	1 (9%)
Initial Constant score					
Pain	3 (0–10)	4 (0–10)	5 (0–12)	3 (0–12)	5 (0–10)
Activity	7 (2–12)	8 (4–15)	9 (2–18)	7 (2–14)	6 (2–14)
Mobility	24 (16–30)	26 (10–38)	23 (4–40)	18 (4–36)	16 (4–32)
Strength	4 (0–7)	8 (0–25)	7 (0–16)	4 (0–20)	3 (0–8)
Total	38 (6–46)	46 (12–65)	44 (9–77)	32 (6–62)	30 (7–60)
Follow-up Constant score					
Pain	9 (0–15)	11 (8–15)	9 (0–15)	12 (0–15)	12 (5–15)
Activity	13 (4–20)	15 (10–18)	13 (2–20)	16 (2–24)	16 (6–20)
Mobility	25 (16–36)	34 (22–40)	26 (6–40)	29 (8–40)	26 (14–32)
Strength	4 (1–9)	10 (2–25)	10 (0–24)	10 (0–25)	9 (4–16)
Total	51 (25–80)	70 (50–80)	58 (20–91)	67 (26–97)	62 (35–83)
Follow-up (months)	92 (24–163)	36 (24–77)	78 (24–172)	95 (24–301)	53 (24–87)
Initial SSV	36 (20–50)	41 (20–80)	40 (10–60)	30 (20–70)	31 (20–40)
Follow-up SSV	55 (20–80)	74 (60–80)	61 (0–100)	73 (40–100)	70 (50–90)
Failure (revision)	3 (30%)	4 (17%)	5 (18%)	7 (9%)	0
Implant exchange	3 (30%)	2 (9%)	3 (11%)	7 (9%)	0
Painful glenoid wear	2 (20%)	3 (13%)	6 (22%)	NA	NA

POA: primary osteoarthritis; PIOA: post-instability osteoarthritis; HA: hemiarthroplasty; PYC: pyrocarbon; HHR: humeral head resurfacing; TSA: total shoulder arthroplasty; RSA: reverse shoulder arthroplasty.

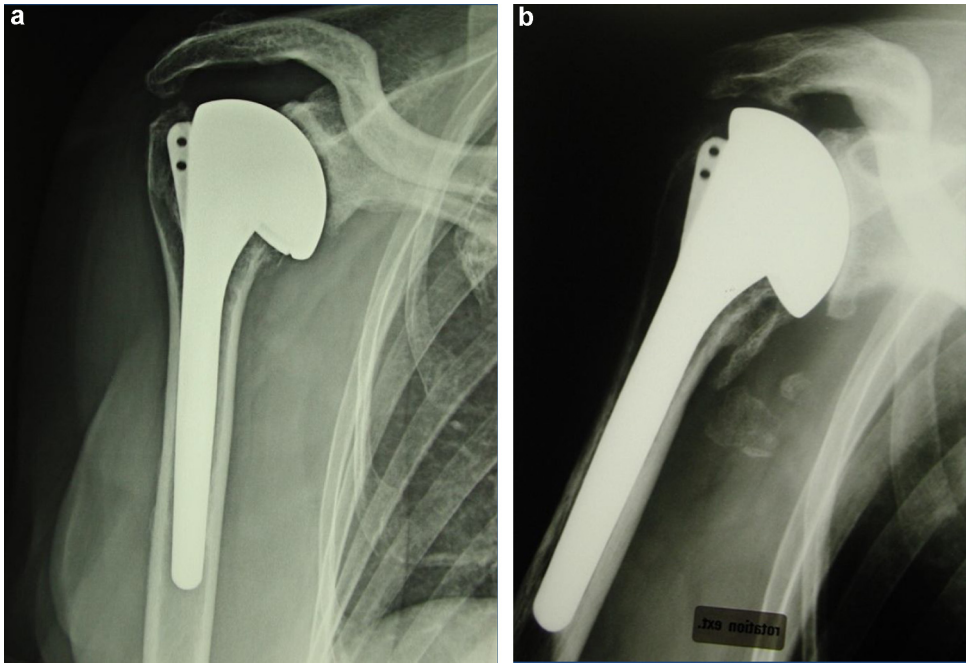

Fig. 1. a and b: early painful glenoid wear in metal hemiarthroplasty at 12 months.

Table 4
Complications of arthroplasty.

Number of prostheses $n = 150$	Non-complicated	Complicated without revision	Complicated with revision	
	122 (82%)	9 (6%)	19 (14%)	
Male	95 (78%)	8 (66%)	12 (63%)	
Manual worker	63 (52%)	3 (33%)	11 (58%)	
Age at treatment (years)	44 (23–65)	43 (35–46)	44 (31–50)	
Follow-up (months)	82 (24–271)	81 (24–127)	98 (24–301)	
Etiology				
POA	68 (56%)	1 (17%)	12 (63%)	
PIOA	49 (40%)	7 (75%)	7 (37%)	
Other	5 (4%)	1 (17%)	0	
History of surgery	52 (42%)	6 (66%)	13 (68%)	
Type of complication/prosthesis	NA	HA + HHR: 7 (90%) TSA: 2 (10%)	HA + HHR: 12 (64%) TSA: 7 (34%) RSA: 0	
Type of complication/revision	NA	Glenoid wear: 4 (1 HA-PYC, 3 HHR) CRPS: 2 (1 TSA, 1 HA-CrCo) Superficial infection: 1 (HHR) Axillary palsy: 1 (TSA) Dislocation: 1 (HHR)	Implant exchange: 15 Glenoid wear: 7 (2 HA-CrCo, 3 HHR and 2 HA-PYC) Glenoid loosening: 4 PE wear: 1 Cuff tear: 3 (2 TSA et 1 HA-CrCo)	Reoperation: 4 Sscp tear: 1 (HAR) Instability: 1 (HA-PYC) Deep infection: 2 (HA-PYC and HHR)
Follow-up Constant score	66 (22–97)[a]	52 (20–91)		
Follow-up SSV (%)	70 (30–100)[a]	61 (10–100)		
Number of complications/type of prosthesis				
HA ($n = 62$)	43 (69%)	19 (31%)		
TSA ($n = 77$)	68 (89%)	9 (11%)		
RSA ($n = 11$)	11 (100%)	0		
Number of revision surgeries/type of prosthesis				
HA ($n = 62$)	58 (93%)	4 (7%)		
TSA ($n = 77$)	77 (100%)	0		
RSA ($n = 11$)	11 (100%)	0		
Number of implant exchanges/prosthesis				
HA ($n = 62$)	54 (87%)	8 (13%)		
TSA ($n = 77$)	71 (91%)	7 (9%)		
RSA ($n = 11$)	11 (100%)	0		

POA: primary osteoarthritis; PIOA: post-instability osteoarthritis; HA: hemiarthroplasty; PYC: pyrocarbon; HHR: humeral head resurfacing; TSA: total shoulder arthroplasty; RSA: reverse shoulder arthroplasty; CRPS: complex regional pain syndrome.

[a] $P < 005$.

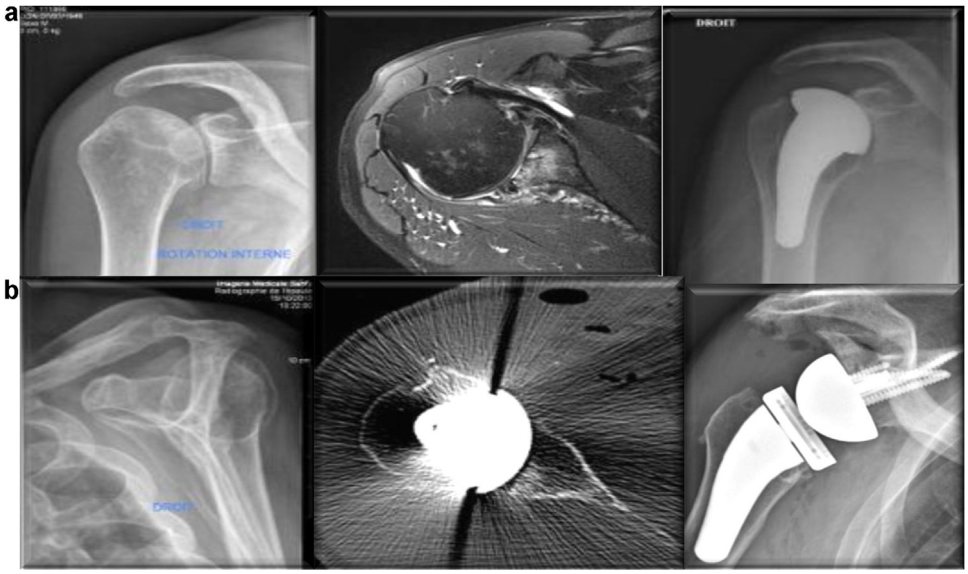

Fig. 2. a and b: two examples of early painful glenoid wear after pyrocarbon hemiarthroplasty (HA-PYC). The second was revised by reverse prosthesis.

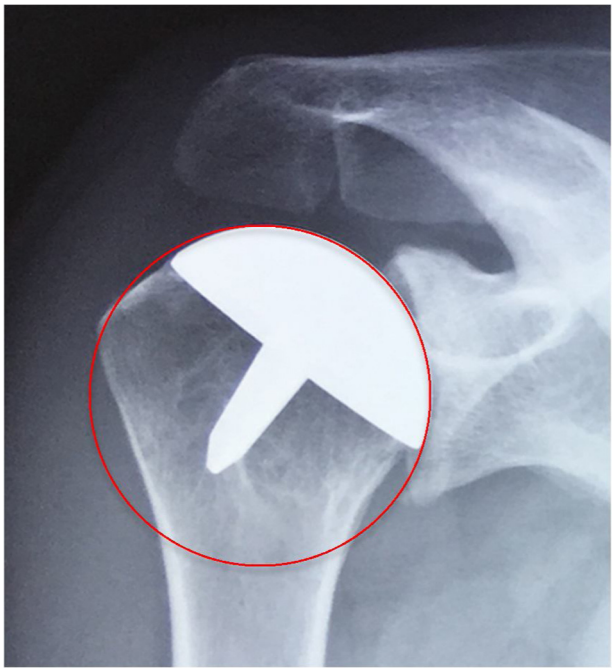

Fig. 3. Early painful glenoid wear with resurfacing implant (HHR) despite anatomic implantation without overstuffing.

In the long-term, the group free of complications had significantly better clinical results in terms of Constant score and SSV: respectively, 66 vs. 52 points ($p = 0.001$) and 52% vs. 61% ($p = 0.021$).

There were more complications in HA (HA-CrCo, HA-PYC and HHR) than TSA (14/59 [20%] vs. 8/77 [10%]), more revision procedures (12/59 [20%] vs. 8/77 [10%]) and significantly lower mean Constant score ($p = 0.004$).

4. Discussion

The present study confirmed the main hypothesis, that first-line non-operative treatment may be indicated in under-50 year-olds for atraumatic centered shoulder OA with ER1 > 30°. In Samilson stage 1 and even 2, a series of 3 ultrasound guided PRP injections significantly relieved pain in 86% of cases. We were unable to retrieve any studies of PRP in osteoarthritis of the shoulder, but several level-1 studies in the knee reported encouraging results [22,23]. It has anti-inflammatory action [24], inhibits inflammation markers such as metalloprotein, cyclo-oxygenase and NF-kappa B [25], promotes chondrogenesis and stem-cell proliferation [26], and stimulates superficial proteins and PRG4 [27] and visco-induction by hyaluronic acid secretion (hepatocyte growth factor: HGF). Likewise, viscosupplementation, in the form of radioscopy-guided 6 mL reticulated hyaluronic acid, enabled implantation to be postponed in 86% of cases at 4–5 years and in 60% at 8 years. The hyaluronic acid restores the mechanical properties of the cartilage and synovial fluid [28]. It has a moderate anti-inflammatory action, reduces enzyme production induced by cytokines, has anti-oxidant and anabolizing action on cartilage, and a direct analgesic effect by masking joint nociceptors. The reticulated structure prolongs joint action compared to a linear structure [29].

Arthroscopy, consisting in debridement/lavage and tenotomy/tenodesis of the long head of the biceps, can give good results even without the axillary nerve release advocated by Hagen [16], allowing associated anterior arthrolysis, although preoperatively restricted ER1 is a major negative prognostic factor. Arthroscopy does not jeopardize subsequent arthroplasty but is not in itself a solution beyond 4 years, as 27% of patients still had Constant scores < 50 and 44% required shoulder replacement.

The secondary hypothesis was also confirmed: total shoulder arthroplasty gave better clinical results than hemiarthroplasty, with fewer complications (10% vs. 24%) and revision procedures (10% vs. 20%) even at 94 months' follow-up. The high long-term rate of revision in TSA for glenoid loosening [4] led some authors to advocate stemmed HA or HHR. In the present study, glenoid wear was the prime cause of revision (30%), well ahead of glenoid PE loosening (20%) or cuff tear (20%), although 94 months was perhaps a bit short for a high rate of these complications to emerge. Glenoid wear rates were higher in HHR (22%) than for stemmed HA (HA-CrCo and HA-PYC) (16%), in agreement with Lebon et al. [30], showing the technical difficulty with resurfacing implants of avoiding "overstuffing" by increased lateral offset (Fig. 4a–c). Pyrocarbon was recommended for its capacity to absorb proteins and phospholipids, inducing a pseudo-membrane and thus reducing friction, thereby limiting glenoid wear. Its Young's modulus is close to that of bone. The present series did not confirm superiority over

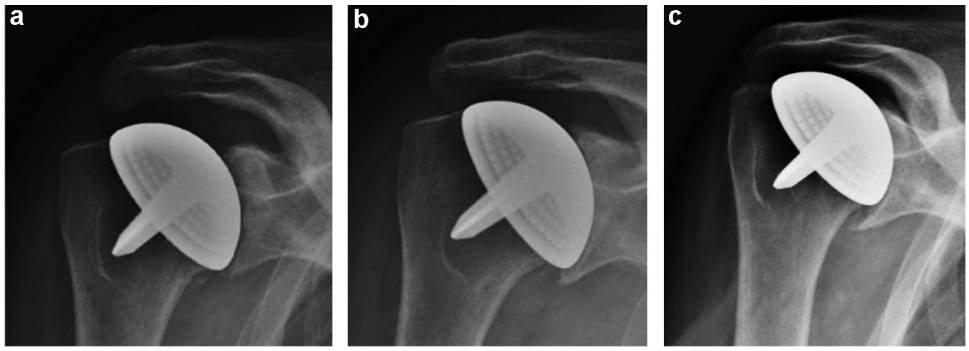

Fig. 4. a–c: primary osteoarthritis treated by resurfacing hemiarthroplasty (HHR) with overstuffing. Control X-ray: postoperative (a), at 2 years (b) and 4 years (c), showing glenoid wear.

metal heads, with no significant difference between the two. Pyrocarbon heads comprise a graphite nucleus covered by a very thin 300–500 μ layer of pyrocarbon, on a metal plate; this alters the Young's modulus and may account for the present 18% medium-term glenoid wear rate, comparable to the 14% rate reported by Garret et al., suggesting moderate adaptive wear; long-term progression, however, is unknown [15]. Thus, the present overall rate of implant revision was 18%, 61% of which concerned early painful glenoid wear in HA (Table 4).

Finally, the present study confirmed the literature findings that TSA gives better medium-term results for pain, range of motion and survival [1,4,31]. Twenty-year survival in under-50 year-olds was 75% for HA vs. 82% for TSA [32]. Return to sport was also better for TSA than HA or RSA [33]. And HA showed only 75% satisfaction in the medium-term, deteriorating over time [34].

The limitations of this multicenter retrospective study relate to the great diversity of treatments reported by the various experts, with variable sample size and follow-up. The conclusions thus need reading against other reports showing a drop in TSA survival over time [35] and higher complications/revision rates than with HA, notably for post-instability OA [36,37]. In the present series, RSA was indicated either for severe B2 glenoid dysplasia or for iterative full-thickness cuff tear and revision; there were no complication and the results were encouraging, but the 53 months' follow-up was too short for definite recommendation as first-line attitude.

5. Conclusion

In early-stage centered osteoarthritis of the shoulder in under-50 year-olds, within the present study limitations and inclusion criteria, arthroplasty can be postponed for 3 or 4 years by non-operative treatment: PRP, viscosupplementation or arthroscopy. In Samilson grade 3 primary or post-instability OA, in case of pain and stiffness, total shoulder replacement gave better medium-term results than hemiarthroplasty.

Disclosure of interest

Jean Kany: FH orthopedics: royalties; Vims: consultant; Mitek: consultant.

Jean David Werthel: FH orthopedics: royalties.

Philippe Valenti: FH orthopedics: royalties; Vims: consultant.

Tewfik Benkalfate: Depuy Mitek, Arthrex and Medacta: onsultant.

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Nicolas Bonnevialle: SBM: consultant.

Philippe Teissier: Zimmer Biomet: consultant.

Laurent Hubert: Depuy Mitek: consultant.

The other authors declare that they have no competing interest.

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Contribution

J. Kany and N. Bonnevialle: study supervision and article writing.
JD. Werthel: bibliography.
L. Favard: epidemiology.
P. Flurin: viscosupplementation analysis.
C. Charousset: PRP analysis.
B. Coulet: arthroscopy analysis.
L. Hubert: non-operative treatment analysis.
J. Garret: pyrocarbon analysis.
T. Benkalfate: resurfacing analysis.
P. Teissier: glenoid analysis in arthroplasty.
P. Valenti: analysis of complications.

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