The Stener Lesion: Historical Perspective and Evolution of Diagnostic Criteria

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Meghan E. Lark¹, Brianna L. Maroukis¹, and Kevin C. Chung^{1,2}

Abstract

Background: In 1962, Bertil Stener first described the anatomy and treatment of the displaced ulnar collateral ligament of the metacarpophalangeal joint, later called the Stener lesion. Since Stener's publication, treatment algorithms for ulnar collateral ligament rupture have aided in preoperative diagnosis, yet the best diagnostic method to assess ligament displacement remains largely undefined. **Methods:** An extensive literature search was performed to explore the treatment evolution of the Stener lesion and explore how technical development has influenced Stener lesion diagnosis. We also sought to illuminate the life and work of Bertil Stener. **Results:** Studies evaluating the use of magnetic resonance imaging (MRI) and ultrasound (US) technology have suggested that these modalities have improved Stener lesion diagnosis. **Conclusion:** Despite the utility of developing MRI and US technology, consensus for one superior diagnostic tool for Stener lesions does not currently exist.

Keywords: Stener lesion, Bertil Stener, ulnar collateral ligament, thumb metacarpophalangeal joint, ulnar collateral ligament rupture

In the early 1960s, Bertil Stener first described a “lesion” near the metacarpal head of the thumb as a result of a displaced ulnar collateral ligament (UCL) following ligament rupture.²⁹ Through anatomical observation of cadavers and surgical patients, the Swedish surgeon discovered that this unique UCL injury was caused by interposition of the ulnar expansion of the dorsal adductor aponeurosis between the ruptured distal end of the ligament and its site of insertion to the proximal phalanx. In addition to an extensive anatomical description of the injury, Stener's publication advocated that displacement of the UCL ligament inhibited the natural healing process and required prompt surgical intervention to prevent long-term morbidity of the MCP joint. Stener's work was published in the *Journal of Bone and Joint Surgery* in 1962.

Approximately 200 000 patients with UCL ruptures are treated annually, with Stener lesion prevalence ranging from 14% to 88%^{11,26} of these cases. Large prevalence of the injury and high frequency of misdiagnosis in an acute setting²⁰ demonstrate the importance of the anatomical history and diagnostic evolution that have shaped treatment of the Stener lesion. Although Stener's proposed anatomy and recommended surgical treatment of the lesion were generally accepted by other surgeons,¹⁵ the specific criteria to identify a Stener lesion upon clinical presentation were not clearly described. In an effort to better understand this

injury, a thorough investigation of world literature was carried out to provide an analysis of the evolution of Stener lesion diagnosis and discuss how the advancement of modern research has influenced this evolution.

Emergence of Ulnar Collateral Ligament Injury Research

Sweden has historically placed a large emphasis on sports, and athletes were constantly becoming stronger, faster, and pushing more limits. Physicians began to focus on treating these athletes' unique medical challenges, with particular focus on soft tissue injuries.²⁵ One sport that is engrained into the Scandinavian culture is skiing. Early residents of the Scandinavian mountains would use wooden skis for travel, hunting, and military combat, eventually transforming skiing into an athletic event. Widespread participation in skiing was undoubtedly accompanied with injury. The

¹University of Michigan Health System, Ann Arbor, USA

²University of Michigan Medical School, Ann Arbor, USA

Corresponding Author:

Kevin C. Chung, Research Associate, Section of Plastic Surgery, University of Michigan Health System, 2130 Taubman Center, SPC 5340, 1500 E. Medical Center Drive, Ann Arbor, MI 48109-5340, USA.
Email: kechung@med.umich.edu

first medical records of skiing injuries, such as femoral fractures, were published in 1889 and increased throughout the early 1900s in both Scandinavia and Europe.⁶ Upper extremity ski injuries became prevalent in the mid-1900s, owing to an evolving intensity of skiing techniques that required a greater distribution of weight on the ski poles.² In addition, ski poles became equipped with straps that bound the skier's hands to the pole and prevented release upon falling. Therefore, a fall at a high velocity would produce a strong force on the MCP joint of the thumb. This led to an increase in prevalence of UCL injury in the thumb, which was later found to occur in nearly 10% of all ski injuries.⁶

This increased prevalence of ski injuries, as well as other acute injuries resulting from athletics, occurred during a time when hand surgery and research was expanding in Sweden. The practice of hand surgery was introduced to Sweden in 1948 by Eric Moberg⁹ through the publication of his book *Emergency Surgery of the Hand*. In 1949, he created the first hand surgery ward and clinic in Gothenburg and is considered by many to be the Swedish "Father of Hand Surgery."¹³ After Stener graduated from medical school in 1948, he was hired by and worked under Moberg in the hand surgery ward. Stener developed an interest in ligamentous injuries of the hand and contributed to Moberg's research surrounding UCL rupture.^{8,19} In 1953, Moberg and Stener published the article "Injuries to the Ligaments of the Thumb and Fingers; Diagnosis, Treatment and Prognosis" in which they described their preference of operative intervention and defined a surgical treatment plan for full UCL ruptures.¹⁹ This publication was the first to indicate a preference for surgical treatment of full UCL rupture, contrary to prolonged plaster immobilization.

Other Scandinavian surgeons such as Strandell³⁰ and Frykman and Johansson⁷ also began to explore soft tissue injuries with particular focus on the UCL. Their findings supported those of Moberg and Stener in advocating surgical treatment for total UCL rupture,^{14,29} attributing their preference to observation of improved patient outcomes after surgical intervention compared with conservative treatment. Injury to the UCL adopted the title of "Gamekeeper's Thumb"³ in 1955 after the Scottish orthopedic surgeon C. S. Campbell published a summary of the unique thumb injury he observed in Scottish gamekeepers. Campbell explained that the way in which the gamekeepers kill rabbits, by holding them in the cleft of the thumb and forefinger and pulling on the neck, often applies a strong valgus force to the ulnar side of the thumb. He concluded that the periodic repetition of this motion would initially lead to UCL lengthening, causing the phalanx to tilt over the metacarpal head under radial stress to the MCP joint and eventually leading to ligament rupture. Similar observations were made by A. J. Alldred,¹ a surgeon in New Zealand, who noted a swollen dorsal-ulnar aspect of the MCP joint and joint instability in stress radiographs of patients presenting with suspected UCL rupture. In 3 cases

Figure 1. Reproductions of Bertil Stener's hand-drawn illustrations of the Stener lesion, as published in his 1962 article "Displacement of the Ruptured Ulnar Collateral Ligament of the Metacarpo-phalangeal Joint of the Thumb."

Note. Dorsal (A) and ulnar (B and C) views of the thumb metacarpophalangeal (MCP) joint. Stener lesion with distal ulnar collateral ligament (UCL) rupture (C). a = dorsal aponeurosis; b = adductor aponeurosis; c = adductor pollicis; d = extensor pollicis longus tendon; e = adductor pollicis tendon; f = collateral ligament; g = accessory collateral ligament.

of UCL rupture, the stress radiography images showed a shift of the base of the phalanx off the metacarpal head to cause opening of the joint. After failed conservative treatment in all 3 cases, Alldred concluded that stability of the joint could only be restored by surgical intervention.

Early Years (Early 1960s to Late 1970s)

Swedish athleticism, in combination with the nation's advanced medical specialization in soft tissue injuries of the hand, likely influenced the large number of patients with MCP joint instability that began to appear in the Gothenburg hand clinic. However, patients presenting to Stener with suspected UCL injury differed from the Scottish gamekeepers treated by Campbell. These injuries, today referred to as "skier's thumb," were caused by an acute force to the thumb joint resulting from falls, accidents, and athletic activities, rather than the chronic, occupational injury described by Campbell. In Stener's article titled "Displacement of the Ruptured Ulnar Collateral Ligament of the Metacarpo-phalangeal Joint of the Thumb,"²⁹ he attributes his discovery of the lesion to the frequent observation of cases in his clinic and his interest in the unique anatomy of their injuries discovered in the operating room. After these observations, Stener conducted his own systematic investigation through surgical management of 39 of his patients, supplemented with additional studies on post-mortem specimens. Stener found that upon UCL rupture in these patients, the distal end of UCL had become folded over to point proximally, which caused the ulnar expansion of the adductor aponeurosis to become interposed between the ruptured end of the ligament and its proximal attachment at the phalanx, thereby causing ligament displacement. Stener argued that, owing to the interposition of adductor aponeurosis blocking the insertion point, the UCL could not undergo natural ligamentous repair without operative intervention.

After extensive anatomical study of the proper and accessory UCLs supplemented with hand-drawn illustrations (Figure 1), Stener characterized the lesion and offered a tentative explanation for the mechanism of displacement. He then provided details of 8 “Illustrative Cases” of his patients, to provide examples of patient presentation and operative repair using the “pull-out-wire” technique described in his publication with Moberg in 1953.¹⁹ When discussing his findings, Stener stated that presentation of a tender and swollen area on the ulnar side of the metacarpal head, caused by either the displacement itself or granulated tissue, could be an indicator of displacement but was not specific for displacement. Stener also made the observation that bony avulsion fractures sometimes occurred upon rupture and that the bone fragment from the distal attachment may show up on radiography images, serving as an indication of displacement. Other than these 2 conditions, Stener concluded that displacement cannot be identified without surgical treatment.²⁹

Stener’s anatomical analyses were comprehensive, and many authors agreed with his insistence on surgical treatment¹⁵; however, his publication did not provide definitive guidelines for assessing displacement in unstable UCL ruptures presenting without swelling near the area of the metacarpal head or avulsion fracture. Despite acceptable results being well supported in conservative treatment of nondisplaced UCL ruptures, many authors, unable to determine displacement and unwilling to risk misdiagnosis, insisted that all patients with suspected UCL rupture undergo surgical exploration to rule out a Stener lesion.¹⁵ This aggressive approach was adapted to treatment plans in response to the high frequency of Stener lesions reported in Stener’s publication (64%),²⁹ paired with the absence of any additional research in the literature providing management guidelines. However, after 5 years of utilizing an aggressive surgical approach, data indicated that institutions were finding a much lower frequency of Stener lesions upon surgery than what Stener’s article reported. One study found Stener lesion prevalence as low as 20% of operative cases of UCL rupture, which raised concerns about excessive operative treatment.¹⁵ This discrepancy highlighted a strong need for the creation of specific management guidelines to preoperatively rule out a Stener lesion and ultimately prevent unnecessary surgeries.

Intermediate Years (Late 1970s to Early 1990s)

In an effort to clarify and define objective measures for injury management, treatment algorithms began emerging for UCL injury in 1977.²² Widely implemented algorithms used degree of MCP joint angulation in valgus stress tests with the thumb in flexion and extension as the determining value to classify UCL injuries into 4 injury types.^{10,15,22,24} The use of joint angulation as an indicator of ligament condition was derived from the knowledge that the proper collateral ligament stabilizes the joint in flexion, whereas the accessory collateral ligament stabilizes the joint in extension^{10,29} (Figure 2).

Figure 2. Images of the metacarpophalangeal joint of the thumb in extension (A) and flexion (B), highlighting the proper (1) and accessory (2) ulnar collateral ligaments that connect the metacarpal (3) and proximal phalanx (4) bones and (5) the sesamoid bone. In extension, the accessory ulnar collateral ligament (UCL) is tight, whereas the proper UCL is loose. The opposite is observed when the thumb is in flexion.

Although the exact value varied by physician opinion, rupture of either the proper UCL or the accessory UCL was confirmed if clinical stress testing caused joint angulation greater than 30° to 35° with thumbs in either flexion or extension.^{10,15,20,22} The treatment algorithm suggested that upon these clinical observations, patients’ injuries would be classified as type IV, confirming UCL rupture and requiring prompt surgical intervention.

In the case of the Stener lesion, the implementation of treatment algorithms increased the efficiency of Stener lesion diagnosis,¹⁵ though it was still impossible to distinguish displacement in patients with type IV injuries without surgical exploration. Despite limitations, joint angulation measurements provided useful information when the comparison of extension and flexion values yielded drastically different values. Heyman et al¹⁰ found a significant correlation of joint stability in extension with Stener lesion absence, concluding that presence of differential laxity values could serve as a contraindication of a Stener lesion. Although the algorithm was shown to be useful, these studies reinforced Stener’s preconceived notion that displacement of the ligament cannot be ruled out without operation, as clinical examination is not specific for diagnosis of a Stener lesion.

Late Years (1990s to Present)

The first studies to use revolutionary imaging methods such as ultrasound and magnetic resonance imaging (MRI) for UCL injury diagnosis and management began appearing in the literature around the early 1990s. The use of this equipment for extremity injuries was made possible by the technological advancement of scanners and coils permitting visualization of small structures,¹⁶ which offered a promising, noninvasive approach for preoperative diagnoses.^{11,12,21,28} Numerous studies began testing the specificity and sensitivity of this equipment in detection of displacement in thumbs with suspected UCL rupture and Stener lesion by comparing diagnoses made through utilization of each imaging technique with those made during surgery. Similar positive results were collected for both imaging techniques, though each provided entirely different perspectives and images of the MCP joint.

Figure 3. A, Stener lesion. Ultrasound image long axis to the ulnar collateral ligament shows torn and proximal Stener lesion (arrows). Note thickened adductor aponeurosis (arrowheads). B, Adductor aponeurosis injury. Ultrasound image long axis to the ulnar collateral ligament shows thickened and injured adductor aponeurosis (arrowheads) with intact ulnar collateral ligament (*). MC = first metacarpal; P = proximal phalanx.

In MRI scans of the MCP joint, a normal UCL appears as a low-signal-intensity band medial to the MCP joint, with the distal attachment of the UCL displaying over the base of the proximal phalanx. In cases of UCL rupture without ligament displacement, images depict a discontinuous distal end of the UCL with intermediate signal intensity remaining in the normal UCL position. In contrast, a displaced UCL appears retracted or folded onto itself proximally, often with the proximal margin of the adductor aponeurosis appearing as a thin, dark line interfering with the folded UCL.²⁸ Studies using MRI to detect UCL injuries found that MRI yielded sensitivity of 96% to 100% and specificity of 94% to 100% for the detection of Stener lesions.^{23,28} The accuracy of MRI has led to the development of a new classification guide for UCL management based on MRI scans displaying distance of UCL displacement in millimeters.¹⁸ A recent treatment-oriented classification proposed by Milner¹⁸ suggests surgery for all ruptured ligaments demonstrating displacement of 3 mm or greater (type 3) as well as those appearing to have a Stener lesion (type 4). Some consider MRI the best modality for UCL visualization, whereas others criticize its high cost and lagging availability,¹⁶ frequently preferring ultrasound techniques to remedy these pitfalls.

Studies evaluating ultrasound efficacy have produced results similar to those evaluating MRI accuracy with ultrasound studies showing positive predictive values of Stener lesions ranging from 87% to 100%.^{4,5,17,27} Sonography of the displaced UCL shows a round, heterogeneous, and well-defined stump located proximal to the metacarpal apex and adductor aponeurosis with an average distance of 9 mm to the proximal aspect to the MCP joint¹⁷ (Figures 3A and 3B). Ultrasound is cost-effective, dynamic, and easily obtainable in ambulatory settings, yet it is important to note pitfalls of misdiagnosis that are potentially threatening to determine an accurate treatment plan. Such pitfalls specific to Stener lesion involve the misconception that a displaced UCL is located superficial to the adductor aponeurosis, instead of proximal, which can be easily differentiated by applying

Figure 4. Bertil Stener (1920-1999).

Source. Adapted from Gunterberg⁸ and Taylor & Francis Ltd at www.tandfonline.com.

passive flexion at the thumb interphalangeal joint to allow isolated movement of adductor aponeurosis.¹⁷ Despite these pitfalls, ultrasound imaging with an experienced technician produces a quick, accurate, and suitable image to detect a Stener lesion and indicate a need for operative intervention.

The evolution of the Stener lesion since the injury's introduction in 1962 has largely been characterized by changes in the way it is diagnosed. Emerging technology has had an impact on injury diagnosis and management, as seen in the utility of MRI and ultrasound in producing novel views of MCP joint structures that greatly exceed any information obtained through physical examination and stress radiographs. For these reasons, it is important that a historical account of the Stener lesion is one that focuses on diagnostics triumphs and controversy, as opposed to evolution of anatomical information or surgical techniques, which have remained relatively constant. Stener's initial publication remains highly regarded for his anatomical precision

Figure 5. An illustration of cerebral nerve nuclei that won Bertil Stener an award in 1948. (A) Posterior aspect. (B) Cross-sectional aspect. Source. Adapted from Gunterberg⁸ and Taylor & Francis Ltd at www.tandfonline.com.

and accuracy in thoroughly describing the injury itself and the surgical steps involved in repairing it. Despite the best modality of imagery as suggested by the literature remaining contested between MRI and ultrasound, large accomplishments have been made in the effort to find a noninvasive and efficient way to determine ligament displacement.

Who Was Stener? (March 1920 to November 1999)

Bertil Stener (Figure 4) was born on March 19, 1920, in the countryside outside of Gothenburg, Sweden, as the

eldest son to a farmer¹³ who worked selflessly to provide Stener with the opportunity to attend school in the city. After completing secondary school and graduating from the nearby Uppsala University Medical School in 1948, Stener began working under Moberg in his hand clinic in Gothenburg. A humble and kind “gentle giant,” Stener began training as a locum tenens, or substitute physician, in general surgery, and in 1953, he was appointed clinical instructor in general surgery in Gothenburg.⁸ After working in general surgery for 10 years, Stener was a candidate for the chair of general surgery at Uppsala University, yet the appointments committee felt his research was better

categorized in the field of orthopedics. Therefore, in 1964, when he was offered the chair position to follow orthopedic surgeon Carl Hirsch in the Department of Orthopedics in Gothenburg, he accepted and subsequently succeeded Hirsch as department head in 1970.

Although Stener made significant medical contributions in ligamentomuscular protective reflexes and ligament injuries, his most impactful contribution was his extensive work with surgical methodology of tumors of the soft tissue and bone.⁸ He developed, pioneered, and taught the total spondylectomy procedure, a unique operation involving intact removal of spinal columns to subsequently remove pieces of cancerous bone on the spine. His crafted operations were considered ingenious measures to excavate tumors that were considered inoperable, allowing postoperative patients to enjoy a relatively active life with only the aid of a colostomy.⁸ A thorough and attentive surgeon, Stener would prepare for each total spondylectomy case weeks in advance by creating custom illustrations of each tumor to form a plan, which once surgically executed often lasted 30 to 40 hours in the operating room.³¹

To maintain physical fitness to perform the long operations, Stener jogged and avidly played tennis, in which he was allegedly unbeatable.³¹ A longtime athlete and lover of sports, Stener was the head physician of both a nearby soccer team and the Stockholm Open Tennis Championship. In addition to his athletic hobbies, he was a masterful linguist and was fluent in English, German, French, and Spanish. He was also a skilled medical illustrator, winning an award for his illustrations of the cerebral nerve nuclei in 1948 (Figure 5) and supplementing many of his published articles with customized drawings.

Throughout his career, Stener performed 61 major tumor operations of the axial skeleton and experienced only 2 cases of early postoperative deaths.⁸ In his late career, he traveled worldwide and presented slides of his unique cases and planning technique, supplementing his presentations with custom drawings, personalized clinical reports, and photographs of patients. Stener remained professor of orthopedics at the University of Gothenburg until his retirement in 1986, when his work was honored by the international symposium in Gothenburg titled "Musculoskeletal Oncology 1986—A Tribute to Bertil Stener."⁸ Stener passed away in November 1999, yet his name and surgical legacy live on through eponyms such as the *Stener reflex*, describing muscle responses to tension forces in sports medicine, the *Stener principle*, omitting biopsy in tumor surgery to avoid contamination of uninvolved tissues, and, finally, the *Stener lesion*, the surgical indicator of acute ligamentous injuries.

Authors' Note

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

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