

Table 1. Summary of studies included in analysis.

Study	Type of study	Evidence level	Sample size (joints)	Age (years)	Male	Female	Follow-up (months)	Comparator (no. joints)	Intervention (no. joints)
Kirzner et al. ¹¹	Retrospective cohort study	III	40	74.7 (59–91)	9	31	20 (12–48)	RSA (22)	BIO-RSA (18)
Boileau et al. ¹⁶	Case series	IV	54	73 (52–85)	13	41	36 (24–81)	–	BIO-RSA (54)
Boileau et al. ⁶	Prospective cohort study	IV	42	72 (52–86)	14	28	28 (24–40)	Grammont “literature” (484)	BIO-RSA (42)
Greiner et al. ¹⁰	Randomized controlled trial	I	31	75.4 (66–88)	9	22	22 ± 8.1	STD RSA (15)	BIO-RSA (16)
Athwal et al. ¹²	Retrospective Cohort study	III	40	74 ± 6	17	23	34 ± 13	Grammont style RSA (20)	BIO-RSA (20)
Collin et al. ¹⁵	Retrospective comparative cohort study	III	130	BIO-RSA 74.4 (58–90) tRSA 75.4 (60–86)	34	96	24 (24–27)	tRSA (69)	BIO-RSA (61)
Athwal and Faber ¹³	Retrospective cohort study	III	24	75 (66–84)	4	20	36 ± 8	25 mm metal baseplate RSA (11)	25 mm baseplate BIO-RSA (13)
Boutsiadis et al. ¹⁴	Retrospective cohort study	III	46 (22 PFSCS excluded)	77 (62–90)	9 (assume 4 PFSCS – excluded)	37 (assume 18 PFSCS – excluded)	39 ± 18	STD-RSA Grammont (13) STD-RSA Ascent (10)	BIO-RSA Grammont (11) BIO-RSA Ascent (12)

PFSCS: press fit short curved stem (Ascent) – gender of patients not specified.

Table 2. Indications for joint arthroplasty and exclusion criteria for analysed studies.

Study Indication:	STD-RSA (Number of joints)				BIO-RSA (Number of joints)				Glenoid bone stock morphology excluded	
	Cuff arthropathy	OA	Fracture	Other	Total	Cuff arthropathy	OA	Fracture	Other	Total
Kirzner et al. ¹¹	5	1	10	6 (AVN, malunion, dislocation)	16	5	11	0	2 (AVN, malunion, dislocation)	16
										All glenoid bone (Walch) morphologies included
										Pre-op acromial abnormality Stress fractures
Boileau et al. ¹⁶	–	–	–	–	0	31	15	2 (fracture sequelae)	6 (RA)	46
										All glenoid bone morphologies included
										Revision RSA Other bone graft (allograft, iliac crest) rather than humeral head
Boileau et al. ⁶	–	–	–	–	0	27	–	3	12 (previous RC surgery with pseudoparalysed shoulder)	30
										Favard E3 Walch B2, C
										Other bone graft (allograft, iliac crest) rather than humeral head
Greiner et al. ¹⁰	15	–	–	–	15	16	–	–	–	16
										Favard E3 Walch B2, C
										Unable to harvest graft from humeral head
Athwal et al. ¹²	20	–	–	–	20	20	–	–	–	20
										Bone loss requiring grafting/augment
										Rheumatoid and/or inflammatory arthritis, osteoarthritis, fracture, nonunion, malunion, prior open shoulder surgery, workers' compensation claims, unresolved litigation

(continued)

Table 2. Continued

Study	STD-RSA (Number of joints)					BIO-RSA (Number of joints)					Glenoid bone stock morphology excluded		
	Indication:	Cuff arthropathy	OA	Fracture	Other	Total	Cuff arthropathy	OA	Fracture	Other	Total	Exclusion criteria	Other criteria
Collin et al. ¹⁵		61	6	–	2	67	48	12	–	1	60	Any glenoid bone loss	Fracture sequelae, history of infection, presence of neurologic problems (e.g. Parkinson disease)
Athwal and Faber ¹³		11	–	–	–	11	13	–	–	–	13	–	Osteoarthritis, inflammatory arthritis, revision surgery, fracture, nonunion, malunion, concurrent procedures
Boutsiadis et al. ¹⁴		13	–	–	–	13	11	–	–	–	11	Not specified but no excessive deformity (E3 glenoids) in cohort	Revision RSA, RSA for proximal humeral fracture, preoperative teres minor fatty infiltration with concomitant latissimus dorsi transfer, postinfection RSA, primary glenohumeral arthritis, incomplete follow-up
Total		125 (83%)	7 (5%)	10 (7%)	8 (5%)	150	171 (73%)	38 (16%)	5 (2%)	21 (9%)	235		

Table 3. Summary of outcome scores in studies included in analysis.

Outcomes (bad–good)	Study	Intervention BIO-RSA Mean $\pm$ SD (range) (no. of joints)	Comparator (STD-RSA unless specified) Mean $\pm$ SD (range) (no. of joints)	Mean difference in post-op score (95% CI) (where able to pool data)
Constant-Murley score (0–100)	Athwal et al. ¹²	Post-op: 61 $\pm$ 12 (20)	Post-op: 61 $\pm$ 10 (20)	4.0 (0.8, 7.1) I² = 47%
	Boutsiadis et al. ^{14a}	Pre-op: 19 $\pm$ 3.5 (2–33) Post-op: 65 $\pm$ 2 (53–77) Change: +46 $\pm$ 8 (37–60) (11)	Pre-op: 23 $\pm$ 3 (12–45) Post-op: 62 $\pm$ 3 (45–71) Change: +39 $\pm$ 11 (13–58) (13)	
	Collin et al. ¹⁵	Pre-op: 26.6 $\pm$ 12.2 (3–56) Post-op: 69.0 $\pm$ 9.4 (40–85) Change: +42.4 (61)	Pre-op: 19.5 $\pm$ 10.8 (4–44) Post-op: 61.4 $\pm$ 12.7 (29–88) Change: +41.9 (69)	
	Greiner et al. ¹⁰	Pre-op: 28.1 $\pm$ 13.2 Post-op: 64.1 $\pm$ 18.4 Change: +36 (16)	Pre-op: 26.1 $\pm$ 15.1 Post-op: 61.5 $\pm$ 16.0 Gain: +35.4 (15)	
	Boileau et al. ¹⁶	Pre-op: 31 (9–62) Post-op: 68 (30–89) Change: +37 (54)		
	Boileau et al. ⁶	Pre-op 31 $\pm$ 13 (8–60) Post-op 66.6 $\pm$ 11 (31–88) Change: +35.6 (42)	Grammont RSA (literature) vs. BIO-RSA Post-op: 62 vs. 66	
DASH (100–0)	Athwal and Faber ¹³	Post-op: 60 $\pm$ 10		
	Athwal et al. ¹²	Post-op: 21 $\pm$ 17 (20)	Post-op: 15 $\pm$ 15 (20)	6.2 (–2.0, –14) I² = 0%
	Greiner et al. ¹⁰	Pre-op: 60.6 $\pm$ 13 Post-op: 40.9 $\pm$ 23.7	Pre-op: 66.5 $\pm$ 11.5 Post-op: 34.2 $\pm$ 20.2	

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Table 3. Continued

Outcomes (bad-good)	Study	Intervention BIO-RSA Mean $\pm$ SD (range) (no. of joints)	Comparator (STD-RSA unless specified) Mean $\pm$ SD (range) (no. of joints)	Mean difference in post-op score (95% CI) (where able to pool data)
SSV (0–100%)		Change: -19.7 (16)	Change: -32.3 (15)	
	Athwal and Faber ¹³	Post-op: 18 ± 15		
	Boutsiadis et al. ^{14a}	Post-op: 77 ± 4 (50–90) (11)	Post-op: 70 ± 4 (50–90) (13)	6.8 (3.7, 9.9) $I^2 = 0\%$
	Kirzner et al. ¹¹	Post-op: 63.5 ± 25.7 (5–100) (18)	Post-op: 60.2 ± 1.8 (20–95) (22)	
	Boileau et al. ¹⁶	Pre-op 30 (10–60) Post-op 83 (0–100) Change: $+53$ (54)	–	
	Boileau et al. ⁶ (2011)	Pre-op 34 ± 16 (10–80) Post-op 75 ± 14 (30–95) Change: $+41$ (42)	–	
ASES (0–100)	Athwal et al. ¹²	Post-op: 68 ± 12 (20)	Post-op: 70 ± 10 (20)	1.5 (–1.4, 4.3) $I^2 = 0\%$
	Boutsiadis et al. ^{14a}	Post-op: 77 ± 4 (57–98) (11)	Post-op: 75 ± 4 (53–98) (13)	
	Kirzner et al. ¹¹	Post-op: 73 ± 18.7 (24–93) (18)	Post-op: 67.5 ± 23.8 (23–100) (22)	
	Athwal and Faber ¹³	Post-op: 70 ± 10		
SST (0–12)	Athwal et al. ¹²	Post-op: 9.3 ± 2.6 (20)	Post-op: 9.8 ± 2.2 (20)	–0.06 (–0.57, 0.45) $I^2 = 0\%$

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Table 3. Continued

Outcomes (bad–good)	Study	Intervention BIO-RSA Mean $\pm$ SD (range) (no. of joints)	Comparator (STD-RSA unless specified) Mean $\pm$ SD (range) (no. of joints)	Mean difference in post-op score (95% CI) (where able to pool data)
	Boutsiadis et al. ^{14a}	Post-op: 7 $\pm$ 0.8 (3–11) (11)	Post-op: 7 $\pm$ 0.5 (4–11) (13)	
	Athwal and Faber ¹³	Post-op: 10 $\pm$ 2		
ADLER (0–30)	Greiner et al. ¹⁰	Change: 12 $\pm$ 8.9 (16)	Change: 13.4 $\pm$ 8.2 (15)	
	Boutsiadis et al. ^{14a}	Post-op: 27 $\pm$ 1 (14–30) (11)	Post-op: 26 $\pm$ 1 (15–30) (13)	
GRC (–5 to +5)	Athwal et al. ¹²	Post-op: 4.6 $\pm$ 0.4 (20)	Post-op: 4.8 $\pm$ 0.5 (20)	
	Athwal and Faber ¹³	Post-op: 4.7 $\pm$ 0.4		
WOOS (100–0)	Kirzner et al. ¹¹	Post-op: 31.4 $\pm$ 24.3 (18)	Post-op: 35.9 $\pm$ 30.3 (22)	
Pain (0–100)	Kirzner et al. ¹¹	Post-op: 15.3 $\pm$ 21.5 (18)	Post-op: 25.7 $\pm$ 27.2 (22)	

STD: standard surgical technique; BIO-RSA: bony increased-offset reversed shoulder arthroplasty; tRSA: traditional reversed shoulder arthroplasty; RSA: reversed shoulder arthroplasty; SSV: Subjective Shoulder Value; DASH: Disabilities of the Arm, Shoulder and Hand; ASES: American Shoulder and Elbow Surgeons; SST: Simple Shoulder Test; GRC: Global Rating of Change; ADLER: Activities of Daily Living Requiring External Rotation; WOOS: Western Ontario Osteoarthritis of the Shoulder.

^aBoutsiadis paper: only Grammont style standard RSA and Grammont style BIO-RSA included (press fit stems excluded).

Table 4. Summary of ROM in studies included in analysis.

Outcomes	Study	Intervention BIO-RSA Mean $\pm$ SD (range) (no. of joints)	Comparator (STD-RSA unless specified) Mean $\pm$ SD (range) (no. of joints)	Mean difference in post-op angle (95% CI) (where able to pool data)
Active internal rotation (level)	Boileau et al. ¹⁶	Pre-op: SI (0–T12) Post-op L4 (GT–D8) (54)	–	
	Boileau et al. ⁶	Post-op: >SI = 86% (42)	Grammont (literature) Post-op: >SI = 26%	
	Athwal et al. ¹²	Post-op: >T12 = 25% (20)	RSA Post-op: >T12 = 45% (20)	
	Athwal and Faber ¹³	Post-op: SIJ		
	Collin et al. ¹⁵	Pre-op: Sacrum (buttock to T8) Post-op: L4 (buttock to T8) (61)	tRSA Pre-op: Sacrum (buttock to T8) Post-op: L4 (buttock to T8) (69)	
	Boutsiadis et al. ^{14a}	Pre-op: Buttock (LT–SI) Post-op: L3 (buttock–T12) (11)	Pre-op: SI (buttock–T12) Post-op: L3 (buttock–T12) (13)	
	Boileau et al. ⁶	Pre-op: 4.4 $\pm$ 2.2 (0–10) Post-op: 5.7 $\pm$ 2.5 (0–10) Gain: +1.3 (–10 to 10) (42)		
Active external rotation (°) (at side or 0° abduction)	Athwal et al. ¹²	Post-op: 23 $\pm$ 15 (20)	Post-op: 23 $\pm$ 16 (20)	4 (–0.8, 8.4) I² = 6%
	Boutsiadis et al. ^{14a}	Pre-op: 5 $\pm$ 20 (–30 to 40) Post-op: 24 $\pm$ 12 (0 to 40) Change: +19 $\pm$ 23 (–15 to 60) (11)	Pre-op: 14 $\pm$ 20 (–30 to 50) Post-op: 14 $\pm$ 13 (–10 to 35) Change: 0 $\pm$ 30 (–30 to 50) (13)	

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Table 4. Continued

Outcomes	Study	Intervention BIO-RSA Mean $\pm$ SD (range) (no. of joints)	Comparator (STD-RSA unless specified) Mean $\pm$ SD (range) (no. of joints)	Mean difference in post-op angle (95% CI) (where able to pool data)
	Collin et al. ¹⁵	Pre-op: 13.1 $\pm$ 19.9 (–40 to 70) Post-op: 20 $\pm$ 16 (0 to 60) Change: +6.9 (61)	Pre-op: 14.8 $\pm$ 16.3 (–10 to 70) Post-op: 17 $\pm$ 20 (–60 to 60) Change: +2.2 (69)	
	Greiner et al. ¹⁰	Pre-op: 16 $\pm$ 31 Post-op: 44 (no SD given) Change: 28 $\pm$ 40 (16)	Pre-op: 22 $\pm$ 23 Post-op: 40 (No SD given) Change: 18 $\pm$ 26 (15)	
	Boileau et al. ¹⁶	Preop: 12° (–20 to 60) Postop: 24° (–20 to 70) Change: +12° (54)	–	
	Boileau et al. ⁶	Preop 12.8 $\pm$ 21.4 (–40 to 50) Postop 22.9 $\pm$ 16.4 (–10 to 70) Change: +10 (–20 to 60) (42)	Grammont (literature) Post-op: 13°	
	Athwal and Faber ¹³	Post-op: 21 $\pm$ 15		
(Active external rotation (°) (in abduction))	Boileau et al. ⁶	Post-op: 53° (42)	Grammont (literature) Post-op: 42°	
	Greiner et al. ¹⁰	Pre-op: 16 $\pm$ 31 Post-op: 58 Change: 42 $\pm$ 54 (16)	Pre-op: 26 $\pm$ 31 Post-op: 59 Change: 33 $\pm$ 42 (15)	
Active forward flexion (°)	Athwal et al. ¹²	Post-op: 140 $\pm$ 16 (20)	Post-op: 143 $\pm$ 13 (20)	6 (–1.4, 12.5), I² = 69%
	Boutsiadis et al. ^{14a}	Pre-op: 74 $\pm$ 35 (10–120) Post-op: 158 $\pm$ 4 (130–175) Change: 92 $\pm$ 37 (50–150) (11)	Pre-op: 63 $\pm$ 21 (10–100) Post-op: 148 $\pm$ 7 (100–170) Change: 86 $\pm$ 36 (20–140) (13)	

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Table 4. Continued

Outcomes	Study	Intervention BIO-RSA Mean $\pm$ SD (range) (no. of joints)	Comparator (STD-RSA unless specified) Mean $\pm$ SD (range) (no. of joints)	Mean difference in post-op angle (95% CI) (where able to pool data)
	Collin et al. ¹⁵	Pre-op: 86.1 $\pm$ 47.4 (0–170) Post-op: 145 $\pm$ 21 (90–180) Change: 58.9 (61)	Pre-op: 84.9 $\pm$ 33.2 (20–180) Post-op: 138 $\pm$ 20 (70–170) Change: 53.1 (69)	
	>Athwal and Faber ¹³	Post-op: 140 $\pm$ 15		
	Boileau et al. ⁶	Pre-op: 86 $\pm$ 35 (20–160) Post-op: 146 $\pm$ 21 (80–170) Gain + 60 (–20 to 130) (42)	Grammont (literature) Post-op: 130	
	Boileau et al. ¹⁶	Pre-op: 85 (20–140) Post-op: 148 (80–170) (54)		
Active abduction (°)	Boutsiadis et al. ^{14a}	Post-op: 145 $\pm$ 7 (100–170) (11)	Post-op: 134 $\pm$ 8.5 (90–170) (13)	

^aBoutsiadis paper: only Grammont style standard RSA and Grammont style BIO-RSA included (press fit stems excluded).

Table 5. Summary of radiographic findings in studies included in analysis.

Outcomes	Study	Intervention BIO-RSA Mean $\pm$ SD (range) (no. of joints)	Comparator (STD-RSA unless specified) Mean $\pm$ SD (range) (no. of joints)	Odds ratio (95% CI) (where able to pool data)
Notching (present, $\pm$ grade)	Athwal et al. ¹²	Total: 40% (8/20) Grade 1: 35% (7/20) Grade 2: 5% (1/20) Grade 3: 0% (0/20) Grade 4: 0% (0/20) (20)	Total: 75% (15/20) Grade 1: 60% (12/20) Grade 2: 10% (2/20) Grade 3: 0% (0/20) Grade 4: 5% (1/20) (20)	OR = 0.19 (0.10, 0.38) I² = 0%
	Athwal, Faber ¹³	Total 46% (6/13) (13)	Total 82% (9/11) (11)	
	Collin et al. ¹⁵	Total: 4.9% (3/61) Grade 1: 3.3% (2/61) Grade 2: 1.6% (1/61) Grade 3: 0% (0/61) Grade 4: 0% (0/61) Notch in graft: 6.6% (4/61) (61)	Total: 33.9% (19/69) Grade 1: 15.9% (11/69) Grade 2: 8.7% (6/69) Grade 3: 2.9% (2/69) Grade 4: 0% (0/69) (69)	
	Kirzner et al. ¹¹	Total 33.3% (6/18) (18)	Total 68.2% (16/22) (22)	
	Greiner et al. ¹⁰	No grade III or IV (16)	(15)	
	Boileau et al. ¹⁶	Total 25% (13/54) All grade I–III (54)		
	Boileau et al. ⁶	Inferior Notching Total: 19% (8/42) Grade 1: 11.9% (5/42) Grade 2: 4.8% (2/42) Grade 3: 2.4% (1/42) Grade 4: 0% (0/42) Posterior notch: 7.1% (3/42) (42)	Grammont vs. BIO-RSA (%) 68% vs. 19%	

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Table 5. Continued

Outcomes	Study	Intervention BIO-RSA Mean $\pm$ SD (range) (no. of joints)	Comparator (STD-RSA unless specified) Mean $\pm$ SD (range) (no. of joints)	Odds ratio (95% CI) (where able to pool data)
S(capula fracture)	Greiner et al. ¹⁰	12.5% (2/16)	13.3% (2/15)	1.4 (0.35, 5.7) I² = 0%
	Kirzner et al. ¹¹	16.7% (3/18)	9.1% (2/22)	
	Athwal and Faber ¹³	15.4% (2/13) I intraoperative glenoid rim fracture I post-op glenoid insufficiency fracture		
	Boileau et al. ¹⁶	1.9% (1/54) I post-op scapula spine fracture		
Loosening	Boileau et al. ¹⁶	Glenoid loosening 5.6% (3/54) all within 6 months I traumatic I infection I incorrect position		Grammont (literature) 3.6%
	Athwal and Faber ¹³	No loosening in any case 0% (0/13)		
	Boileau et al. ⁶	0% (0/42)		
	Greiner et al. ¹⁰	Humeral component 0% (0/16)		
Healed/Graft incorporated	Boileau et al. ⁶	92% (41/42)		
	Greiner et al. ¹⁰	100% (16/16)		
	Athwal et al. ¹²	Complete: 80% (16/20) Incomplete: 20% (4/20)		
	Boileau et al. ¹⁶	94.4% (51/54) 3 glenoid loosening as above		
	Athwal and Faber ¹³	Full incorporation: 77% (10/13) Partial incorporation: 23% (3/13)		

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Table 5. Continued

Outcomes	Study	Intervention BIO-RSA Mean $\pm$ SD (range) (no. of joints)	Comparator (STD-RSA unless specified) Mean $\pm$ SD (range) (no. of joints)	Odds ratio (95% CI) (where able to pool data)
Prosthetic instability	Boileau et al. ⁶	0% (0/42)	Grammont RSA (Literature) 3.4%	
Spur	Collin et al. ¹⁵	14.8% (9/61)	7.2% (5/69)	
Ossification	Collin et al. ¹⁵	1.6% (1/61)	7.2% (5/69)	
Other complication	Boileau et al. ¹⁶	1.9% (1/54) Infection 1.9% (1/54) Pulmonary embolism No dislocation No subluxation		
	Greiner et al. ¹⁰	0% graft resorption 0% lysis 0% radiolucent lines around pegs /screws		