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Scaphotrapeziotrapezoidal Joint Osteoarthritis: A Systematic Review of Surgical Treatment

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Background: The management of scaphotrapeziotrapezoidal (STT) joint osteoarthritis (OA) remains controversial. This systematic review aims to review the evidence for surgical interventions specific to STT OA.

Methods: Medline and Embase libraries were searched using a pre-defined search strategy in October 2014. All study designs and languages were included and evaluated by two reviewers (VMD and LM) against the inclusion/exclusion criteria. The study eligibility criteria included papers discussing surgical treatment of STT OA, and the review was conducted using the PRISMA guidelines.

Results: 295 unique results were identified from the search strategy after duplicates were filtered. 21 articles met the eligibility criteria.

Conclusions: Trapezial excision and partial trapezoidal excision is an effective treatment with low morbidity and complications, although can lead to weakness of the thumb. Distal scaphoid excision remains an effective pain relief treatment with improved grip and pinch strengths post-operatively. The procedure is technically less demanding than arthrodesis, does not carry the risks of non-union and complication rate of STT joint arthrodesis, and has a shorter immobilisation requirement. It produces reliable results, but is contraindicated if there is either scapholunocapitate pathology or midcarpal instability. STT joint fusion has a place, typically producing 75% range of movement of the non-operated wrist. However it has a higher associated complication rate, and simultaneous radial styloidectomy is recommended to reduce ongoing pain from impingement. Implant arthroplasty using a graphite-coated pyrocarbon implant has been used more recently. The patients gained significant pain relief, although there have been reports of implant dislocation secondary to surgical errors. A reduction in post-operative wrist extension and radial deviation has been noted. From this systematic review, we have composed a treatment algorithm for the surgical management of STT joint OA.

Keywords: *Scaphotrapeziotrapezoidal (STT) joint osteoarthritis, Scapho-trapezial-trapezoid joint, Scaphotrapezotrapezoid joint, Trapeziectomy, Arthrodesis*

INTRODUCTION

The STT joint is the predominant link between the proximal and distal rows of the carpus. The distal articulating surface of the scaphoid has two facets separated by a ridge, orientated from radio-dorsal to ulno-palmar. The joint has dorsal and palmar joint capsules providing support, along with the palmar scapho-capitate and scapho-trapezial ligaments. The scapho-trapezial ligament is the most important stabilising structure of the joint.[1,2]

The prevalence of isolated STT joint OA varies from 2-16% in various anatomical studies, but is most commonly seen in older women.[3-6] It is frequently associated with thumb carpometacarpal (CMC) joint OA.[7] Armstrong et al.[3] found a radiological prevalence of isolated STT joint OA of 2%. The prevalence of combined CMC and STT joints OA was 8%.

Isolated OA of the STT joint commonly presents

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with both wrist pain and weakness.[7,8] The pain is characteristically on the radial side of the wrist, overlying the scaphoid tubercle volarly. Whereas CMC joint pain typically presents with pain more dorsally and distally. The character of the pain may be sharp in nature causing patients to drop things, compared to the characteristic 'ache' of CMC thumb joint pain.

The literature suggests a wide range of possible surgi-

Table 1. Database search strategy and results

☐	1	MEDLINE	scaphotrapezio-trapez*.ti,ab	23
☐	2	MEDLINE	STT.ti,ab	723
☐	3	MEDLINE	SCAPHOID BONE/	1384
☐	4	MEDLINE	TRAPEZOID BONE/	87
☐	5	MEDLINE	CARPAL BONES/	4954
☐	6	MEDLINE	1 OR 2 OR 3 OR 4	2152
☐	7	MEDLINE	(osteoarthriti* OR arthriti* OR OA OR wear OR degenerat*).ti,ab	349210
☐	8	MEDLINE	ARTHRITIS/	24750
☐	9	MEDLINE	OSTEOARTHRITIS/	29702
☐	10	MEDLINE	7 OR 8 OR 9	368518
☐	11	MEDLINE	6 AND 10	354
☐	12	MEDLINE	(surg* OR resection* OR arthroplasty OR injection* AND of AND fusion* OR arthrodesi*).ti,ab	1530
☐	13	MEDLINE	ARTHRODESIS/	7615
☐	14	MEDLINE	ARTHROPLASTY/	6858
☐	15	MEDLINE	exp SURGICAL PROCEDURES, MINOR/ OR exp SURGICAL PROCEDURES, OPERATIVE/	2490420
☐	16	MEDLINE	su.fs	1644899
☐	17	MEDLINE	12 OR 13 OR 14 OR 15 OR 16	3083096
☐	18	MEDLINE	11 AND 17	289
☐	19	MEDLINE	18 [Limit to: Humans and Publication Year 1980-2014 and (Age Groups All Adult 19 plus years)]	209
☐	20	MEDLINE	19 [Limit to: Humans and Publication Year 1980-2014 and (Age Groups All Adult 19 plus years) and (Clinical Queries Reviews maximizes sensitivity or Therapy maximizes sensitivity or Prognosis maximizes sensitivity)]	170
☐	21	EMBASE	scaphotrapezio-trapez*.ti,ab	24
☐	22	EMBASE	STT.ti,ab	851
☐	23	EMBASE	SCAPHOID BONE/	2047
☐	24	EMBASE	TRAPEZOID BONE/	167
☐	25	EMBASE	21 OR 22 OR 23 OR 24	2979
☐	26	EMBASE	(osteoarthriti* OR arthriti* OR OA OR wear OR degenerat*).ti,ab	405751
☐	27	EMBASE	ARTHRITIS/	54212
☐	28	EMBASE	OSTEOARTHRITIS/	57747
☐	29	EMBASE	26 OR 27 OR 28	443278
☐	30	EMBASE	25 AND 29	521
☐	31	EMBASE	(surg* OR resection* OR arthroplasty OR injection* AND of AND fusion* OR arthrodesi*).ti,ab	31381
☐	32	EMBASE	ARTHRODESIS/	9515
☐	33	EMBASE	ARTHROPLASTY/	13904
☐	34	EMBASE	SURGICAL TECHNIQUE/	275784
☐	35	EMBASE	SURGERY/ OR MINOR SURGERY/ OR PLASTIC SURGERY [+NT]/	314878
☐	36	EMBASE	su.fs	1715300
☐	37	EMBASE	31 OR 32 OR 33 OR 34 OR 35 OR 36	2077221
☐	38	EMBASE	30 AND 37	369
☐	39	EMBASE	38 [Limit to: Human and Publication Year 1980-2014 and (Human Age Groups Adult 18 to 64 years or Aged 65+ years)]	214
☐	40	EMBASE	39 [Limit to: Human and (Clinical Queries Reviews maximizes sensitivity or Therapy maximizes sensitivity or Prognosis maximizes sensitivity) and Publication Year 1980-2014 and (Human Age Groups Adult 18 to 64 years or Aged 65+ years)]	180
☐	41	MEDLINE, EMBASE	Duplicate filtered: [19 [Limit to: Humans and Publication Year 1980-2014 and (Age Groups All Adult 19 plus years) and (Clinical Queries Reviews maximizes sensitivity or Therapy maximizes sensitivity or Prognosis maximizes sensitivity)]], [39 [Limit to: Human and (Clinical Queries Reviews maximizes sensitivity or Therapy maximizes sensitivity or Prognosis maximizes sensitivity) and Publication Year 1980-2014 and (Human Age Groups Adult 18 to 64 years or Aged 65+ years)]]	350 295 Unique results 55 Duplicate results

cal interventions for treating STT OA, reflecting the lack of consensus as to the most effective treatment. Most papers to date are retrospective case series of a particular technique with the authors' results at short to medium term follow up. Such evidence can potentially be prone to selective reporting within the series, and retrospective data can produce less reliable results.[9] No systematic reviews of the evidence have been reported to date. The traditional surgical treatment of STT OA is arthrodesis, but this has been reported as having a high complication rate by a number of authors.[10-14] Other surgical interventions include distal scaphoid excision, trapeziectomy +/- partial trapezoidal excision, arthroscopic surgery and interposition/implant arthroplasty.

This systematic review identifies and summarises, from studies, the evidence of the effectiveness of surgical treatments for STT OA. The objective is to evaluate which interventions provide the greatest improvement in pain, functional and/or radiological outcome.

METHODS

The Embase and Medline (1980 to present) databases were searched in October 2014. The search terms and strategy are shown in Table 1. Inclusion criteria were all human and cadaveric study designs addressing surgery for STT OA, in any language. Eligible studies had to report outcome measures regarding pain, function or radiological scores. Exclusion criteria were animal studies due to their different anatomy and inability to report outcomes. Also excluded were studies of subjects less than 18 years of age to allow the results to be representative of an adult population.

The reference lists of all papers were hand-searched for other relevant papers. Study selection was performed by two reviewers (VMD and LM). In papers where there was disagreement between these two reviewers, the third author (ZN) confirmed the decision.

RESULTS

295 papers were reviewed for inclusion using the inclusion and exclusion criteria identified. The methodology of paper identification, screening, eligibility and inclusion is illustrated in the flow diagram (Fig. 1). 21 papers met the eligibility criteria and are detailed in Table 2.

DISCUSSION

Trapeziectomy and partial trapezoidal excision

Several studies reported the results of trapeziectomy and partial trapezoidal excision for treating STT OA. Andrachuk and Yang[15] described their results of this technique combined with ligament reconstruction tendon interposition (LRTI) in 12 wrists for isolated STT joint OA. Although their sample group is small and statistically insignificant, patients symptoms, grip and pinch strength were improved.

Tomaino et al.[16] studied 37 patients undergoing trapezium excision. They compared the results between 23 patients undergoing trapezium excision and proximal trapezoid excision for combined CMC and STT joint OA, with 14 patients undergoing trapeziectomy only for isolated CMC joint OA. There was no increased morbidity with the combined procedure. The differences in post-operative grip and pinch strengths between the two groups were not statistically significant.

Trapeziectomy and partial trapezoidal excision has produced good pain relief and ROMs with low morbidity and complication rates, although can lead to thumb weakness. It has been stressed that intra-operative evaluation of the scapho-trapezoid joint after trapeziectomy is important to evaluate whether partial trapezoidal excision is necessary to avoid ongoing post-operative symptoms.

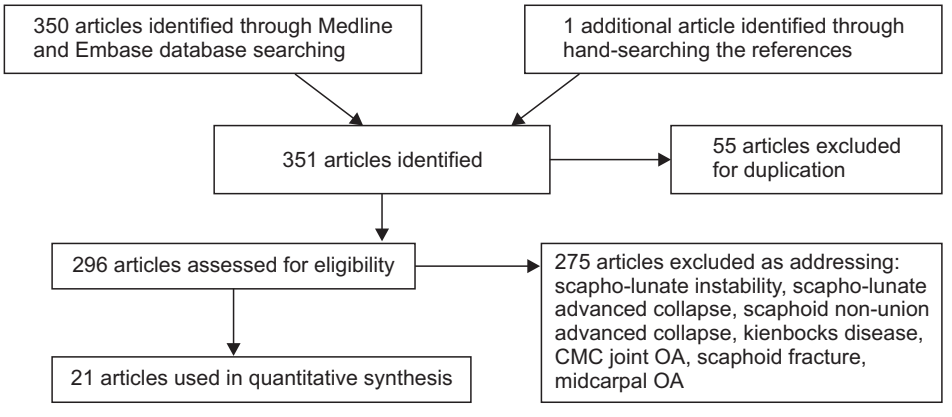


Fig. 1. Study selection methodology.

Table 2. 21 papers meeting eligibility criteria

Reference	Study design	Population	Intervention	Follow up	Outcome and complications	Conclusions
Andrachuk and Yang (2012)	Retrospective case series	10 patients, 12 wrists with isolated STT OA	Total trapezial and partial trapezoidal excision with LRTI	Mean 18 (11-42) months	↓ pain scores uniformly, increased flexion, extension, grip and pinch strengths.	Effective surgical treatment
Normand et al. (2012)	Retrospective case series	8 patients, mean age 70 years	Arthroscopic resection distal pole scaphoid	13 months	Pain ↓ in 7 cases, completely gone in 6.	Effective treatment and low complication rate.
Mathoulin And Darin (2011)	Retrospective case series	13 patients	Isolated resection distal scaphoid	20 months (11-27) in	Pain, ROM and strength improved.	Effective treatment
		13 patients	Pyrocarbon implant	Pyrocarbon group	Complications; 2 implant dislocations.	
Garcia-Elias (2011)	Surgical technique and case study	1 patient 54 years	FCR tenosynovectomy, STT distal scaphoid excision, capsulodesis	28 months	Pain free except at extremes of ROM. Wrist extension 35 degrees less than other side, mild DISI.	Effective treatmen
Low and Edmunds (2007)	Retrospective case serie	9 patients, 10 pyrocarbon implants	Pyrocarbon implants	Mean 16.4 (3-35) month	Improved pain scores, mean DASH of 21. Mean grip strength 82%, pinch strength 85% of other side	Good alternative to STT fusion
Tay et al. (2007)	Retrospective chart and radiographic review	16 patients with 24 wrists with STT OA and radiographic DISI deformity	Chart and radiographic review	N/A	Patients with STT OA may instability that is not related to radiographic scapho-lunate instability.	If STT OA and DISI, surgery can progress MC instability radiographically
Goubier et al. (2006)	Retrospective case series	12 patients, 13 wrists	STT arthrodesis	Mean 60 months	↓ pain scores, strength not decreased. 4 nonunions.	Effective for pain relief
Pegoli et al. (2006)	Pilot study	8 patients, 10 hands	Pyrocarbon implants	19 (2-24) months	Average DASH score reduced from 49 to 39. First 2 implants dislocated.	Good results
Udeshi et al. (2006)	Case study	54 year old female	Polytetrafluoroethylene implant	7 years	Foreign body giant cell reaction to implant	Potential complication
Pequignot et al. (2005)	Retrospective case series	12 patients, 15 wrists	Pyrocarbon implants	4 (1-8) years	↓ pain, loss of radial deviation (< 10 degrees) and extension (< 15 degrees)	Good results
Meier et al. (2003)	Retrospective case series	111 patients	STT arthrodesis	4 (2-8) years	↓ pain, average DASH scores 27 points	Good for pain relief
Ashwood et al. (2003)	Retrospective case series	10 patients	Arthroscopic STT joint debridement	36 (12-65) months	All patients had ↓ pain scores	Good short term symptom relief
Minami et al. (2003)	Retrospective case series	30 patients average 41 years	STT arthrodesis	84 months	All patients achieved fusion at average 11.2 weeks. 8 patients (27%) had complications	Good surgery but high complications
Kalb et al. (2001)	Retrospective case series	87 patients, 88 fusions	STT arthrodesis	3 years	Average DASH score 29 points, non-union 7.7%	Valid therapeutic method, need Long-term results
Srinivasan And Matthews (1996)	Retrospective case series	8 patients, average 57 years	STT arthrodesis	Mean 47 (18-80) months	7 patients had satisfactory symptom relief. One non-union.	Satisfactory results, minimal complications
Ishida and Tsai (1993)	Retrospective case series	40 patients	STT arthrodesis	Mean 41 months	23 patients (58%) became pain free or minimal pain, with limited ROM. 10 patients needed 13 additional procedures	Can give a painless wrist, limited ROM, frequent complications
Nemoto and Inagaki (2011)	Retrospective case series		STT arthrodesis with vascularised BG from radius	43 (38-50) months	↓ pain and ↓ ROM. Radiological bone union achieved at 8-12 weeks	Effective intervention
Cobb et al. (2011)	Retrospective case series	34 patients, 35 wrists	Arthoscopic resection of STT and CMC joints	One year minimum	Pain, key pinch and grip all improved	Good short term pain relief, strength,function
Wessels KD (2004)	Retrospective case series	56 patients	Resecton 3-4mm distal scaphoid and capsulorraphy	86 (12-180) months	54 of 56 patients had marked reduction/elimination pain. 2 superficial radial nerve and 2 radial artery injuries	good pain relief
Garcia-Elias et al. (1999)	Retrospective case series	21 patients	Partial distal scaphoid excision. 12 joints filled with capsular/tendon tissue, 9 no fibrous interposition	29 (12-61) months	13 wrists pain free, 8 occasional mild discomfort. Grip 26% and pinch strength 40% improved. Post-operative DISI in 12 wrists	Good pain relief. Wrists with no fibrous interposition more ROM than those with
Watson et al. (1999)	Retrospective case series	798 patients	STT arthrodesis and radial styloidectomy 5mm	52 (12-197) months	Overall improvement in wrist function in 86%. ROM 75%, power 80% other side. 4% non-union, 1.5% SLAC	Effective, low complication rate

Key; ↑: increased, ↓: decreased, BG: bone graft, CMC: carpometacarpal, DASH: disabilities of the arm and shoulder, DISI: dorsal intercalated segmental instability, FCR: flexor carpi radialis tendon, LRTI: ligament reconstruction and tendon interposition, MC: midcarpal, N/A: not applicable, OA: osteoarthritis, ROM: range of motion, SLAC: scapho-lunate advanced collapse, STT: scaphotrapeziotrapezoidal.

Distal scaphoid excision

Two studies in the review reported the results of excising the distal scaphoid for treating STT OA. Garcia-Elias et al.[17] proposed resecting the distal one fourth of the scaphoid, based on the assumption that a greater scaphoid resection would obviate the need for tendon interposition without consequence. In their study of 21 wrists, nine wrists received no fibrous interposition and 12 wrists had capsular or tendon tissue to fill the defect. At follow-up, 13 wrists were pain-free while eight had occasional mild discomfort. Mean range of movement (ROM) was 118 degrees of flexion-extension with grip strength improved by 26% (p = 0.001) and pinch strength by 40% (p = 0.001). Of note, the wrists with no fibrous interposition showed significantly greater flexion-extension (mean 127 degrees) than the patients with interposition (mean 113 degrees)(p = 0.04). They found that distal scaphoid excision consistently led to a change in carpal alignment. Four patients had a dorsal intercalated segmental instability (DISI) malalignment preoperatively, whilst 12 patients had a DISI at the latest follow up, using a radio-lunate angle equal to or greater than 15 degrees to define a DISI. Of significance, they found no correlation between their patients' functional outcomes and the DISI malalignments.

Following distal pole scaphoid excision, the majority of the load across the STT articulation transfers to the central midcarpal joint. Consequently the scapholunocapitate joint may suffer from overload, so distal pole scaphoid excision is contraindicated if the scapholunocapitate joint is arthritic, unstable or incongruent.

A further possible sequelae of distal pole scaphoid excision is dorsal subluxation of the capitate and development of a DISI malalignment. When the distal scaphoid is excised, the flexion tendency from the load across the STT joint is removed. So the extension force transmitted from the triquetrum to the lunate increases relatively and these bones rotate into abnormal extension and DISI.[17] These authors suggested a method of not interposing soft tissue, but tightly reattaching the distally based capsular flap on to the scaphoid and lunate dorsal ridge with transosseous or bone anchor sutures. This prevented DISI formation in their series.

Distal pole of scaphoid excision is thus contraindicated in the presence of chronic dorsal midcarpal instability.[18-20] If the wrist has weak dorsal midcarpal capsuloligamentous constraints and the distal scaphoid is excised, this can cause DISI malalignment, carpal collapse and dorsal capitate subluxation. Park[21] described the 'posterior drawer test' preoperatively to detect when this procedure should be avoided. Under xray, if the capitate can be dorsally displaced beyond the lunate, distal scaphoid excision causing wrist destabilisation is likely[18,20] and STT joint arthrodesis may be a better alternative.

Wessels[22] achieved reduction or elimination of pain in 54 of his 56 patients after open excision of the distal 3-4mm of the scaphoid and capsulorraphy. He had complications of 2 transient radial nerve irritations and 2 injuries to the radial artery. He agreed that this procedure is contraindicated if there is accompanying CMC or midcarpal joint OA, bacterial infection, or rheumatoid arthritis.

The importance of the volar scaphotrapezial ligaments in maintaining extension of the scaphoid has been described.[2,23] It is possible that the surgical approach for excision of the distal pole of the scaphoid damages the competence of this ligamentous complex.

So in the absence of midcarpal instability, distal scaphoid excision is recommended as an effective surgical option providing reliable results. It is technically less demanding and needs a shorter post-operative immobilisation period than STT joint arthrodesis. Distal scaphoid excision also has with fewer complications than STT joint arthrodesis, but arthrodesis is the suggested alternative procedure in the presence of midcarpal instability.[20]

Arthroscopic STT joint surgery

A number of authors have reported their results of arthroscopic debridement of the STT joint or excision of the distal scaphoid. Cobb et al.[24] produced satisfactory pain relief and return of grip strength, key and chuck pinch in their case series of 35 resection arthroplasties for treatment of combined CMC and STT joint OA. Although the follow-up was short at one year minimum, all their patients experienced significantly less pain and improved scores on the Disabilities of the Arm, Shoulder and Hand (DASH) patient surveys post-operatively. The average return to full duty was 34 (14-91) days. Four patients required additional surgery for persistent pain at final follow up, one for deep infection and one for flexor carpi radialis tendonitis. The remaining two were revised to an open procedure at another centre, so the complication details unknown.

Normand et al.[25] reported very good results for arthroscopic resection of the distal scaphoid for isolated STT OA in eight patients, who had a mean age of 70 years. Pain had completely resolved in six patients, and decreased in one patient post-operatively.

Mathoulin and Darin[26] reported good outcomes using their technique of resecting 2-3mm of bone at the STT

joint via a 1-2 midcarpal portal, and in some patients introducing a pyrocarbon implant spacer as well. Their study population included 13 women with an average age of 58 (52-64) years. Although they noted a progressive compression of the scaphotrapezial space, no further pain occurred. A further 13 patients with an average age of 62 (48-79) years received a pyrocarbon implant for disabling pain with a significant reduction in pinch strength. Overall mobility improved in all patients postoperatively. Complete resolution of pain was reported in 12 patients, with diminished pain in one patient. Two implant dislocations occurred due to incomplete resection of the distal pole, leaving a medial bone wall causing inadequate insertion of the implant.

Ashwood et al.[27] described good short-term symptomatic relief using their approach of arthroscopic debridement of synovitis, chondral flaps and rim osteophytes rather than distal scaphoid excision. Their ten patients all showed a reduction in visual analogue pain scores from a mean of 86 to 14 points, with an average follow up of 36 (12-65) months.

Arthroscopic debridement/bony excision has produced good results in experienced hands, and may be an area of future development. At the present time the long term outcome of these procedures is not clear.

Implant arthroplasty

During the 1990's the use of graphite-coated with pyrocarbon was extended to develop the scaphoid trapezium pyrocarbon implant (STPI). This material has a Young's modulus close to that of cortical bone, and is bioinert. The implant has a concave and a convex surface to fit the gap after distal scaphoid excision and is available in two sizes. The spacer is designed to maintain scaphoid length after resection, allowing compressive forces to be dissipated from the implant to the scaphoid, hence decreasing the likelihood of a DISI malalignment developing.[20]

Three studies in this review produced improved pain scores after interposition arthroplasty, and two improved DASH scores. Pegoli et al.[28] gave their patients STPI's by open and arthroscopic approaches for isolated STT OA. All of their 8 patients (10 wrists) had functional improvement and returned to daily activities at three months post operatively. Average DASH scores reduced from 49 pre operatively to 39 post operatively. However their first two implants dislocated, which they identified as their learning curve due to inadequate distal scaphoid resection. No further dislocations occurred.

Low and Edmunds[29] inserted ten STPI's in nine patients with a mean age of 66 (58-76) years, and reviewed them at a mean follow up of 16.4 (3-35) months. Post operatively, pain scores improved significantly, the mean DASH score was 21, mean grip strength 82% and mean pinch strength 85% compared to the non-operated side. No complications or changes in carpal alignment were noted.

Pequignot et al.[30] reported on inserting a discoid pyrocarbon implant in 15 wrists with a mean four year follow up. Pain scores decreased post operatively, but a loss of radial deviation (< 10 degrees) and a loss of wrist extension (< 15 degrees) was noted, with no complications.

No longer term follow-ups are reported. Implant arthroplasty has produced good medium term results, although authors of this technique have described the importance of adequate bony resection to avoid implant dislocation. Once again the long term survival and outcome of these implants is not certain, but it is a useful alternative to STT joint arthrodesis.

Other materials have been tried in the wrist for joint reconstruction/interposition arthroplasty. Fracture of the implant and reactive synovitis have been described after silicone prosthesis insertion.[31] A persistently painful foreign body giant cell reaction after use of a polytetrafluoroethylene implant has been described in a case report of a single patient.[32]

STT joint arthrodesis

STT joint arthrodesis was first described by Peterson and Lipscomb in 1967.[33] Early descriptions of the technique favoured a dorso-radial approach to the joint, whilst others preferred a volar approach centred over the scaphoid tubercle and trapezium.[34]

Contraindications to this procedure include degenerative change in the radioscaphoid joint, as the inevitable increased load transfer to this joint after STT fusion would increase symptoms. If on pre operative evaluation the scaphoid is highly mobile, moving into excessive flexion and pronation on radial deviation, this can cause painful radioscaphoid subluxation after STT fusion. STT joint fusion should be avoided in these cases.

Irrespective of surgical approach, it is important to maintain bony alignment during bony fixation to gain a good outcome. It has been determined in cadaveric studies that the scaphoid should lie at 40-60 degrees of flexion relative to the long axis of the radius on the lateral radiograph in order to maximise post-operative ROM.[35] Scaphoid extension should be avoided to prevent impingement and decreased ROM.

STT arthrodesis has been reported as having a high complication rate in a number of series.[10-12] with non-

union rates of 21%,[10] 25%[11] and 31% reported.[12] Development of painful degenerative CMC joint OA post operatively is described by several authors.[10,13,14] Other complications have included flexor pollicis longus tendon rupture and radioscaphoid arthrosis,[14] fracture of the distal radius after bone graft harvesting and needing further surgery of radial styloidectomy for impingement.[10]

Watson et al.[36] have produced the largest series of results of 1,000 intercarpal arthrodeses, 798 of which were STT joint fusions. They had a wide spectrum of indications for this fusion including rotary subluxation of the scaphoid, midcarpal instability, scaphoid non-union, Kienbock's disease and congenital synchondrosis, with 8% of operations being for degenerative disease. Their results showed a lower non-union rate of 4%, with an average length of time to union of 48 days. ROM achieved was 75% of the contralateral wrist, power more than 80% of the contralateral wrist and an overall improvement in wrist function demonstrated in 86% of patients post operatively. Watson et al. stressed the importance of performing a radial styloidectomy simultaneously, as they reported that 33% of their patients had persistent pain secondary to radial styloid impingement. 1.5% of patients developed scapho-lunate advanced collapse changes post fusion and required reconstructive surgery. Overall he found this to be a reliable and effective procedure with high patient satisfaction and low complication rates.

Other studies[37,38] have shown STT joint arthrodesis to be a valid therapeutic treatment with satisfactory results . Nemoto and Inagaki[39] achieved radiological union at 8-12 weeks post-operatively using vascularised bone graft from the radius.

Meier et al.[40] agreed that STT joint fusion is an effective treatment for pain relief in their 111 patient series, with an average 4 (2-8) year follow up. Their indications for STT joint fusion included chronic dissociation of the scapho-lunate joint, STT OA, advanced Kienbock's disease and trapezium dislocation. Patients pain scores decreased and grip strengths improved post-operatively. However their patients had a decreased post-operative ROM, of 81% of the pre-operative flexion extension arc, and a decreased radio-ulnar arc of 68% of the pre-operative range.

STT joint fusion provides good pain relief and outcomes but has a high complication rate and is technically demanding.

We conclude that the most effective surgery for isolated STT joint OA remains unclear. However the notion that STT joint arthrodesis is the 'gold standard' has been challenged by the good results from other more modern procedures.

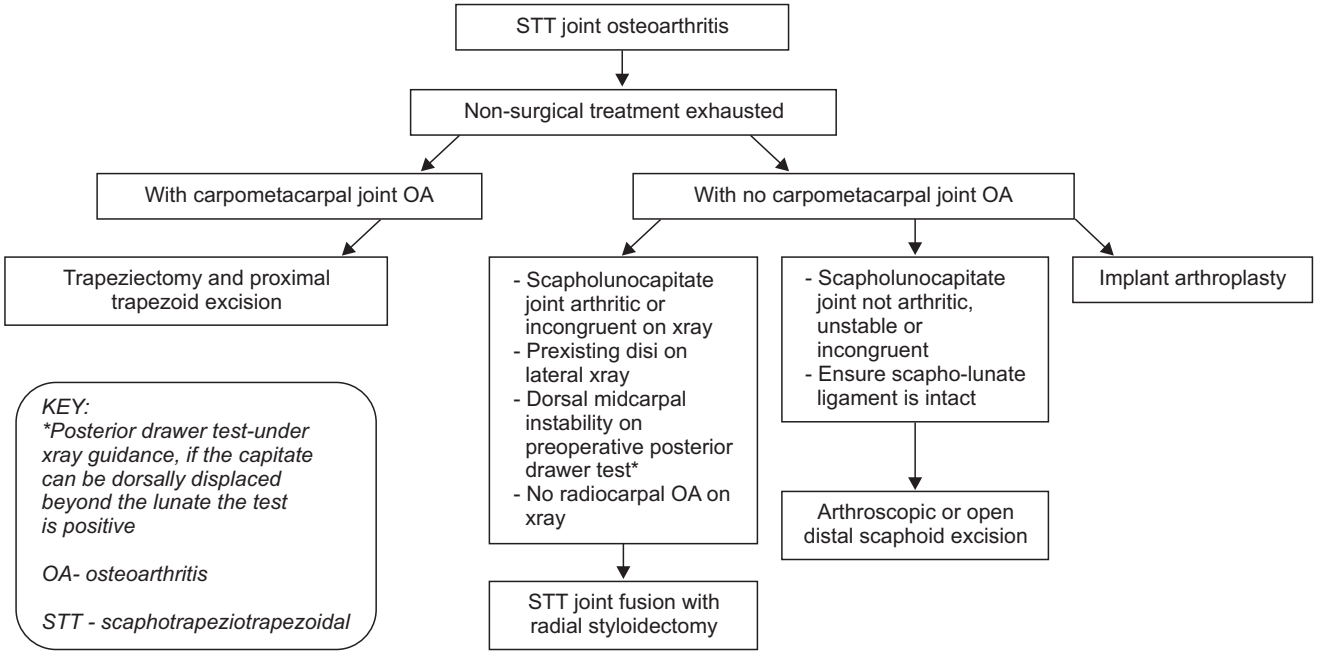
It is acknowledged that the majority of papers reviewed are of level four evidence, with a minority of level five papers. They are all retrospective in nature, and thus potentially prone to publication bias and selective reporting within studies. Future knowledge would benefit greatly from studies of a higher level of evidence, being prospective in nature and having a longer follow up period.

REFERENCES

1. Moritomo H, Viegas SF, Nakamura K, DaSilva MF, Patterson RM. The scaphotrapezio-trapezoidal joint. Part 1. An anatomic and radiographic study. J Hand Surg Am. 2000; 25:899-910.
2. Drewniany JJ, Palmer AK, Flatt AE. The scaphotrapezial ligament complex: an anatomic and biomechanical study. J Hand Surg Am. 1985;10:492-8.
3. Armstrong AL, Hunter JB, Davis TR. The prevalence of degenerative arthritis of the base of the thumb in postmenopausal women. J Hand Surg Br. 1994;19:340-1.
4. North ER, Eaton RG. Degenerative joint disease of the trapezium: a comparative radiographic and anatomic study. J Hand Surg Am. 1983;8:160-6.
5. Watson HK, Ryu J. Degenerative disorders of the carpus. Orthop Clin North Am. 1984;15:337-53.
6. Bhatia A, Pisoh T, Touam C, Oberlin C. Incidence and distribution of scaphotrapezotrapezoidal arthritis in 73 fresh cadaveric wrists. Ann Chir Main Memb Super. 1996;15: 220-5.
7. Crosby EB, Linscheid RL, Dobyns JH. Scaphotrapezial trapezoidal arthrosis. J Hand Surg Am. 1978;3:223-34.
8. Ferris BD, Dunnett W, Lavelle JR. An association between scapho-trapezio-trapezoid osteoarthritis and static dorsal intercalated segment instability. J Hand Surg Br. 1994;19: 338-9.
9. Petrie A. Statistics in orthopaedic papers. J Bone Joint Surg Br. 2006;88:1121-36.
10. Ishida O, Tsai TM. Complications and results of scapho-trapezio-trapezoid arthrodesis. Clin Orthop Relat Res. 1993;287:125-30.
11. Frykman EB, Af Ekenstam F, Wadin K. Triscaphoid arthrodesis and its complications. J Hand Surg Am. 1988;13: 844-9.
12. Goubier JN, Bauer B, Alnot JY, Teboul F. Traitement de l'arthrose scaphotrapezotrapezoidienne isolee par arthrodese scaphotrapezotrapezoidienne: une serie de 13 cas. [Scapho-trapezio-trapezoidal arthrodesis for scapho-trapezio-trapezoidal osteoarthritis]. Chir Main. 2006;25:179-84.
13. Fortin PT, Louis DS. Long-term follow-up of scaphoid –

trapezium-trapezoid arthrodesis. J Hand Surg Am. 1993;18: 675-81.

14. Minami A, Kato H, Suenaga N, Iwasaki N. Scaphotrapeziotrapezoid fusion: long-term follow-up study. J Orthop Sci. 2003;8:319-22.
15. Andrachuk J, Yang SS. Modified total trapezial and partial trapezoidal excision and ligament reconstruction tendon interposition reduced symptoms in isolated scaphotrapezial-trapezoid arthritis of the wrist. J Hand Surg Eur. 2012;37: 637-41.
16. Tomaino MM, Vogt M, Weiser R. Scaphotrapezoid arthritis: prevalence in thumbs undergoing trapezium excision arthroplasty and efficacy of proximal trapezoid excision. J Hand Surg Am. 1999;24:1220-4.
17. Garcia-Elias M, Lluch AL, Farreres A, Castillo F, Saffar P. Resection of the distal scaphoid for scaphotrapeziotrapezoid osteoarthritis. J Hand Surg Br. 1999;24:448-52.
18. Tay SC, Moran SL, Shin AY, Linscheid RL. The clinical implications of scaphotrapezium-trapezoidal arthritis with associated carpal instability. J Hand Surg Am. 2007;32:47-54.
19. Corbin C, Warwick D. Midcarpal instability after excision arthroplasty for scapho-trapezial-trapezoid (STT) arthritis. J Hand Surg Eur. 2009;34:537-8.
20. Garcia-Elias M. Excisional arthroplasty for scaphotrapeziotrapezoidal osteoarthritis. J Hand Surg Am. 2011;36:516-20.
21. Park MJ. Normal anteroposterior laxity of the radiocarpal and midcarpal joints. J Bone Joint Surg Br. 2002;84:73-6.
22. Wessels KD. Arthroplastik bei Arthrose im Triskaphoidgel enk (Synonym: Distales Kahnbeingelenk) nach koob. [Arthroplasty of osteoarthritic triscaphe (distal scaphoid) joint]. Operative Orthopadie und Traumatologie. 2004;16:48-58.
23. Boabighi A, Kuhlmann JN, Kenesi C. The distal ligamentous complex of the scapho-lunate ligament. An anatomic, histological and biomechanical study. J Hand Surg Br. 1993;18:65-9.
24. Cobb T, Sterbank P, Lemke J. Arthroscopic resection arthroplasty for treatment of combined carpometacarpal and scaphotrapeziotrapezoid (pantrapezial) arthritis. J Hand Surg Am. 2011;36:413-9.
25. Normand J, Desmoineaux P, Boisrenoult P, Beaufils P. Resection arthroscopique du pole distal du scaphoide dans l'arthrose scapho-trapezo-trapezoidienne. [The arthroscopic distal pole resection of the scaphoid: clinical results in STT osteoarthritis]. Chir Main. 2012;31:13-7.
26. Mathoulin C, Darin F. Arthroscopic treatment of scaphotrapeziotrapezoid osteoarthritis. Hand Clin. 2011;27:319-22.
27. Ashwood N, Bain GI, Fogg Q. Results of arthroscopic debridement for isolated scaphotrapeziotrapezoid arthritis. J Hand Surg Am. 2003;28:729-32.
28. Pegoli L, Zorli IP, Pivato G, Berto G, Pajardi G. Scaphotrapeziotrapezoid joint arthritis: a pilot study of treatment with the scaphoid trapezium pyrocarbon implant. J Hand Surg Br. 2006;31:569-73.
29. Low AK, Edmunds IA. Isolated scaphotrapeziotrapezoid osteoarthritis: preliminary results of treatment using a pyrocarbon implant. Hand Surg. 2007;12:73-7.
30. Pequignot JP, D'asnieres de Veigy L, Allieu Y. Traitement de l'arthrose S.T.T. par un Implant en pyrocarbone. Premiers resultats. [Arthroplasty for scaphotrapeziotrapezoidal arthrosis using a pyrolytic carbon implant. Preliminary results]. Chir Main. 2005;24:148-52.
31. Khoo Ct. Silicone synovitis. The current role of silicone elastomer implants in joint reconstruction. J Hand Surg Br. 1993;18:679-86.
32. Udeshi M, Bangash H, Gagliardi J. Foreign body giant cell reaction to polytetrafluoroethylene used as interposition material in scaphoid-trapezium arthroplasty. Australas Radiol. 2006;50:233-6.
33. Peterson HA, Lipscomb PR. Intercarpal arthrodesis. Arch Surg. 1967;95:127-34.
34. Essman JA, Reilly TJ, Forshew FC. Palmar approach for treatment of scapho-trapezio-trapezoid arthrodesis. J Hand Surg Am. 1990;15:672-4.
35. Minamikawa Y, Peimer CA, Yamaguchi T, Medige J, Sherwin FS. Ideal scaphoid angle for intercarpal arthrodesis. J Hand Surg Am. 1992;17:370-5.
36. Watson HK, Weinzweig J, Guidera PM, Zeppieri J, Ashmead D. One thousand intercarpal arthrodeses. J Hand Surg Br. 1999;24:307-15.
37. Kalb K, Fuchs V, Bartelmann U, Schmitt R, Landsleitner B. Erfahrungen mit der STT-Arthrodese. Eine retrospektive Auswertung. [Experiences with the STT (scapho-trapeziotrapezoid) arthrodesis. A retrospective evaluation]. Handchir Mikrochir Plast Chir. 2001;33:181-8.
38. Srinivasan VB, Matthews JP. Results of scaphotrapeziotrapezoid fusion for isolated idiopathic arthritis. J Hand Surg Br. 1996;21:378-80.
39. Nemoto T, Inagaki K. Scaphotrapeziotrapezoid fusion for arthritis with vascularized bone grafting from the radius. J Hand Surg Eur. 2011;36:820-1.
40. Meier R, Prommersberger KJ, Krimmer H. Teil-Arthrodesen von Skaphoid, Trapezium und Trapezoideum (STT-Fusion). [Scapho-Trapezio-Trapezoid Arthrodesis (Triscaphe Arthrodesis)]. Handchir Mikrochir Plast Chir. 2003;35:323-7.



Appendix Fig. 1. STT osteoarthritis surgical treatment algorithm.