Clin Orthop Relat Res (2019) 477:663-666
DOI 10.1097/CORR.0000000000000451

Clinical Orthopaedics and Related Research®
A Publication of The Association of Bone and Joint Surgeons®

In Brief

Classifications in Brief: Watson and Ballet Classification of Scapholunate Advanced Collapse Wrist Arthritis

Andrew McLean BPhty(Hons), MBBS(Hons), Fraser Taylor FRACS(Ortho) BSc, MBChB

Received: 11 May 2018 / Accepted: 25 July 2018 / Published online: 29 August 2018

History

Wrist osteoarthritis is a common condition that can lead to substantial functional impairment [9, 19]. One of the most common causes of wrist osteoarthritis involves the radioscaphoid and capitolunate joints in what is known as the scapholunate advanced collapse (SLAC) wrist [17, 18]. Watson and Ballet first coined the term SLAC wrist in their seminal paper in 1984 [17]. After reviewing 4000 films, among which there were 210 patients with wrist osteoarthritis, the authors noted the SLAC wrist pattern progressed in a consistent and repetitive way. SLAC wrist osteoarthritis progresses from the articulation between the distal scaphoid and the radial styloid (SLAC Stage 1), to the entire radioscaphoid joint (SLAC Stage 2), to then involve the capitolunate joint (SLAC Stage 3). The radiolunate joint was originally described as always remaining preserved from osteoarthritis.

Since Watson and Ballet's original description modifications have been proposed by several authors for SLAC wrists to include pancarpal arthritis (SLAC Stage 4), they propose the radiolunate joint may become involved in advanced disease [13, 19].

The Watson and Ballet classification system remains the only commonly used classification system for the SLAC wrist of which we are aware.

Purpose

The purpose of a good classification system is to aid communication between professionals and researchers, aid in prognosis, and guide treatment. Watson and Ballet sought to first identify and label specific patterns of wrist arthritis and then to define the progression of the SLAC wrist in detail and, second, to propose a treatment based on their classification for patients with a SLAC wrist.

Watson and Ballet described three distinct stages of SLAC wrist arthritis, which was intended to outline a common, predictable pattern of wrist arthritis [17, 18]. Subsequently the Watson and Ballet classification of SLAC wrist has become the gold standard for communication between professionals and researchers.

Watson and Ballet proposed a single operative treatment for management of the SLAC wrist in their original paper. Watson and Ballet proposed fusion of the capitate, lunate, hamate, and triquetrum and replacement of the scaphoid with a silastic implant [17]. Since then, various authors, including Watson, have proposed treatment strategies according to SLAC stage [7, 8, 14, 15, 18, 20]. When nonoperative treatment does not alleviate symptoms, radial styloidectomy is usually proposed in SLAC Stage 1 disease [12], proximal row carpectomy (PRC) or midcarpal arthrodesis in SLAC Stage 2, midcarpal arthrodesis in SLAC Stage 3, and total arthrodesis or total wrist arthroplasty in SLAC Stage 4. Partial or complete neurectomy of the wrist is a treatment option at all stages of the disease [5].

Each author certifies that neither he, nor any member of his immediate family, has funding or commercial associations (consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Department of Orthopaedics, Gold Coast University Hospital, Gold Coast, Australia

A. McLean (✉), Department of Orthopaedics, Gold Coast University Hospital, 1 Hospital Boulevard Southport QLD 4215, Australia, email: mcleanandrews@gmail.com

All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research*® editors and board members are on file with the publication and can be viewed on request.

Wolters Kluwer

Table 1. Watson and Ballet classification of scapholunate advanced collapse wrist

Stage	Joint(s) involved
1	Distal radioscaphoid
2	Entire radioscaphoid
3	Stage 2 and capitolunate

Prognosis of a SLAC wrist was not reported in Watson and Ballet's seminal paper. Although there is a predictable progression from radiologically isolated radioscaphoid arthritis to pancarpal arthritis [17, 18], radiologic changes of SLAC wrist osteoarthritis do not correlate closely with patients' symptoms. Fassler and colleagues [4] reported that up to two-thirds of patients with a SLAC wrist remain asymptomatic for up to 2 years from diagnosis and that none required surgical intervention.

Description

Watson and Ballet classified the SLAC wrist into three stages (Table 1). In SLAC Stage 1, degenerative changes are limited to the articulation between the tip of the radial styloid and the distal pole of the scaphoid (Fig. 1A). In SLAC Stage 2, degeneration progresses to include the whole radioscaphoid articulation (Fig. 1B). In SLAC Stage 3, degeneration progresses to include the capitolunate joint (Fig. 1C). Watson and Ballet noted that the radiolunate joint was almost never involved. Peterson and Szabo [13] and Weiss and Rodner [19] added a fourth stage to include pancarpal arthritis, because they believed the radiolunate joint became involved in advanced disease.

Validation

Despite widespread acceptance of the Watson and Ballet classification system, only recently have efforts been made to test its reliability. In 2013, Vishwanathan et al. [16] assessed the reliability of the Watson and Ballet classification system by reviewing radiographs of 41 patients with a SLAC wrist. They were graded on two separate occasions by four orthopaedic consultants specializing in hand and wrist surgery. They reported moderate inter- and intraobserver agreement ($\kappa = 0.65$ and 0.59, respectively) for classification of the SLAC wrist. They also found that interobserver reliability improved as the SLAC grade increased ($\kappa = 0.47$, 0.52, and 0.69 for SLAC Stages 1, 2, and 3, respectively). This reflects the fact that subtle signs of osteoarthritis may mimic normal variation in the lower grades making interpretation more difficult. They also found that for all three stages of SLAC wrist, better

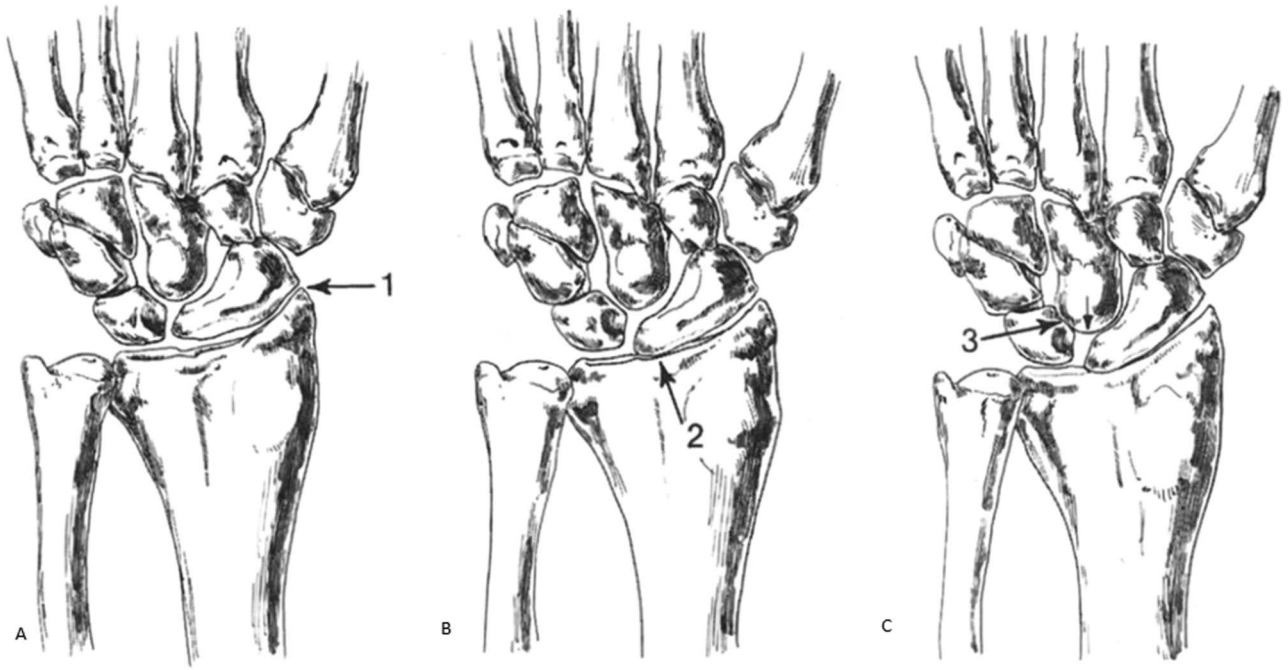

Fig. 1 A-C The Watson and Ballet classification system is shown with (**A**) SLAC 1: involvement of the distal radioscaphoid joint; (**B**) SLAC 2: involvement of the entire radioscaphoid joint; and (**C**) SLAC 3: entire radioscaphoid and capitolunate joint. Reprinted and published with permission from Elsevier: Watson HK, Ballet FL. The SLAC wrist: scapholunate advanced collapse pattern of degenerative arthritis. *J Hand Surg Am.* 1984;9:358-365.

interobserver agreement was observed at the second reading (κ = 0.7) than at the first (κ = 0.49).

In 2016, Belhaouane et al. [1] reviewed the reproducibility of radiographs and CT arthrography to diagnose arthritis in individual carpal joints and to diagnose and stage modified SLAC, scaphoid nonunion advanced collapse (SNAC), and scaphoid chondrocalcinosis advanced collapse (SCAC) classifications. Belhaouane et al. [1] reported the overall diagnosis based on interpretation of CT arthrography was often difficult with intraobserver and interobserver κ values of 0.43 to 0.98 and 0.18 to 0.48, respectively. The comparison between plain radiographs and CT arthrography revealed poor reproducibility for the overall diagnosis. No particular stage of disease was associated with poorer or better reproducibility.

There has been no published research to determine the reliability of MRI in staging the SLAC wrist according to the Watson and Ballet classification. However, in 2017, Li et al. [11] reviewed radiographs and MRI studies of 46 patients with SLAC and SNAC arthritis to determine reliability of determining individual carpal joint osteoarthritis. The images were reviewed by two hand surgeons and two radiologists and were graded according to severity of osteoarthritis at seven carpal joints. For those images with SLAC arthritis, interobserver and intraobserver agreements were 0.34 to 0.52 and 0.50 to 0.63, respectively, for radiographs and 0.62 and 0.67, respectively, for MRI. In patients with a SLAC wrist, MRI was 11.73 times more likely than radiographs to show moderate osteoarthritis at the radiolunate joint. The improved ability of MRI to assess carpal osteoarthritis at isolated joints did not significantly improve reliability of SLAC stage. MRI improved ability to determine moderate osteoarthritis at isolated joints and has implications for surgical planning and possibly management of the SLAC wrist.

Limitations

The Watson and Ballet classification system is widely accepted among hand surgeons and is often used to determine treatment.

However, despite its common use, numerous studies have found the classification not to have moderate interobserver reliability [1, 11, 16]. Practically this means that two individuals looking at the same radiograph are unlikely to give it the same grade; this severely limits the utility of the classification as a tool to help clinicians and researchers communicate. The Watson and Ballet classification also has moderate intraobserver reliability. Practically this means that the same clinician or researcher would not read the same radiograph the same way twice, suggesting that the Watson and Ballet classification system is of limited value as a prognostic tool and should be used cautiously to guide treatment decisions. Another significant limitation of the Watson and Ballet classification system is there are no validation studies available in the literature to compare radiographic and surgical findings of the SLAC wrist. This lack of validity undermines the use of Watson and Ballet classification systems in preoperative treatment planning.

These limitations have somewhat been attributed to the difficulty in interpreting arthritic changes on plain radiographs of the carpus. The original Watson and Ballet classification system is based on plain radiographs, both posteroanterior and lateral radiographs as needed. It has previously been suggested that lateral and semisupinated views may better identify osteoarthritis of the radioscaphoid joint [6]. All the studies reviewed only used posteroanterior radiographs in their analysis, which may have limited the viewer's ability to ascertain if there were changes in osteoarthritis, particularly of the radioscaphoid joint, and this adversely affected the outcome. Again, if plain radiographs are used alone in treatment of the SLAC wrist, it has been suggested decision-making may differ if further axial imaging (CT or MRI) was available [1, 11]. Whereas in SLAC Stage 2 wrists, PRC is a viable treatment option, it is contraindicated in SLAC Stage 3 wrists as a result of involvement of the capitolunate joint. Previous studies of PRC compared with partial fusion and scaphoidectomy for SLAC Stage 2 have yielded similar functional outcomes between the two groups [2, 3]. It has been suggested that this may be the result of inconsistencies in the classification of the SLAC wrist rather than similarity of outcome for the treatments [16].

To overcome this, with the advent of axial imaging in the form of CT and MRI, it has become the recommendation of many authors to include these in the preoperative workup of the SLAC wrist [1, 11]. Although MRI classification of the SLAC wrist has substantial interobserver and intraobserver reliability, which are better than the fair to moderate reliability of plain radiographs, CT arthrography offered no such advantage [1, 11]. Clinicians and researchers should use caution when ordering additional axial imaging to better define SLAC stage because it offers, at best, limited improvement in inter- and interobserver reliability. If there is any doubt remaining as to SLAC stage, it has been suggested that wrist arthroscopy may have a place in selected patients [1]. However, in practice, as a result of the nature of surgery, which is almost universally through a dorsal wrist approach, the final decision as to treatment pathway can be made when the articular surface is viewed intraoperatively.

Watson and Ballet identified a pattern of progression of arthritis common to all SLAC wrists in their series. However, as a result of the large number of articulations in the wrist, combinations of wrist arthritis are innumerable and not all SLAC wrists may follow the exact sequence and make classifying as SLAC Stage 1 to 3 difficult. For

example, Belhaouane et al. [1] noted concomitant radial styloscaphoid and lunocapitate lesions without complete radioscaphoid involvement, which raises a diagnostic problem between Stage 1 with lunocapitate osteoarthritis and the Stage 3 SLAC wrist [1]. To overcome this, it has been proposed that individual joints are documented to aid communication and treatment planning [10].

The Watson and Ballet classification of SLAC wrist osteoarthritis was designed to aid communication between professional and researchers as well as to aid treatment planning. As a result of to its moderate inter- and interobserver reliability and lack of validity, use of the Watson and Ballet classification system should be undertaken with these limitations in mind.

Conclusions

Despite its significant limitations, the Watson and Ballet classification of SLAC wrist osteoarthritis is widely accepted, simple, and a well-recognized guide to treatment.

The Watson and Ballet classification of SLAC wrist osteoarthritis has two major limitations that clinicians and researchers should be aware of when contemplating its use. First, no studies have tested the classification system's validity. Second, only moderate reliability at best was seen with the use of plain radiographs. Attempts to improve the reliability with the use of axial imaging yielded only marginal improvement in both inter- and intraobserver reliability. These major limitations restrict the classification's utility in treatment planning, communication, and research.

Further research should aim to validate the Watson and Ballet classification system of SLAC wrist osteoarthritis.

References

1. Belhaouane R, Lebeau N, Maes-Clavier C, Hustin C, Krief E, Bonnaire B, Warin M, Rotari V, David E. Reproducibility of X-rays and CT arthrography in SLAC, SNAC, SCAC wrists. *Hand Surg Rehabil.* 2016;35:393–400.
2. Cohen MS, Kozin SH. Degenerative arthritis of the wrist: proximal row carpectomy versus scaphoid excision and four-corner arthrodesis. *J Hand Surg Am.* 2001;26:94–104.
3. Dacho AK, Baumeister S, Germann G, Sauerbier M. Comparison of proximal row carpectomy and midcarpal arthrodesis for the treatment of scaphoid nonunion advanced collapse (SNAC-wrist) and scapholunate advanced collapse (SLAC-wrist) in stage II. *J Plast Reconstr Aesthet Surg.* 2008;61:1210–1218.
4. Fassler PR, Stern PJ, Kiefhaber TR. Asymptomatic SLAC wrist: does it exist? *J Hand Surg Am.* 1993;18:682–686.
5. Foucher G, Da Silva JB, Ferreres A. [Total denervation of the wrist. Apropos of 50 cases] [in French]. *Rev Chir Orthop Reparatrice Appar Mot.* 1992;78:186–190.
6. Inoue G, Sakuma M. The natural history of scaphoid non-union. Radiographical and clinical analysis in 102 cases. *Arch Orthop Trauma Surg.* 1996;115:1–4.
7. Kiefhaber TR. Management of scapholunate advanced collapse pattern of degenerative arthritis of the wrist. *J Hand Surg Am.* 2009;34:1527–1530.
8. Krakauer JD, Bishop AT, Cooney WP. Surgical treatment of scapholunate advanced collapse. *J Hand Surg Am.* 1994;19:751–759.
9. Laulan J, Marteau E, Bacle G. Wrist osteoarthritis. *Orthop Traumatol Surg Res.* 2015;101:S1–S9.
10. Lenoir H, Toffoli A, Coulet B, Lazerges C, Waitzenegger T, Chammas M. Radiocapitate congruency as a predictive factor for the results of proximal row carpectomy. *J Hand Surg Am.* 2015;40:1088–1094.
11. Li A, Lee S, Rancy S, Burge A, Potter H, Wolfe S. Comparison of magnetic resonance imaging and radiographs for evaluation of carpal osteoarthritis. *J Wrist Surg.* 2017;6:120–125.
12. Nakamura T, Cooney WP, Lui W-H, Haugstvedt J-R, Zhao KD, Berglund L, An K-N. Radial styloidectomy: a biomechanical study on stability of the wrist joint. *J Hand Surg Am.* 2001;26:85–93.
13. Peterson B, Szabo RM. Carpal osteoarthrosis. *Hand Clin.* 2006;22:517–528.
14. Shah CM, Stern PJ. Scapholunate advanced collapse (SLAC) and scaphoid nonunion advanced collapse (SNAC) wrist arthritis. *Curr Rev Musculoskelet Med.* 2013;6:9–17.
15. Tomaino MM, Miller RJ, Cole I, Burton RI. Scapholunate advanced collapse wrist: proximal row carpectomy or limited wrist arthrodesis with scaphoid excision? *J Hand Surg Am.* 1994;19:134–142.
16. Vishwanathan K, Hearnden A, Talwalkar S, Hayton M, Murali SR, Trail IA. Reproducibility of radiographic classification of scapholunate advanced collapse (SLAC) and scaphoid nonunion advanced collapse (SNAC) wrist. *J Hand Surg Eur Vol.* 2013;38:780–787.
17. Watson HK, Ballet FL. The SLAC wrist: scapholunate advanced collapse pattern of degenerative arthritis. *J Hand Surg Am.* 1984;9:358–365.
18. Watson HK, Ryu J. Evolution of arthritis of the wrist. *Clin Orthop Relat Res.* 1986;202:57–67.
19. Weiss KE, Rodner CM. Osteoarthritis of the wrist. *J Hand Surg Am.* 2007;32:725–746.
20. Wyrick JD. Proximal row carpectomy and intercarpal arthrodesis for the management of wrist arthritis. *J Am Acad Orthop Surg.* 2003;11:277–281.