



Original Article

Fixation methods and implants in shoulder stabilization: A historical perspective

Jonathan D. Kramer^{a,*}, Sean Robinson^a, Eric Hohn^a, Connor Purviance^b, Eugene M. Wolf^a^a San Francisco Orthopaedic Residency Program, 450 Stanyan St, San Francisco, CA, 94117, USA^b The Taylor Collaboration, 450 Stanyan St, San Francisco, CA, 94117, USA

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ABSTRACT

Background: Treatment for shoulder instability has changed significantly over the past decade from open procedures to arthroscopic procedures using a variety of different fixation methods and implants. The development of these implants has been highly influenced by the numerous complications that have arisen using early designs.

Methods: A review of the literature was performed to describe the history of shoulder stabilization.

Conclusion: As biomedical technology improves, we should continue to see changes to implant design and manufacturing. Having an understanding of the history and evolution of these implants will provide us with context in which to guide future implant design and clinical use. This review article provides a comprehensive overview of the evolution of early shoulder stabilization techniques and implants to the modern implants being used today.

Introduction

Glenohumeral instability is a common shoulder disorder, particularly in young active patients. Instability can be categorized into traumatic unidirectional instability or multidirectional instability (MDI). Multiple soft tissue pathologic processes have been associated with instability and surgical stabilization has been shown to be beneficial in many of them. Initial surgical interventions were performed through open approaches as early as 1906.¹ The first documented use of the arthroscope was by Dr. Severin Nordentoft, who made his own endoscope and presented his work on knee arthroscopy in Berlin in 1912.² Dr. Kenji Takagi, who performed an arthroscopic examination of a tuberculous knee joint in 1919, a time when minimally invasive procedures became a focus of clinical research and practice.³ Dr. Masaki Watanabe made significant contributions to the design and production of arthroscopes, and developed the concept of “triangulation”, involving bringing instruments from multiple portals to treat pathology.⁴

Later, Kreuzer and Burman were the first to publish about arthroscopy in the United States, and used an arthroscope to examine the shoulder.^{5,6} Since then, the arthroscope as evolved to be the primary modality used for surgical interventions of the shoulder. Numerous operative procedures have been described to prevent recurrent instability for these processes. The following review article will highlight the history and evolution of these arthroscopic surgical procedures for shoulder instability.

Staples

Early descriptions of glenohumeral stabilization surgery were through open techniques. The first report of surgical stabilization was by Perthes in 1906 who used staples.¹ In 1923 Blundell Bankart first described the detachment of the antero-inferior labrum from the glenoid (bankart lesion) and his stabilization technique of suturing the anterior capsule to the detached labrum using silk gut sutures.^{2,7} Some surgeons found the Bankart technique technically demanding and in 1931 F. P. Fouche and A. Lewer Allen described their technique of using chisel pointed staples made from bicycle spokes to pin the anterior capsule to the glenoid rim.⁸ Slight modifications of this technique including the use of conical tipped stainless steel staples and staples fashioned from kirschner wires.^{8,9} The first series of staple capsulorrhaphy for anterior instability reported in the US was in 1965 by Boyd and Hunt who used barbed stainless steel staples to prevent hardware migration.¹⁰ Despite advances in these techniques, complications related to stapling persisted including nerve injury, incorrect hardware placement, hardware migration and articular injury, leading to the need for hardware removal.¹¹

Meanwhile, arthroscopic techniques were being developed and by the mid 1980's arthroscopy was shown to be superior to some open orthopedic procedures.¹² In 1983 Matthews performed the first staple capsulorrhaphies as demonstrated in Fig. 1. A postoperative radiograph is demonstrated in Fig. 2. He utilized staples through an arthroscopic

* Corresponding author.

E-mail address: jondkramer@gmail.com (J.D. Kramer).

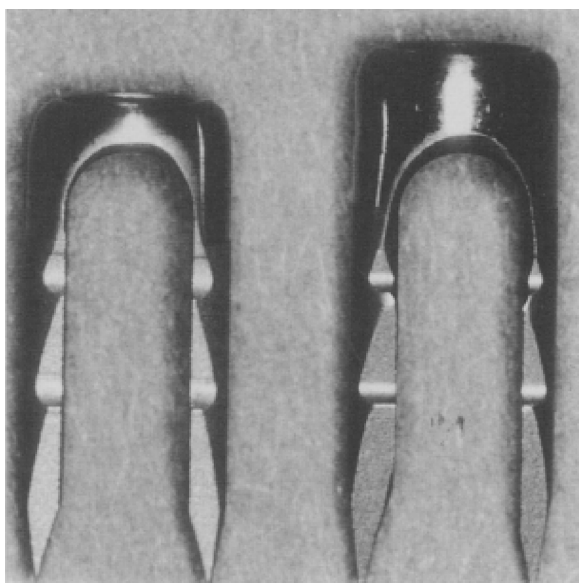


Fig. 1. A staple used through arthroscopic cannulas.

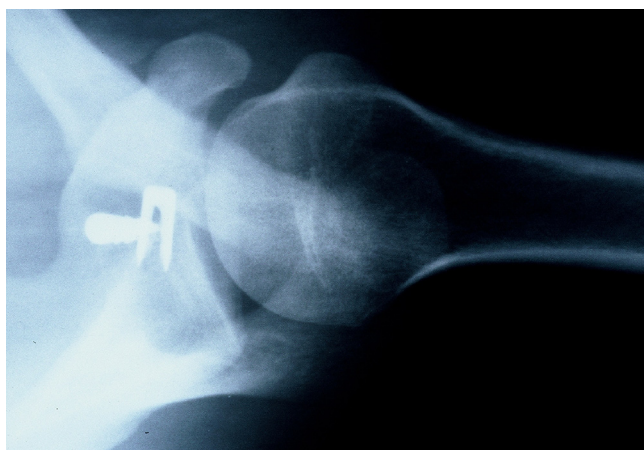


Fig. 2. Postoperative radiograph after staple capsulorrhaphies.

staple cannula. His results showed 67% good to excellent to results, with 20% of his patients needing further surgery. There was one case of staple loosening and one case of staple impingement resulting in chondral damage.

In 1989, Hawkins published a series using staples on 50 cases. He had a relatively high recurrence rate of 15%, which he attributed to his shorter rehabilitation period. He also had two cases of loose intra-articular staples that required surgery for removal. Furthermore, at least one staple broke during insertion, requiring creation of an additional portal for extraction. In total, 4.3% failed due to hardware loosening.¹³ In 1993, Lane et al reported an even higher rate of hardware loosening of 26%, of which 19% required open revision.¹⁴ Eventually, staple use diminished as it is often inadequate in the thin cortical bone and can dislodge easily with motion, as evidenced by the abundance of hardware complications as described above.

Spiked washers

Spiked washers were first described for use in open ligamentous repair by Hurson and Sheehan in 198. The concept behind this innovation was to prevent the screw head from cutting through the ligament.¹⁵ They used spiked plastic washers in conjunction with A.O. compression screws to repair various ligament avulsions including



Fig. 3. Cannulated screw and washer.

lateral ankle ligaments, the lateral collateral ligament of the knee, and the labrum in a bankart lesion in the shoulder. In 1986, Robertson et al compared fixation of two and four-pronged staples to spiked circular washers in a cadaveric model.¹⁶ They found that spiked washers coupled to compression screws provided better fixation strength. Additionally, they noted staples tended to tear through capsular and ligamentous tissue during cyclic loading.

In 1988, Wolf et al. described the use of cannulated screws with spiked washers for the arthroscopic shoulder capsulorrhaphy as seen in Figs. 3 and 4.¹⁷ In this technique, a sharp trochar was used to spear the avulsed glenohumeral ligament complex and advance them superomedially on the scapular neck. After drilling through the scapular neck, a kirschner wire was used to preliminarily fix the ligament complex in place; this was followed by final fixation with a 4.5 cannulated screw with a spiked washer. During the 26 month follow up, none of the 23 patients had recurrent instability and there was no evidence of screw migration.

Spiked washers with compression screws continued to be used into the 1990s for both arthroscopic and open shoulder stabilization. In 1998 Takeda et al. described the use of a spiked washer and cancellous screw in a modified open bankart procedure in chronic anterior shoulder instability.¹⁸ However, arthroscopic use of cannulated screws

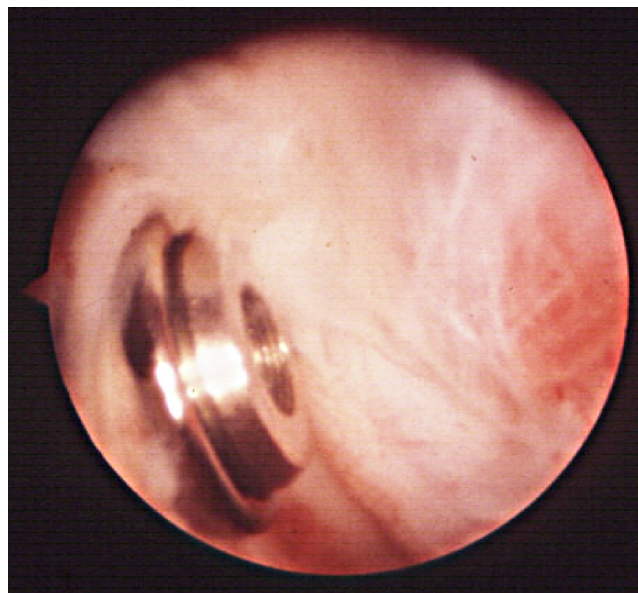


Fig. 4. Arthroscopic photograph of cannulated screw and washer.

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