2001

A case study : Scaphoid fracture in a collegiate softball player

Shanelle L. Schlicher
San Jose State University

Follow this and additional works at: https://scholarworks.sjsu.edu/etd_theses

Recommended Citation

Schlicher, Shanelle L., "A case study : Scaphoid fracture in a collegiate softball player" (2001). *Master's Theses*. 2241.

DOI: <https://doi.org/10.31979/etd.5r49-u8hv>
https://scholarworks.sjsu.edu/etd_theses/2241

This Thesis is brought to you for free and open access by the Master's Theses and Graduate Research at SJSU ScholarWorks. It has been accepted for inclusion in Master's Theses by an authorized administrator of SJSU ScholarWorks. For more information, please contact scholarworks@sjsu.edu.

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

**ProQuest Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600**

UMI[®]

A Case Study:
Scaphoid Fracture in a Collegiate Softball Player

A Project
Presented to
The Faculty of the Department of Human Performance
San Jose State University

In Partial Fulfillment
of the Requirements for the Degree
Masters of Arts

by
Shanelle L. Schlicher
December, 2001

UMI Number: 1407317

UMI[®]

UMI Microform 1407317

Copyright 2002 by ProQuest Information and Learning Company.
All rights reserved. This microform edition is protected against
unauthorized copying under Title 17, United States Code.

ProQuest Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

© 2001

Shanelle Schlicher

ALL RIGHTS RESERVED

APPROVED FOR THE DEPARTMENT OF HUMAN PERFORMANCE

Leamor Kahanov

Maria Veri

Jeb Burns

APPROVED BY THE UNIVERSITY

ABSTRACT
A CASE REPORT:
SCAPHOID FRACTURE IN A COLLEGIATE SOFTBALL PLAYER
by Shanelle Schlicher

Scaphoid fractures in the wrist are one of the most difficult upper extremity injuries to diagnose and properly treat. A misdiagnosed scaphoid fracture has the potential for increasing the risk of healing complications and a prolonged period of inactivity. The purpose of this case study is to aid in educating sports medicine personnel to better evaluate and properly treat possible scaphoid fractures by presenting a unique scaphoid fracture in a collegiate softball player. The intricate function and anatomy of the wrist makes injury to this site serious and difficult to treat. This athlete underwent five surgeries and a myriad of treatment and rehabilitative therapy. The high frequency of fracture nonunion and avascular necrosis of the scaphoid makes early diagnosis and treatment essential.

ACKNOWLEDGMENTS

I would like to extend a very sincere thank you to the participant of this study, who just happened to walk in the door, you're the best rose garden. A big thanks to my committee, Leamor, Maria and Jeb, for all their help and guidance to complete this study. A very loving thank you goes out to my family, although so very far away, provided me with support and encouragement that I needed to keep going. A very special thank you to Kev, who spent the past two years supporting me through this project. Finally, thank you to all those people who persistently encouraged and pointed me in the right direction. A big thank you!

TABLE OF CONTENTS

List of Tables	viii
-----------------------------	------

List of Figures	viii
------------------------------	------

Project

Article Submission	1
Cover Page	1
Contribution Form	2
Release Form	3
Abstract	4
Introduction	5
Case Report	5
Discussion	8
Conclusions	14
References	20

Chapter 1

Introduction	22
Significance of the Problem	23
Statement of Purpose	23
Delimitations	24
Limitations	24
Definitions	24
Summary	25

Chapter 2

Review of Literature	26
Case Study Characteristics	27
Competencies and Continuing Education	28
Anatomy of the wrist	29
Scaphoid Bone Properties	30
Scaphoid Fracture Recognition	32
Treatment of a Scaphoid Fracture	35
Complications of Scaphoid Fractures	37
Summary	38

Chapter 3

Introduction	39
Participant	39
Procedures	40
Research Design	41
Summary	41

References	43
-------------------------	----

Appendix A. Authors notes for <u>Journal of Athletic Training</u> submission	46
---	----

Appendix B. Consent to participate in study	51
--	----

Appendix C. Medical record release	53
---	----

List of Tables

Table 1.	Timeline.....	19
-----------------	----------------------	-----------

List of Figures

Figure 1. Wrist Anatomy.....	30
Figure 2. Scaphoid Bone Anatomy.....	31
Figure 3. Carpal Vascular Supply.....	32
Figure 4. Scaphoid Fracture Mechanism of Injury.....	33
Figure 5. Anatomical Snuffbox.....	34

A CASE REPORT:
SCAPHOID FRACTURE IN A COLLEGIATE SOFTBALL PLAYER

By

Shanelle L. Schlicher
San Jose State University
Assistant Athletic Trainer
One Washington Square
San Jose, CA 95192
408-924-1297
slicker2001@msn.com

Leamor Kahanov
San Jose State University

Maria J. Veri
San Jose State University

Jeb Burns
San Jose State University

JAT# _____ Title of the manuscript A Case Study: Scaphoid fracture in a collegiate softball player

Please write or type in each author's last name, and then indicate the contributions of that person in the appropriate categories.

Contributors who do not meet the criteria for authorship should be thanked in the Acknowledgments section.

Contribution											
Author's Last Name	conception & design	acquisition of data	analysis & interpretation of the data	drafting of the article	critical revision of the article for important intellectual content	final approval of the article	provision of study materials or patients	statistical expertise	obtaining of funding	administrative, technical, or logistic support	collection & assembly of data
Schlicher	X	X	X	X	X	X	X			X	X
Kahanov	X		X	X	X	X	X			X	
Veri			X		X	X				X	
Burns	X				X	X				X	

*Contribution descriptions reprinted with permission of the *Annals of Internal Medicine*.

Release of information for case report:

Date: _____

I, _____ freely give my consent for the release of information regarding my medical history, injury, surgery, and rehabilitation for use in the following case report, which is being submitted to the *Journal of Athletic Training*:

Author(s): Shanelle L. Schlicher, Leamor Kahanov, Maria J. Veri, Jeb Burns

Title: A Case Report: Scaphoid fracture in a collegiate softball player

I understand that this information may be used in publication and that my name will remain confidential.

Signature: _____

Witness: _____

ABSTRACT

A CASE REPORT:

SCAPHOID FRACTURE IN A COLLEGIATE SOFTBALL PLAYER

Objective: The purpose of this case study is to aid in educating sports medicine personnel to better evaluate and properly treat possible scaphoid fractures by presenting a unique scaphoid fracture in a collegiate softball player.

Background: Scaphoid fractures in the wrist are one of the most difficult upper extremity injuries to diagnose and properly treat. A misdiagnosed scaphoid fracture has the potential for increasing the risk of healing complications and a prolonged period of inactivity. The intricate function and anatomy of the wrist are what makes injury to this site serious and difficult to treat. The high frequency of fracture nonunion and avascular necrosis of the scaphoid makes early diagnosis and treatment essential.

Differential Diagnosis: Scaphoid fracture verse wrist contusion and/or muscular or ligament injury.

Treatment: The scaphoid fracture was initially treated with immobilization. Following non-unity at the fracture site, three separate bone grafts, a carpectomy, and a thermal capsular shrinkage procedure were completed.

Uniqueness: The severity of the athlete's injury coupled with a delay in treatment, necessitated five wrist surgeries over a two-and-a-half year period following the original incident, and creates a unique set of circumstances.

Conclusions: The athletic trainer should know proper evaluation techniques and treatment protocols for hard to diagnose injuries, and injuries with the potential for physical deformity, such as scaphoid fractures of the wrist. With proper and early assessment, scaphoid fracture complications may be decreased.

Key Words: wrist injury, wrist fracture, carpal fracture

INTRODUCTION

The wrist and hand are the most common sites of upper extremity injury during sporting activities,¹ with the scaphoid accounting for most fractured carpal bones in the wrist.² Approximately 350,000 scaphoid fractures occur each year in the United States.³ In addition, approximately 10% to 15% of scaphoid fractures fail to unite after immobilization.³ The high frequency of fracture nonunion and avascular necrosis of the scaphoid makes early diagnosis and treatment essential.^{1,2} Although complications of scaphoid fractures are a possibility, it is unique for many complications to occur in one individual case.

The athletic trainer is in a unique position to evaluate injuries from inception, as well as treat and rehabilitate most injuries presented by athletes. Thus it is essential for the athletic trainer to properly evaluate and implement appropriate treatment protocols for hard to diagnose injuries such as scaphoid fractures of the wrist.

A CASE REPORT

A 19 year-old collegiate softball player presented in the athletic training room complaining of right wrist pain in May 1997. Initially, the athletic trainer conducted an assessment documenting general swelling and pain upon palpation of the wrist area. The athletic trainer also reported limited grip strength of the right hand. The wrist was assessed to have a contusion and the athlete returned to play. Two weeks after initial injury, the athlete was referred to the team physician because of a continued complaint of pain and increased swelling. Pain in the anatomic snuffbox and upon extension and radial deviation was documented by the team physician. A mid or waist scaphoid

fracture was confirmed through X-ray, and diagnosed by the athlete's team and primary care physicians.

Treatment Plan

The initial treatment plan consisted of wearing a long arm cast for approximately 4 weeks, then transferring into a short arm cast until healing occurred. Table 1 chronicles the athlete's evaluation and treatment plan. Two months following the initial injury X-rays, a nonunion of the scaphoid fracture was identified. Surgery was suggested with the use of a bone graft from the radius along with internal fixation using Herbert screw and wire fixation. A thumb spica cast was applied and retained for an additional 3 weeks after x-ray one month post-op revealed nonunion of the scaphoid. A seven-week post-op examination indicated little reabsorption at the fracture and complaints of shooting pain in the wrist.

Four months following initial injury and two months following surgery, a second surgery was performed to remove the old hardware and conduct a new bone graft from the iliac crest with internal fixation. A long arm cast was applied following surgery for one month. The long arm cast was changed to a short arm cast one month post-op (surgery 2) when good positioning of the graft was visible on X-ray. The use of electromagnetic therapy was recommended for bone healing stimulation. Seven months post initial injury radiology reports indicated the bone graft was not fully incorporated and treatment protocol was directed by the primary care physician to continue use of electrical stimulation and obtain a second opinion.

75 The athlete was allowed to return to softball for the upcoming season based on
76 adequate scaphoid healing by a second physician's opinion. Nine months following
77 initial injury, no tenderness in the anatomic snuffbox was identified and X-rays indicated
78 no change in the position of the scaphoid bone. The athlete was instructed to progress
79 with activities as tolerated, tape for softball practices, and focus on strengthening, not
80 stretching, of the wrist musculature.

81 One month following the athlete's return to play, she returned to her primary care
82 physician with complaints of soreness and swelling of the wrist while playing softball.
83 Since these signs and symptoms were not a serious deterrent to her softball activities, the
84 athlete was instructed to complete the softball season. Upon conclusion of the softball
85 season, the athlete returned to her physician with tenderness in the anatomic snuffbox and
86 progressive pain with daily living activities. A CT (computed axial tomography) scan,
87 one year following initial injury, concluded early sclerosis proximal to the graft and
88 healing distal to the bone graft. Overall, no signs of progressive healing existed. New X-
89 rays indicated an increase in the angle between the axes of the scaphoid and lunate. One
90 year and two months following the initial occurrence of injury, a third surgery was
91 indicated to explore the scaphoid nonunion and probable humpback deformity identified
92 through the most recent clinical assessment.

93 To correct the progressive collapse of the scaphoid, a repeating of the initial bone
94 graft from the iliac crest along with internal fixation was performed. Two weeks
95 following the third surgery, a follow-up visit confirmed that the scapholunate angle was
96 acceptable. The athlete returned to the primary care physician four months following the
97 third surgery for a follow up examination. A CT scan identified a subluxation of the

scapholunate articulation one year and eight months following initial injury. A carpectomy of the scaphoid, lunate and triquetrum was performed to increase the stability of the carpals. The athlete was returned to limited throwing and batting three months following the fourth surgery. Six months following the fourth surgery, she complained of wrist soreness and was placed in a cast for three weeks to allow the capsule to scar, then transferred into a brace for an additional three weeks intended to create scar tissue in the capsule to provide additional stability to the wrist joint. Palmar flexion exercises were prescribed while in the brace; however, dorsiflexion was to be avoided.

Thermal capsular shrinkage was recommended if the condition were to worsen in order for the athlete to conclude her last season of softball eligibility. Two years and four months following the initial injury, thermal capsulorrhaphy to decrease the chance of wrist subluxation was performed. A short arm cast was indicated for approximately five weeks following surgery. The wrist was assessed as stable during the one-month physician follow-up visit. Three months post the fifth surgery a Velcro brace was prescribed and the athlete was allowed to return to throwing and batting. Wrist taping for sporting activities to prevent wrist dorsiflexion was also prescribed. The athlete competed in the 2000 softball season with minimal soreness and swelling throughout the season.

Following the end of her softball eligibility and graduation from college, she began to experience wrist pain with daily activities. After returning to her primary care physician, there is discussion of fusion for the remaining carpals to relieve her pain.

DISCUSSION

Scaphoid Bone Properties

The scaphoid bone consists of three parts: proximal, waist or mid, and distal sections (Figure 1). The scaphoid is unique since it articulates with five other bones and spans the length of both proximal and distal rows of the carpal bones.² Three of the four articulating carpal bones are part of the distal row: capitate, trapezoid, trapezium. The fourth articulating carpal bone, the lunate, is in the proximal row of the wrist. The fifth bone that the scaphoid articulates with is the radius in the forearm (Figure 2). With the wrist in a neutral position, the scaphoid bone lies in 45-60 degrees of flexion in relation to the radius, lunate, and capitate.⁴ Flexion of the scaphoid increases with radial deviation and wrist extension and decreases with ulnar deviation and wrist flexion. The proximal half of the wrist is stabilized among the radius, the capitate, and the palmer capsule, when the wrist is placed in extension, thus resulting in a bending load applied to the distal one-half of the scaphoid.^{4,5} According to Barton (1992), Weber and Chao (1978) found that “failure of the scaphoid occurs at the point receiving the highest bending movement” (p. 289). In the case of forced wrist dorsiflexion, the waist of the bone receives the highest bending motion (Figure 3). Of all scaphoid fractures, 70% occur through the waist or mid, 20% proximally, and 10% distally.¹ As in this case, the athlete suffered a fracture to the waist or mid section of the scaphoid.

With a small surface area devoid of articulating cartilage, the scaphoid bone has limited space for vascular supply to enter.⁶ The radial artery is the main source of blood to the scaphoid.² The proximal pole and 70% to 80% of the bone receive their blood supply from vessels entering through the dorsal ridge.⁷ The volar branch of the radial artery supply the tuberosity and 20% to 30% of the bone with blood.⁷ Fractures to the proximal pole have up to 100% incidence of avascular necrosis and 30% incidence in the

distal pole.¹ Consistent with the literature, it was seen in this case that at the nonunity fracture site there was sclerosis towards the proximal pole and healing distal to the fracture.

Scaphoid Fracture Recognition

A scaphoid fracture should be identified by differential diagnosis. The first step in the evaluation process is to establish a good history. A crucial step in the history is the mechanism of injury. The primary mechanism of injury to the scaphoid is falling on an outstretched dorsiflexed hand.^{2,6} Understanding the mechanism of injury aids in the evaluation process by providing the examiner with a verbal cue as to the positioning of the bone during the time of trauma. Understanding the wrist position at the time of injury aids in determining the force placed on the scaphoid bone and allows for a better understanding of possible injuries. Although, at times, the athlete may present with an injury without direct mechanism of injury; as in this case. Therefore, further physical evaluation needs to be conducted.

Clinical suspicion, physical examination, and X-ray examination are also evaluative measures that aid in the diagnosis of a fracture.⁶ The physical examination and X-ray should be conducted in order to support fracture suspicion. The physical exam must be conducted on both wrists to assess bilateral differences and ensure accurate assessment. Tenderness during palpation over the anatomical snuffbox remains the cardinal sign for suspicion of a scaphoid fracture.^{2,6,8} Most people are tender bilaterally in the anatomical snuffbox because the sensory branch of the radial nerve also lies there.⁴ The level of tenderness from the injured wrist to the non-injured wrist is compared. Our

athlete showed positive findings of point tenderness in the right anatomical snuffbox when performed by the physician.

Other special tests identified in the literature may identify scaphoid fractures. Longitudinal compression of the thumb is one evaluation technique.⁸ Longitudinal compression is performed by grasping the extended and abducted thumb and pushing it proximally, towards the scaphoid. Pain on wrist extension and/or diminished grip strength are also common signs and symptoms found when a scaphoid fracture is present.⁶ In this case, diminished grip strength and limited range of motion due to pain were found initially by the athletic trainer. An examination conducted two weeks later by the team physician reported findings of pain with wrist extension but did not report on grip strength. Resisted pronation with gentle ulnar deviation that produces pain in the anatomical snuffbox area has also been reported to be indicative of a scaphoid fracture.⁴ The diagnosis of a scaphoid fracture should be based upon the combination of clinical signs as opposed to just one positive test.⁸

When a scaphoid fracture is suspected, the athlete must be referred to a physician for further examination and diagnostic testing. X-rays may aid in further diagnosing the injury with the understanding that fresh scaphoid fractures are not always evident on the first set of X-rays. Reabsorption at the fracture site may not occur until approximately two weeks following injury. Thus, it is during the reabsorption process that the fracture may be visualized on X-rays.^{2,9} All patients with suspicious wrist injury and pain in the anatomical snuffbox region should be treated as if they have a fracture until X-rays at two and four weeks are normal.⁶ Up to 25% of clinically suspected fractures of the scaphoid cannot be confirmed by radiographic examination; therefore it is

recommended that early bone scans be conducted to increase the accuracy of scaphoid fracture diagnosis.¹⁰ If follow-up X-rays at two and four weeks are negative but symptoms are positive, then a bone scan is indicated.² In this case, X-rays taken approximately two weeks following initial complaint of wrist pain indicated scaphoid fracture, thus a bone scan was not obtained initially.

Treatment of a Scaphoid Fracture

Treatment of scaphoid fractures remains controversial.² Principles of scaphoid fracture treatment are related to the location of the fracture, its stability, and the timing of the treatment.² The goal when providing treatment for scaphoid fractures is to obtain bony union within the fracture site. Initial treatment for a suspected scaphoid fracture is immobilization of the hand, wrist, and forearm. In this case, immobilization was delayed by approximately two weeks. During that time the athlete actively participated in softball practices and competition. Once her primary care physician diagnosed the scaphoid fracture, she was placed in a long arm cast. Controversy exists regarding short arm casts versus long arm casts for immobilization of the fracture site.⁶ The short arm cast does not include the elbow joint, and wrist pronation and supination may allow the scaphoid bone to move, increasing the likelihood of non-union of the fracture. A long arm cast does not allow the arm to pronate and supinate; therefore, possibly increasing chances for unity of a scaphoid fracture.

Alternative treatment techniques are instigated when bony union does not occur following cast immobilization. Treatment options for nonunion fractures include internal fixation, bone grafting, and electromagnetic stimulation.^{2,6} According to Barton (1992), Herbert (1990) suggests using both bone grafting and internal fixation when treating a

non-union scaphoid fracture. Electromagnetic stimulation may be used prior to surgery options or following a case of non-unity. The use of electrical stimulation devices may reduce disability time if used as soon as a non-union fracture is suspected.¹¹ In this case, all three of the above mentioned treatments were conducted, and yet the scaphoid fracture failed to unite, following three separate surgeries.

Complications of Scaphoid Fracture

A scaphoid fracture must be stabilized in order to reunite. In cases of fresh fractures (less than four weeks old), union rates of 95% have been reported.⁶ Nonunity occurs in the other 5% of the cases and nonfresh fracture cases. The rate of nonunity occurs in increasing frequency from distal to proximal fracture sites, and most of nonunion fractures are asymptomatic.² Patients who have sustained a scaphoid fracture should be counseled regarding the high probability of future osteoarthritis and carpal collapse without scaphoid stabilization.² Although in this case the scaphoid was stabilized initially through immobilization and then with surgical procedures, instability among the carpals became evident. Carpal collapse from a chronic scaphoid nonunion can lead to the removal of the proximal row of carpal bones.¹² Negative results that have been found following carpectomy are a loss of strength, decrease in range of motion, long periods of rehabilitation, and progressive arthritis.¹³ Although, some studies also found no negative reports following a carpectomy.¹³ Following a carpectomy, an athlete may also experience instability in the wrist joint. In the case of joint laxity that produces clinical instability, caused by a carpectomy, the ability to shrink the collagenous tissue may provide an effective method for reducing excessive joint motion.¹⁴ The athlete in this case had feelings of “looseness” in the wrist following the carpectomy. The thermal

235 capsollorophy was performed to tighten the wrist capsule in order to increase stability of
236 the wrist joint.

237 CONCLUSIONS

238 Sports medicine personnel must be well trained in clinical evaluation techniques
239 to properly assess scaphoid fractures and extreme cases to decrease the potential for long-
240 term problems. The knowledge of forearm, wrist and hand anatomy and clinical tests for
241 injuries is of utmost importance for accurate diagnoses. Referral of the injured athlete to
242 a physician should not be delayed when symptoms of a scaphoid fracture are present.
243 Treatment protocols should be based on individual situations, and not on a standard
244 protocol. Complications arising during the healing of scaphoid fractures may be due to
245 the individuality of the fracture characteristics or the treatment protocol.

246 Athletic trainers and sports medicine personnel need to stay current with medical
247 knowledge. Scaphoid fractures have the potential for permanent physical deformity if
248 not properly diagnosed, supervised, and treated. Thus, the purpose of this case study is to
249 aid in educating sports medicine personnel to better evaluate and properly treat possible
250 scaphoid fractures.

251

Legend to Figures

252

253 **Figure 1: Scaphoid Bone Sections**

254 **From Sections of Scaphoid and Common Fracture Sites. (n.d.) Retrieved October 17,**

255 **2000, from the World Wide Web: www.darkwing.uoregon.edu/~scrawfins/pictures.html**

256

257 **Figure 2: Anatomy of the Wrist**

258 **Huston, C., & Brandser, E. (1999). Anatomy of the wrist. Retrived December 7, 2000,**

259 **from the World Wide Web:**

260 **www.vh.org/Providers/Textbooks/Joint%20Text/wrist.html**

261

262 **Figure 3: Position of the scaphoid with wrist extension**

263 **Scaphoid Fracture. (n.d.). Retrived October 20, 2000, from the World Wide Web:**

264 **www.eatonhand.com/hw/hw021.htm**

Figure 1. Scaphoid Bone Sections

Note: From Sections of Scaphoid and Common Fracture Sites. (n.d.)

Retrieved October 17, 2000, from the World Wide Web:

www.darkwing.uoregon.edu/~crawlin/pictures.html

Figure 2. Wrist Anatomy

Note: From Huston, C., & Brandser, E. (1999). Anatomy of the wrist. Retrived December 7, 2000, from the World Wide Web:

www.vh.org/Providers/Textbooks/JointFluoro/Text/wrist.html

278

279

280

281

282

283

Figure 3. Position of the scaphoid with wrist extension

Note: From Scaphoid Fracture. (n.d.). Retrived October 20, 200, from the World Wide Web: www.eatonhand.com/hw/hw021.htm

	Time from initial injury	Physical Exam	X-Ray	CT Scan	Surgery	Immobilization	Electromagnetic therapy	Rehabilitation	Return to activities
284	Initial Injury	X							
285	Two weeks	X	X			X			
286	Two Months		X			X			
287	Three months		X		X	X			
288	Four months				X	X			
289	Five months		X			X	X		
290	Six Months		X			X		X	
291	Seven Months			X					
292	Eight Months	X	X						X
293	Nine Months	X	X						
294	Ten Months	X	X						
295	Eleven Months			X					
296	One year & two months		X		X	X			
297	One year & three months								
298	One year & four months								
299	One year & five months								
300	One year & six months		X						
301	One year & seven months								
302	One year & eight months			X					
303	One year & nine months								
304	One year & ten months				X	X			
305	One year & eleven months								
306	One year & twelve months								
307	Two years & one month							X	X
308	Two years & two months					X			
309	Two years & three months								
310	Two years & four months	X			X	X			
311	Two years & five months								
312	Two years & six months	X				X		X	
313	Two years & seven months								
314	Two years & eight months								X

315 REFERENCES

- 316 1. Mirabello SC, Loeb PE, Andrews JR: The wrist: field evaluation and treatment. Clin
317 Sports Med 1992;11:1-25.
- 318 2. Calandra JJ, Goldner RD, Hardaker WT: Scaphoid fractures: assessment and
319 treatment. Orthopedics 1992;15:931-937.
- 320 3. Kuschner SH, Lane CS, Brien WW, Gellman H: Scaphoid fractures and scaphoid
321 nonunion. Orthopedic Review 1994; 2:226-236.
- 322 4. Barton NJ: Twenty questions about scaphoid fractures. J Hand Surg (Br) 1992;
323 17B:289-310.
- 324 5. Stern JD, Reitman HS: Fractures of the scaphoid bone. How to handle this common
325 wrist injury. Postgraduate Medicine 1988;83:91-92, 95-97.
- 326 6. Richards RS, Roth JH: Scaphoid fractures. Can J Plas Surg 1996; 4:143-149.
- 327 7. Gelberman RH, Menon J: The vascularity of the scaphoid bone. The Journal of Hand
328 Surgery 1980; 5:508-513.
- 329 8. Parvizi J, Wayman J, Kelly P, Moran, CG: Combining the clinical signs improves
330 diagnosis of scaphoid fractures. A prospective study with follow-up. J Hand Surg (Br)
331 1998;23B:324-327.
- 332 9. Langhoff O, Andersen J L: Consequences of late immobilization of scaphoid
333 fractures. J Hand Surg 1988;13B:77-79.
- 334 10. Tiel-van Buul MMC, van Beek EJR, Broekhuizen AH, Nootgedacht EA, et al.:
335 Diagnosing scaphoid fractures: radiographs cannot be used as a gold standard. Injury
336 1992;23:77-79.
- 337 11. Dunn AW, Rush GA III: Electrical stimulation in treatment of delayed union and
338 nonunion of fractures and osteotomies. Southern Medical Journal 1984;77:1530-1534.
- 339 12. Krakauer JD, Bishop AT, Cooney WP: Surgical treatment of scapholunate advanced
340 collapse. J Hand Surg 1994;19A:751-759.
- 341 13. Imbriglia JE, Broudy AS, Hagberg WC, McKernan D: Proximal row carpectomy:
342 Clinical evaluation. J Hand Surg 1990;15A:426-430.
- 343 14. Wall MS, Deng XH, Torzilli PA, Doty SB, et al.: Thermal modification of collagen.
344 J Shoulder Elbow Surg 1999;8:339-344.

EXTENDED SUPPORT MATERIAL

CHAPTER 1

Introduction

The wrist and hand are the most common sites of upper extremity injury during sporting activities (Mirabello, Loeb, & Andrews, 1992). Scaphoid fractures in the wrist are one of the most difficult upper extremity injuries to diagnose and properly treat. A misdiagnosed scaphoid fracture has the potential for increasing the risk of healing complications and a prolonged period of inactivity. The intricate function and anatomy of the wrist are what makes injury to this site serious and difficult to treat. Furthermore, the scaphoid is the most commonly fractured carpal bone in the wrist (Calandra, Goldner, & Hardaker, 1992). Approximately 350,000 scaphoid fractures occur each year in the United States (Kuschner, Lane, Brien, & Gellman, 1994). Even though these fractures account for 70% of all carpal fractures, they are often misdiagnosed (Zachazewski, Magee, & Quillen, 1996). Kuschner et al. (1994) report an increased incidence of nonunion and delayed union of scaphoid fractures if immobilization is delayed more than four weeks. Kuschner et al. (1994) also report that approximately 10% to 15% of scaphoid fractures will fail to unite even after immobilization. The high frequency of fracture nonunion and avascular necrosis of the scaphoid makes early diagnosis and treatment essential (Calandra et al., 1992; Mirabello et al., 1992).

Within the sports medicine team, the athletic trainer is usually the first person to evaluate and treat any injury presented by an athlete. Therefore, it is important for the athletic trainer to know proper evaluation techniques and treatment protocols for hard to diagnose injuries such as scaphoid fractures of the wrist. With proper and early assessment by an athletic trainer, scaphoid fracture complications may be decreased.

Arnheim and Prentice (1997) suggest that athletic trainers should assume personal responsibility for maintaining and expanding their own knowledge base and expertise. This can be done through continuing education programs and reviewing professional journal articles and current textbooks. The purpose of this project is to conduct and present a scaphoid fracture case study in order to educate athletic trainers about the proper techniques for evaluation and treatment of this injury.

Significance of the Problem

Improper diagnoses and delayed treatment of scaphoid fractures may result in a physically disabled player (Mirabello et al., 1992). Richards and Roth (1996) report scaphoid fractures occur with a frequency of 35 fractures per 250,000 in the general population. Rates of nonunion scaphoid fracture have been reported to vary from 5% to 50% (Richards & Roth, 1996). In order to minimize the cessation of athletic and average daily living activities for the injured athlete, athletic trainers must be well equipped with the knowledge necessary to effectively treat scaphoid fractures.

Statement of Purpose

The purpose of this study is to detail one case of a scaphoid fracture injury incurred by a collegiate softball player in order to help educate athletic trainers about evaluation and treatment of this injury. The severity of the athlete's injury necessitated five wrist surgeries over a two-year period following the original incident. This case study will be compiled into an article and submitted to the Journal of Athletic Training according to the journal's submission policies (see Appendix A).

Delimitations

This case study is delimited to a single female collegiate softball player who had sustained a scaphoid fracture with the following parameters: healing complications of the fracture including nonunion with bone grafting, carpectomy, and capsular shrinkage.

Limitations

The limitations of this case study include:

1. The inability to be present during time of original case may limit the researcher's ability to retrieve complete medical records.
2. The lack of researcher's control over environmental effects on the case
3. The researcher's ability to be present at the time of original incidence may limit the researcher's ability to properly interpret data as it was originally meant to be reported.

Definitions

The following terms are defined for the purpose of this study:

Anatomic SnuffBox: The groove between the tendons of the extensor pollicis longus, on the ulnar side of the wrist, and extensor pollicis brevis and abductor pollicis longus, on the radial side of the wrist.

Avascular Necrosis: The death of tissues caused by lack of blood supply.

Bone Grafting: The surgical removal of bone to fill in a non-union fracture site.

Carpal: The small bones that constitute the wrist joint.

Carpectomy: The surgical removal of carpal bones.

Differential Diagnosis: The determination of distinction between two or more possible injury diagnoses.

Distal: A body part farthest from the trunk.

Fracture: A partial or complete interruption in bone continuity.

Lateral: Away from the median, middle, plane of the body.

Medial: Toward the median, middle, plane of the body.

Non-Union Fracture: A fracture site that does not heal and reunite.

Proximal: A body part nearest to the trunk.

Scaphoid Bone: Carpal bone located in the proximal row on the radial side of the wrist.

Sports Medicine Personnel: A medical professional dealing specifically with any aspect of an athlete's health.

Summary

The high frequency of scaphoid fracture nonunion and avascular necrosis makes early diagnosis and meticulous care of a suspected scaphoid fracture essential (Mirabello et al., 1992). The purpose of this study is to present a case study of a collegiate softball player who sustained a scaphoid fracture and experienced complications that prolonged her return to competitive softball in order to educate athletic trainers about the necessity of proper treatment in such cases.

Athletic trainers must be ready and able to evaluate and treat injuries that occur both on and off the field. Therefore, continuous education on new and old topics related to their discipline is essential. This case study will aid in better preparation to properly evaluate and treat scaphoid injuries. This case study will be submitted to the Journal of Athletic Training for publication.

CHAPTER 2

Review of Literature

A nonunion of a scaphoid fracture is a serious situation that can cause time-loss injuries, in addition to irreversible medical complications. Sports medicine evaluators must understand the anatomy of the wrist, the mechanism of injury, and the clinical signs associated with the individual injury in order to be effective practitioners. Kuschner et al. (1994) reported that approximately 350,000 scaphoid fractures occur in the United States a year. They also reported that although 85%-95% of scaphoid fractures heal following cast immobilization, 5%-15% will not unite and are at risk for healing complications. Athletic trainers, as part of the sports medicine team, are responsible for maintaining a competent level of education in a field that is continually making advances in order to properly assess and treat scaphoid fractures.

This chapter will provide a literature review, in eight sections, of topics related to scaphoid fractures, including: case study characteristics, competencies and continuing education of athletic trainers, anatomy of the wrist, scaphoid bone properties, scaphoid fracture recognition, scaphoid fracture characteristics, treatment of a scaphoid fracture, and complications of scaphoid fractures. The first section reviews case study characteristics to provide insight into the use of case study methodology for this project. The second section explains how athletic trainers become competent and stay up-to-date on issues in the sports medicine field. The anatomy section will explore the structure of the wrist in general. The scaphoid bone articulations and blood supply will be thoroughly examined under the topic of scaphoid bone properties. Sections on mechanism and

evaluation of injury will be described in the scaphoid fracture recognition section. An explanation of blood supply and fracture sites within the scaphoid bone will also be provided in the scaphoid fracture recognition section. Acute and chronic treatment information will be discussed in the treatment and complications of scaphoid fracture sections.

Case Study Characteristics

Case studies are one facet of non-experimental or descriptive research, that are often conducted when it is not possible or feasible to manipulate the potential causes of behavior, when variables are not easily identified, and when the researcher accepts situations and/or ideas as they are presented (Merriam, 1988). Stake (1995) describes a case study as specific, complex, and functioning. A case study is not necessarily a problem, a relationship, or a theme; instead it incorporates all three to make the case an entity (Stake, 1995). The first characteristic is particularistic, meaning that the study is specifically focused on a particular event or situation (Merriam, 1988). Case studies are a poor basis for generalizations, rather there is an emphasis on the uniqueness of a particular case (Stake, 1995). The second characteristic is that of description (Merriam, 1988). The final outcome of a case study should provide thorough and meaningful description of an event or situation. Heuristic, meaning that the study expands the reader's understanding of the event, is the third characteristic (Merriam, 1988). The final characteristic is inductive; stated hypothesis and generalizations may change as new data presents itself (Merriam, 1988). Stake (1995) suggests that a case study is progressively focused; as the study moves along, concepts may change. Often, case studies will not

have a hypothesis, but will work from the research questions derived at the beginning of the study. The current case study satisfies all of the above characteristics by focusing on one scaphoid fracture with specific qualities that present a meaningful description of events to expand the knowledge of sports medicine personnel.

Merriam (1988) also described the collection and analysis of case study data. The collection of data may include interviews, observations, and the reviewing of documents. The analysis of interviews comes from the interviewees' perspective on the study (Merriam, 1988; Stake, 1995). The analysis of observations and reviewed documents often relies on the researcher's interpretations of the situations (Merriam, 1988; Stake, 1995). Often, the collection and analysis of data is conducted at the same time (Merriam, 1988). Stake (1995) reports that the researcher should have an organized mind while reviewing documents and yet should have the capacity to be open to unexpected clues. This case study will use retrospective analysis of medical records, including doctor's reports, diagnostic reports, and operative reports.

Competencies and Continuing Education in Athletic Training

The National Athletic Trainers' Association Board of Certification (NATABOC) conducts role delineation studies to determine the primary tasks of the entry-level athletic trainer and the knowledge and skills required to perform each task (Arnheim & Prentice, 1997; National Athletic Trainers Association, 1999). Based on the 1999 role delineation studies, six domains of performance have been established: 1) prevention of athletic injuries; 2) recognition, evaluation, and assessment of athletic injuries; 3) immediate care of injury 4) treatment, rehabilitation, and reconditioning of athletic injuries; 5) health care

administration; 6) professional development and responsibility. According to the National Athletic Trainers' Association (NATA) athletic training educational competencies booklet (1999), entry level athletic trainers, who are sitting for the certification exam, must possess the ability to perform the competencies within each domain using cognitive, affective, psychomotor, and clinical proficiency.

The NATABOC has set the requirement that certified athletic trainers must obtain a certain amount of continuing education units (CEU's) per every three years in order to maintain their certification (Arnheim & Prentice, 1997). A few ways the CEU's may be obtained are by attending continuing education programs, reviewing professional journals and taking a quiz based on the research in the journal, and completing postgraduate work. In addition to continuing their education to obtain CEU's, certified athletic trainers also continue their education for their personal professional development. This case study will aid in refreshing and furthering athletic trainer's knowledge of scaphoid fractures.

Anatomy of the Wrist

The wrist is located between the hand and the forearm. It is comprised of eight small bones called carpals. Carpals are arranged in proximal and distal rows, each containing four bones (Moore, 1992). The proximal row of carpals (distal to the radius and ulna bones), running lateral to medial, is made up of the scaphoid, lunate, triquetrum, and pisiform (see Figure 1). The trapezium, trapezoid, capitate, and hamate makes up the distal row of carpals (lateral to medial) (see Figure 1). The metacarpals begin just distally to the distal row of carpal bones.

Figure 1. Wrist Anatomy

Note: From www.vh.org/Providers/Textbooks/JointFluoro/Text/wrist.html

Scaphoid Bone Properties

The scaphoid is one of eight carpal bones. It is referred to in three parts: proximal, waist or mid, and distal sections (see Figure 2). This bone is unique in that it articulates with five other bones and spans the length of both proximal and distal rows of the carpal bones (Calandra et al., 1992). Three of the four articulating carpal bones are part of the distal row: capitate, trapezoid, trapezium. The fourth articulating carpal bone, the lunate, is in the proximal row of the wrist. The fifth bone that the scaphoid articulates with is the radius in the forearm. With the wrist in a neutral position, the scaphoid bone lies in 45-60 degrees of flexion in relation to the radius, lunate, and capitate (Barton, 1992). Flexion of the scaphoid increases with radial deviation and decreases with ulnar deviation.

Figure 2. Scaphoid Bone Anatomy

Note: From www.darkwing.uoregon.edu/~crawling/pictures.html

The scaphoid bone has limited room for vascular supply, with only a small surface area devoid of articulating cartilage (Stern & Reitman, 1988). The radial artery is the main source of blood to the scaphoid (Calandra et al., 1992; Gelberman & Menon, 1980). Gelberman and Menon (1980) reported that the proximal pole and 70% to 80% of the bone receives their blood supply from vessels entering through the dorsal ridge. Volar branches of the radial artery supply the tuberosity and 20% to 30% of the bone with blood. Mirabello et al. (1992) reported that fractures to the proximal pole have up to 100% incidence of avascular necrosis and 30% incidence in the distal pole (see Figure 2 & 3). Although the properties of the scaphoid bone make it unique, these same properties make it susceptible for injury and healing complications. The position of the scaphoid bone puts it at risk for injury, while the poor blood supply contributes to the incidence of healing complications.

Figure 3. Carpal Vascular Supply

Note: From www.amirmd.com/ortho-info/scaphoid/X.html

Scaphoid Fracture Recognition

A scaphoid fracture should be identified by differential diagnosis. The first step in the evaluation process is to establish an accurate history of the injury. A crucial step in the history is the mechanism of injury. Understanding the mechanism of injury aids in the evaluation process by providing the examiner with a verbal cue as to the positioning of the bone during the time of trauma. Understanding the wrist position at the time of injury aids in determining the force placed on the scaphoid bone and allows for a better understanding of possible injuries. The primary mechanism of injury to the scaphoid is falling on an outstretched dorsiflexed hand (Calandra et al., 1992; Stern & Reitman, 1988) (see Figure 4). The proximal half of the wrist is stabilized among the radius, the capitate, and the palmar capsule when the wrist is placed in extension, thus resulting in a bending load applied to the distal one-half of the scaphoid (Richards & Roth, 1996;

Barton, 1992). According to Barton (1992), Weber and Chao (1978) found that “failure of the scaphoid occurs at the point receiving the highest bending movement” (p. 289). In the case of forced wrist dorsiflexion, the waist of the bone receives the highest bending motion. Barton also reports on three studies that have identified scaphoid fractures occurring through mechanisms other than dorsiflexion of the wrist, including flexion injuries in 3% of the cases. Of all scaphoid fractures, 70% occur through the waist, 20% proximally, and 10% distally (Mirabello et al., 1992).

Figure 4. Scaphoid fracture mechanism of injury: Fall on dorsiflexed wrist
Note: From www.eatonhand.com/hw/hw021.htm

Clinical suspicion, physical examination, and X-ray examination are also evaluative measures that aid in the diagnosis of a fracture (Stern & Reitman, 1988). The physical examination and X-ray should be conducted in order to support fracture suspicion. The physical exam must be conducted on both wrists to assess bilateral differences and ensure accurate assessment. Tenderness during palpation over the anatomical snuffbox remains the cardinal sign for suspicion of a scaphoid fracture (Calandra et al., 1992; Parvizi et al., 1998; Stern & Reitman, 1988) (see Figure 5). Since the scaphoid bone is the floor of the anatomical snuffbox, palpation directly over this area

will result in direct palpation over the scaphoid. Most people are tender bilaterally in the anatomical snuffbox because the sensory branch of the radial nerve also lies there (Barton, 1992). The level of tenderness from the injured wrist to the non-injured wrist is compared. Another evaluation technique is longitudinal compression of the thumb (Parvizi et al., 1998). Longitudinal compression is performed by grasping the extended and abducted thumb and pushing it proximally, towards the scaphoid. Stern and Reitman (1988) found that pain on wrist dorsiflexion and/or diminished grip strength are also common signs and symptoms found when a scaphoid fracture is present. Barton (1992) reports that resisted pronation with gentle ulnar deviation produces pain in the anatomical snuffbox area. The diagnosis of a scaphoid fracture should be based upon the combination of clinical signs as opposed to just one positive test (Parvizi et al., 1998).

Figure 5. Anatomical Snuffbox

Note: From www.hawaii.edu/medicine/pediatrics/pemxray/v1e14.html

An athlete should be referred to a physician for further evaluation when an athletic trainer suspects the existence of a scaphoid fracture. X-rays may aid in further diagnosing the injury with the understanding that fresh scaphoid fractures are not always evident on the first set of X-rays. Reabsorption at the fracture site may not occur until approximately two weeks following injury. Thus it is during the reabsorption process that the fracture may be visualized on X-rays (Calandra et al., 1992; Langhoff & Andersen,

1988). Stern and Reitman (1998) suggest that all patients with suspicious wrist injury and pain in the anatomical snuffbox region should be treated as if they have a fracture until x-rays at two and four weeks are normal. Tiel-van Buul, van Beek, Broekhuizen, Nootigedacht, Davids, and Bakker (1992) report that up to 25% of clinically suspected fractures of the scaphoid cannot be confirmed by radiographic examination and recommend that early bone scans be conducted to increase the accuracy of scaphoid fractures diagnosis. Calandra et al. (1992) suggest that if follow-up X-rays at two and four weeks are negative but symptoms are positive, then a bone scan is indicated.

A scaphoid fracture diagnosis should be based on a complete evaluation. Sports medicine personnel must listen to the injured athlete to be able to take a good history of how the injury happened and the symptoms that the athlete is experiencing. Physical examination and diagnostic testing should accompany the verbal portion of the assessment. The physical assessment allows the evaluator to pinpoint, anatomically, where the injury is in the wrist, while diagnostic testing may determine whether or not a fracture in the bony structure has occurred.

Treatment of a Scaphoid Fracture

Treatment of scaphoid fractures remains controversial (Calandra et al., 1992). Principles of scaphoid fracture treatment relate to the location of the fracture, its stability, and the timing of the treatment (Calandra et al., 1992). The goal when providing treatment for scaphoid fractures is to obtain bony union within the fracture site. Initial treatment for a suspected scaphoid fracture is immobilization of the hand, wrist, and forearm. Immobilization prevents further damage to the injured area until a scaphoid fracture is over-ruled. The physician may choose to rule out a fracture by using x-rays or

a bone scan. Following clinical and diagnostic examination, suspected fractures may be casted.

There is controversy regarding the question of short arm casts versus long arm casts for immobilization of the fracture site (Stern & Reitman, 1988). The short arm cast does not include the elbow joint. The forearm and wrist pronate and supinate in a short arm cast, which may allow the scaphoid bone to move, increasing the likelihood of non-union of the fracture. A long arm cast does not allow the arm to pronate and supinate; therefore, it is theorized to increase the chances for unity of a scaphoid fracture.

When bony union does not occur following cast immobilization, alternative treatment techniques are instigated. Treatment options for nonunion fractures include internal fixation, bone grafting, and electromagnetic stimulation (Calandra et al., 1992; Stern & Reitman, 1988). According to Barton (1992), Herbert (1990) suggests using both bone grafting and internal fixation when treating a non-union scaphoid fracture. Internal fixation procedure includes using a screw, wires and/or pin to hold the fracture site together, in order to facilitate fracture site union. Bone grafting entails taking a piece of bone from another body part and filling in the fracture site. The bone grafting procedure is considered in hope that the new piece of bone will unite with the original bone. There is controversy in the literature about which bone grafting technique gives the best results. Barton (1997) has used five different methods over 24 years. He found a 78% unite rate when using a wedge bone graft with a Herbert screw. Carrozzella (1989) reports on thirteen different studies that give the Russe technique of bone grafting about an 80% success rate for non-union scaphoid fractures. Electromagnetic stimulation may be used prior to surgery options or following a case of non-unity. Dunn and Rush (1984) report

that the use of electrical stimulation devices may reduce disability time if used as soon as a non-union fracture is suspected.

Complications of Scaphoid Fractures

A scaphoid fracture must be stabilized in order to reunite. In cases of fresh fractures (less than four weeks old), union rates of 95% have been reported (Stern & Reitman, 1988). Nonunion occurs in the other 5% of the cases and nonfresh fracture cases. The rate of nonunion occurs in increasing frequency from distal to proximal fracture sites, and most of nonunion fractures are asymptomatic (Calandra et al., 1992). Calandra et al. (1992) reported that patients who have sustained a scaphoid fracture should be counseled regarding the high probability of future osteoarthritis and carpal collapse without scaphoid stabilization. Carpal collapse from a chronic scaphoid nonunion can lead to the removal of the proximal row of carpal bones (Krakauer, Bishop, & Cooney, 1994). Imbriglia, Broudy, Hagberg, and McKernan (1990) reported on studies that found negative results in patients who had their proximal row of carpals removed. The negative results were loss of strength, decrease in range of motion, long periods of rehabilitation, and progressive arthritis. However, after performing their own similar studies, Imbriglia et al. (1990) and Krakauer et al. (1994) found the opposite results. Imbriglia reports that grip strength improved following carpectomy. Imbriglia and Krakauer both found that wrist range of motion either matched preoperative figures or improved on them.

Following a carpectomy, an athlete may also experience an unstable or loose feeling in the wrist joint. In the case of joint laxity that produces clinical instability caused by a carpectomy, the ability to shrink the collagenous tissue may provide an

effective method for reducing excessive joint motion (Wall, Deng, Torzilli, Doty, O'Brien, & Warren, 1999). Shrinkage of the tissue may be performed with either thermal or chemical methods. Thermal methods were used in the study conducted by Wall et al. (1999). Wall et al. found that time and temperature were directly related to how much the tissue would shrink. The study stated that tissue shrinks more rapidly with higher temperatures and less rapidly at lower temperatures. Since mechanical properties of tissue decrease with increased shrinkage of the tissue, the goal would optimally be to shrink the tissue without over shooting the desired shrinkage amount (Wall et al., 1990).

Summary

Sports medicine personnel must be well trained in clinical evaluation techniques to properly assess scaphoid fractures. The knowledge of forearm, wrist and hand anatomy and clinical tests for related injuries is of utmost importance for accurate diagnoses. Referral of the injured athlete to a physician should not be delayed when scaphoid fracture is suspected. Treatment protocols should be based on individual situations, and not on a standard protocol. Complications arising during the healing of scaphoid fractures may be due to the individuality of the fracture characteristics or the treatment protocol.

Athletic trainers and sports medicine personnel need to stay up-to-date with medical knowledge, particularly in the area of scaphoid fractures. This need is due to the possibility that permanent physical deformity can arise if not properly diagnosed and treated. Thus, the purpose of this case study is to aid in educating sports medicine personnel to better evaluate and properly treat possible scaphoid fractures.

CHAPTER 3

Introduction

Proper education in the recognition of scaphoid fractures is essential for choosing proper treatment techniques. The purpose of this case study is to educate athletic trainers on potential scaphoid fracture outcomes. In order to reach the targeted audience with the current information, this case study will be compiled into an article for submission to the Journal of Athletic Training (see Appendix A).

The following chapter outlines the methodology used in this study. This chapter is presented in three sections: participant, procedures, and research design. The participant section will describe the subject and how she was selected for this project. The procedure section details what type of methods are used to collect data. The research design section explores the rationale for a case study format.

Participant

This study focuses on one collegiate softball player who sustained a scaphoid fracture during her junior year, 1997. The participant was chosen due to the number of injury complications and the surgical treatments rendered. Treatment for this injury extended over a two-year period (1997-1999) due to healing complications. Healing complications included nonunion of the fracture site with bone grafting, carpal collapse followed by carpectomy, and thermal capsular shrinkage. Although all of these complications are possibilities with scaphoid fractures, very seldom do they occur simultaneously to one individual. The participant was asked to participate in the study at the beginning of her fifth collegiate softball year, 1999. The subject voluntarily agreed to participate in this project (see Appendix B).

Procedures

This case study examines the participant's medical records as well as past research on scaphoid fractures. The researcher was responsible for the collection and reporting of the data for this study. The data was collected from the medical records and retrospectively viewed to accumulate information on the participant's injury and treatment. Medical records were obtained, with the participant's permission, from her family hospital and her attending university (see Appendix C). The athletic trainer and team physician at the attending university were responsible for recording the initial assessment of the injury. Following the initial assessment, the participant was referred to her primary care physician. The consent form was sent to the athlete's primary care physician in order to request that his or her office send all information pertaining to this particular injury to the researcher. The records requested include doctor's visit reports, operation reports, and diagnostic reports. X-ray, magnetic resonance imaging (MRI), and bone scan reports are included as diagnostic reports.

The reports were compiled in order to create a time line from the initial diagnoses of injury to follow-up treatments, to surgeries performed and their respective follow-ups, to the resolution of injury. Research of the literature regarding the topics related to the study was conducted in order to further understand the topic of scaphoid fractures. Medline Internet Explorer was used to find research related to scaphoid fractures and the complications pertaining to this case. Research was derived from medical journals that have published articles pertaining to the scaphoid bone. Out of the twenty-four articles that were reviewed by the researcher, seventeen of them were used based on the qualifying criteria. The criteria for the articles were that they described anatomical

characteristics, evaluation, treatment, healing complications, and surgery for scaphoid fractures. Journals include, but are not limited to: Journal of Athletic Training, Journal of Hand Surgery, Journal of Bone and Joint Surgery, The Physician and Sports Medicine, and Clinical Sports Medicine. These journals and previously researched articles were used to study and assess standard protocols once the timeline was compiled for this specific scaphoid fracture. The case study was compiled into a journal article and submitted for publication to the Journal of Athletic Training. (see Appendix A)

Research Design

The case study research design is descriptive in nature. The case study design was chosen for three reasons. First, the case is presented with a single participant who dealt with multiple situations. The case is an entity: there is a theme to the case, and problems, and relationships between the problems, are present. Second, a case study design was chosen due to the retrospective nature of the situation, with the injury occurring a number of years prior to the case study investigation. Third, the descriptive nature of the case study was chosen to better understand this injury phenomenon due to its rarity and complexities. Case studies allow for the reporting of atypical situations that may give insight to some cases without making generalizations for all typical cases (Stake, 1995). Stake (1995) comments that often when an atypical case presents itself for study, it is better than allowing the researcher to choose a case topic to study, because more times than not, the researcher will choose the typical case.

Summary

The single participant case study presented is descriptive in nature and allows for the further enhancement of knowledge pertaining to scaphoid fracture phenomenon. As

the primary tool of instrumentation, the researcher is directly involved in the collection, compilation, and reporting of the data for the study. The data for this study is derived from the participant's medical history files and literature research. Once all the data and literature research is compiled into an article, it will be submitted for publication to the Journal of Athletic Training. Sports medicine personnel will have access to the case study to aid in reviewing and expanding their knowledge of scaphoid fractures.

References

- Arnheim, D. D., & Prentice, W. E. (1997). Principles of Athletic Training. 9th edition. St. Louis, MS: Mosby-Year Book, Inc.
- Barton, N. J. (1997). Experience with scaphoid grafting. The Journal of Hand Surgery, 22B, 153-160.
- Barton, N. J. (1992). Twenty questions about scaphoid fractures. The Journal of Hand Surgery, 17B, 289-310.
- Calandra, J. J., Goldner, R. D., & Hardaker, W. T. Jr. (1992). Scaphoid fractures: Assessment and treatment. Orthopedics, 15, 931-937.
- Carrozzella, J. C., Stern, P. J., & Murdock, P. A. (1989). The fate of failed bone graft surgery for scaphoid nonunions. The Journal of Hand Surgery, 14A, 800-806.
- Dunn, A. W., & Rush, G. A. III (1984). Electrical stimulation in treatment of delayed union and nonunion of fractures. Southern Medical Journal, 77, 1530-1534.
- Gelberman, R. H., & Menon, J. (1980). The vascularity of the scaphoid bone. The Journal of Hand Surgery, 5, 508-513.
- Huston, C., & Brandser, E. (1999). Anatomy of the wrist. Retrived December 7, 2000, from the World Wide Web: www.vh.org/Providers/JointFluoroText/wrist.html
- Imbriglia, J. E., Broudy, A. S., Hagberg, W. C., & McKernan, D. (1990). Proximal row carpectomy: Clinical eval. The Journal of Hand Surgery, 15A, 426-430.
- Krakauer, J. D., Bishop, A. T., & Cooney, W. P. (1994). Surgical treatment of scapholunate advanced collapse. The Journal of Hand Surgery, 19, 751-759.
- Kuschner, S. H., Lane, C. S., Brien, W. W., & Gellman, H. (1994). Scaphoid fractures and scaphoid nonunion. Orthropeadic Review, 2, 226-236.
- Langhoff, O., & Andersen, J. L. (1988). Consequences of late immobilization of scaphoid fractures. The Journal of Hand Surgery, 13B, 77-79.
- Merriam, S.B. (1988). Case study research in education. San Francisco, CA: Jossey-Bass Inc.
- Mirabello, S. C., Loeb, P. E., & Andrews, J. R. (1992). The wrist: Field evaluation and treatment. Clinical Sports Medicine, 11, 1-25.
- Moore, K. L. (1992). Overview of anatomy. Clinically Oriented Anatomy. Baltimore, MD: Williams & Wilkins.

National Athletic Trainers' Association Athletic Training Educational Competencies. (1999). Dallas, TX.

Parvizi, J., Wayman, J., Kelly, P., & Moran, C.G. (1998). Combining the clinical signs improves diagnosis of scaphoid fractures. A prospective study with follow-up. The Journal of Hand Surgery, 23, 324-327.

Richards, R. S., & Roth, J. H. (1996). Scaphoid fractures. Canadian Journal of Plastic Surgery, 4, 143-149.

Scaphoid Fracture. Retrived October 20, 2000, from the World Wide Web: www.eatonhand.com/hw/hw021.htm

Scaphoid Fractures: Blood Supply. Retrived October 17, 2000, from the World Wide Web: www.amirmd.com/ortho-info/scapoidfx.html

Sections of Scaphoid and Common Fracture Sites. Retrieved October 17, 2000, from the World Wide Web: www.darkwing.uoregon.edu/~crawfins/pictures.html

Stake, R. E. (1995). The art of case study research. Thousand Oaks, CA: Sage Publications, Inc.

Stern, J. D., & Reitman, H. S. (1988). Fractures of the scaphoid bone. How to handle this common wrist injury. Postgraduate Medicine, 83, 91-92, 95-97.

Tiel-van Buul, M. M. C., van Beek, E. J. R., Broekhuizen, A. H., Nootgedacht, E. A., Davids, P. H. P., & Bakker, A. J. (1992). Diagnosing scaphoid fractures: Radiographs cannot be used as a gold standard. Injury, 23, 77-79.

Wall, M. S., Deng, X. H., Torzilli, P. A., Doty, S. B., O'Brien, S. J., & Warren, R. F. (1999). Thermal modification of collagen. Journal of Shoulder and Elbow Surgery, 8, 339-344.

Weber, E. R., & Chao, E. Y. (1978). An experimental approach to the mechanism of scaphoid waist fractures. Journal of Hand Surgery, 3, 142-148.

Yamamoto, L. A Hand Contusion. Radiology Cases in Pediatric Emergency Medicine, 1. Retrieved October 20, 2000, from the World Wide Web: www.hawaii.edu/medicine/pediatrics/pemxray/v1c14.html

Zachazewski, J. E., Magee, D. J., & Quillen, W. S. (1996). Hand and wrist injuries. In McCue, F.C., Hussamy, O., Gieck, J.H. (Eds.), Athletic Injuries and Rehabilitation (pp. 592). Philidelphia, PA: The Curtis Center.

”

APPENDIX A

AUTHORS NOTES FOR THE JOURNAL OF ATHLETIC TRAINING

Appendix A: Authors notes for the Journal of Athletic Training

Authors' Guide (Revised January 1998)

The mission of the Journal of Athletic Training is to enhance communication among professionals interested in the quality of health care for the physically active through education and research in prevention, evaluation, management, and rehabilitation of injuries.

SUBMISSION POLICIES

1. Submit one original and five copies in English of the entire manuscript (including tables and figures) to: Journal of Athletic Training Submissions, Hughston Sports Medicine Foundation, Inc: 6262 Veterans Parkway; PO Box 9517; Columbus, GA 31908-9517. The term figure refers to items that are not editable, either halftones (photographs) or line art (charts, graphs, tracings, schematic drawings), or combinations of the two. A table is an editable item that needs to be typeset.

2. Manuscripts must be accompanied by a letter signed by all authors and must contain the following statements: "This manuscript 1) contains original unpublished material that has been submitted solely to the Journal of Athletic Training, 2) is not under simultaneous review by any other publication, and 3) will not be submitted elsewhere until a decision has been made concerning its suitability for publication by the Journal of Athletic Training. In consideration of the NATA's taking action in reviewing and editing my submission, I the undersigned author hereby transfer, assign, or otherwise convey all copyright ownership to the NATA, in the event that such work is published by the NATA. Further, I verify that I have contributed substantially to this manuscript as outlined in item #3 of the current Authors' Guide." By signing the letter, the authors agree to comply with all statements. Manuscripts that are not accompanied by such a letter will not be reviewed. Accepted manuscripts become the property of the NATA. Authors agree to accept any minor corrections of the manuscript made by the editors.

3. Each author must have contributed to the article. This means that all coauthors should have made some useful contribution to the study, should have had a hand in writing and revising it, and should be expected to be able to defend the study publicly against criticism.

4. Financial support or provision of supplies used in the study must be acknowledged. Grant or contract numbers should be included whenever possible. The complete name of the funding institution or agency should be given, along with the city and state in which it is located. If individual authors were the recipients of funds, their names should be listed parenthetically.

5. Authors must specify whether they have any commercial or proprietary interest in any device, equipment, instrument, or drug that is the subject of the article in question. Authors must also reveal if they have any financial interest (as a consultant, reviewer, or evaluator) in a drug or device described in the article.

6. For experimental investigations of human or animal subjects state in the "Methods" section of the manuscript that an appropriate institutional review board approved the project. For those investigators who do not have formal ethics review committees (institutional or regional), the principles outlined in the Declaration of Helsinki should be followed (41st World Medical Assembly. Declaration of Helsinki: recommendations guiding physicians in biomedical research involving human subjects. Bull Pan Am Health Organ. 1990;24:606-609). For investigations of human subjects, state in the "Methods" section the manner in which informed consent was obtained from the subjects. (Reprinted with permission of JAMA 1997; 278:68, copyright 1997, American Medical Association.)

7. Signed releases are required to verify permission for the Journal of Athletic Training 1) to reproduce materials taken from other sources, including text, figures, or tables; 2) to reproduce photographs of

individuals; and 3) to publish a Case Report. A Case Report cannot be reviewed without a release signed by the individual being discussed in the Case Report. Release forms can be obtained from the Editorial Office and from the JAT web page or authors may use their own forms.

8. The Journal of Athletic Training uses a double blind review process. Authors should not be identified in any way except on the title page.

9. Manuscripts are edited to improve the effectiveness of communication between author and reader and to aid the author in presenting a work that is compatible with the style policies found in the AMA Manual of Style, 9th ed. (Williams & Wilkins), 1989. Page proofs are sent to the author for proofreading when the article is typeset for publication. It is important that they be returned within 48 hours. Important changes are permitted, but authors will be charged for excessive alterations.

10. Published manuscripts and accompanying work cannot be returned. Unused manuscripts will be returned if submitted with a stamped, self-addressed envelope.

STYLE POLICIES

11. Each page must be printed on one side of 8 1/2 by 11-inch plain paper, double-spaced, with one-inch margins. Do not right justify pages.

12. Manuscripts should contain the following, organized in the order listed below, with each section beginning on a separate page:

- a. Title page
- b. Acknowledgments
- c. Abstract and Key Words (first numbered page)
- d. Text (body of manuscript)
- e. References
- f. Tables (each on a separate page)
- g. Legends to figures
- h. Figures

13. Begin numbering the pages of your manuscript with the abstract page as #1; then, consecutively number all successive pages.

14. Units of measurement shall be recorded as SI units, as specified in the AMA Manual of Style except for angular displacement, which should be measured in degrees rather than radians. Examples include mass in kilograms (kg), height in centimeters (cm), velocity in meters per second (m/sec or m/s), angular velocity in degrees per second ($^{\circ}$ /sec), force in Newtons (N), and complex rates (mL/kg per minute).

15. Titles should be brief within descriptive limits (a 16-word maximum is recommended). If a disability is the relevant factor in an article, the name of the disability should be included in the title. If a technique is the principal reason for the report, it should be in the title. Often both should appear.

16. The title page should also include the names, titles, and affiliations of each author, and the name, address, phone number, fax number, and E-mail address of the author to whom correspondence is to be directed.

17. A structured abstract of 75 to 200 words must accompany all manuscripts. Type the complete title (but not the authors' names) at the top, skip two lines, and begin the abstract. Items that are needed differ by type of article and should include: Literature Reviews: Objective, Data Sources, Data Synthesis, Conclusions/Recommendations, and Key Words; Original Research articles: Objective, Design and Setting, Subjects, Measurements, Results, Conclusions, and Key Words; Case Reports: Objective, Background, Differential Diagnosis, Treatment, Uniqueness, Conclusions, and Key Words; Clinical Techniques: Objective, Background, Description, Clinical Advantages, and Key Words. For the Key Words entry, use three to five words that do not appear in the title.

18. Begin the text of the manuscript with an introductory paragraph or two in which the purpose or hypothesis of the article is clearly stated and developed. Tell why the study needed to be done or the article written and end with a statement of the problem (or controversy). Highlights of the most prominent works of others as related to your subject are often appropriate for the introduction, but a detailed review of the literature should be reserved for the discussion section. In a one- to two-paragraph review of the literature, identify and develop the magnitude and significance of the controversy, pointing out differences among others' results, conclusions, and/or opinions. The introduction is not the place for great detail; state the facts in brief specific statements and reference them. The detail belongs in the discussion. Also, an overview of the manuscript is part of the abstract, not the introduction. The active voice is preferred. For examples, consult the AMA Manual of Style.

19. The body or main part of the manuscript varies according to the type of article (examples follow); however, the body should include a discussion section in which the importance of the material presented is discussed and related to other pertinent literature. Liberal use of subheadings and figures is recommended.

a. The body of an Original Research article consists of a methods section, a presentation of the results, and a discussion of the results. The methods section should contain sufficient detail concerning the methods, procedures, and apparatus employed so that others can reproduce the results. The results should be summarized using descriptive and inferential statistics and a few well-planned and carefully constructed illustrations.

b. The body of a Literature Review article should be organized into subsections in which related thoughts of others are presented, summarized, and referenced. Each subsection should have a heading and brief summary, possibly one sentence. Sections must be arranged so that they progressively focus on the problem or question posed in the introduction.

c. The body of a Case Report should include the following components: personal data (age, sex, race, marital status, and occupation when relevant—but not name), chief complaint, history of present complaint (including symptoms), results of physical examination (example: "Physical findings relevant to the rehabilitation program were . . ."), medical history (surgery, laboratory results, exam, etc), diagnosis, treatment and clinical course (rehabilitation until and after return to competition), criteria for return to competition, and deviation from expectations (what makes this case unique).

d. The body of a Clinical Techniques article should include both the how and why of the technique: a step-by-step explanation of how to perform the technique, supplemented by photographs or illustrations, and an explanation of why the technique should be used. The discussion concerning the why of the technique should review similar techniques, point out how the new technique differs, and explain the advantages and disadvantages of the technique in comparison with other techniques.

20. Communication articles, including official Position Statements and Policy Statements from the NATA Pronouncements Committee; technical notes on such topics as research design and statistics; and articles on other professional issues of interest to the readership are solicited by the Journal. An author who has a suggestion for such a paper is advised to contact the Editorial Office for instructions.

21. The manuscript should not have a separate summary section—the abstract serves as a summary. It is appropriate, however, to tie the article together with a summary paragraph or list of conclusions at the end of the discussion section.

22. References should be numbered consecutively, using superscripted Arabic numerals, in the order in which they are cited in the text. References should be used liberally. It is unethical to present others' ideas as your own. Also, use references so that readers who desire further information on the topic can benefit from your scholarship.

23. References to articles or books, published or accepted for publication, or to papers presented at professional meetings are listed in numerical order at the end of the manuscript. Journal title abbreviations conform to Index Medicus style. Examples of references are illustrated below. See the AMA Manual of Style for other examples.

Journals:

1. van Dyke JR III, Von Trapp JT Jr, Smith BC Sr. Arthroscopic management of postoperative arthrofibrosis of the knee joint: indication, technique, and results. *J Bone Joint Surg Br.* 1995;19:517-525.

2. Council on Scientific Affairs. Scientific issues in drug testing. *JAMA.* 1987;257:3110-3114.

Books:

1. Fischer DH, Jones RT. *Growing Old in America.* New York, NY: Oxford University Press Inc; 1977:210-216.

2. Spencer JT, Brown QC. Immunology of influenza. In: Kilbourne ED, Gray JB, eds. *The Influenza Viruses and Influenza.* 3rd ed. Orlando, FL: Academic Press Inc; 1975:373-393.

Presentations:

1. Stone JA. Swiss ball rehabilitation exercises. Presented at the 47th Annual Meeting and Clinical Symposia of the National Athletic Trainers' Association; June 12, 1996; Orlando, FL.

24. **Table Style:** 1) Title is bold; body and column headings are roman type; 2) units are set above rules in parentheses; 3) numbers are aligned in columns by decimal; 4) footnotes are indicated by symbols (order of symbols: *,); 5) capitalize the first letter of each major word in titles; for each column or row entry, capitalize the first word only. See a current issue of the Journal for examples.

25. All black and white line art should be submitted in camera-ready form. Line art should be of good quality; should be clearly presented, the art itself must be 3 1/2 or 7 1/2 inches wide with black ink, 8- to 10-point sans serif typeface, and no box; and should be printed on a laser printer—no dot matrix. Photographs should be glossy black and white prints. Do not use paper clips, write on photographs, or attach photographs to sheets of paper. On the reverse of each figure attach a write-on label with the figure number, name of the author, and an arrow indicating the top. (Note: Prepare the label before affixing it to the figure.) Authors should submit one original of each figure and five copies for review.

26. Authors must request color reproduction in a cover letter with the submitted manuscript. Authors will be notified of the additional cost of color reproduction and must confirm acceptance of the charges in writing.

27. Legends to figures are numbered with Arabic numerals in order of appearance in the text. Legends should be printed on separate pages at the end of the manuscript.

APPENDIX B
CONSENT FORM

.

San José State
UNIVERSITY

**College of Applied
Sciences and Arts
Department of Human
Performance**

One Washington Square
San Jose, CA 95128-1014
Phone: 408/281-7221
Fax: 408/281-7274

**Appendix B: Consent to participate in study form
Agreement to Participate in Research**

**Responsible Investigator: Shanelle Schlicher
Title of Protocol: A Case Study: Scaphoid Fracture of a
Collegiate Softball Player**

1. I have been asked to participate in a research study investigating an injury that I sustained while participating in softball at San Jose State University. The injury that the research study will focus on is the scaphoid fracture and the complications that arose during the healing process.
2. I grant the investigator access to all medical reports related to the scaphoid fracture. The medical records will be kept secure at the researcher's home and all identification on them that relates them to me will be removed.
3. No risks are anticipated and no benefits are expected.
4. There will be no compensation awarded for participation.
5. The results of the study may be published but no information that could identify me will be included.
6. Any questions about the research may be addressed to Shanelle Schlicher at (408) 272-5064. Complaints or comments about the research may be presented to Greg Payne, P.E.D at (408) 924-3028. Questions about the research, subjects' rights, or research-related injury may be presented to Nabil Ibrahim, Ph.D at (408) 924-2480.
7. I voluntarily give consent to participate in this study. I may refuse to participate in the study or in any part of the study. I am free to withdraw at any time without prejudice to my relations with San Jose State University and I will not lose any services in which I am entitled.
8. I have received a signed and dated copy of the consent form.

Signature

Date

Investigator's Signature

Date

The California State University
System
San Jose State University
College of Applied Sciences and Arts
Department of Human Performance
One Washington Square
San Jose, CA 95128-1014
Phone: 408/281-7221
Fax: 408/281-7274

APPENDIX C
MEDICAL RECORD RELEASE

Appendix C: Medical Record Release

To: Medical Records

Date:

From: _____

SSN: _____

DOB: _____

Medical #: _____

I, _____, give XXXXXX Medical Center the right to release a copy of my entire medical file (from May 1997 to Present) related to my right wrist to Dr. Martin Trieb, team physician for San Jose State University. Please include, but do not limit to, doctor reports, operation reports, X-rays, MRI's, and bone scans.

You can mail them to:

Dr. Martin Trieb
Department of Intercollegiate Athletics
San Jose State University
One Washington Square
San Jose, CA 95121

If you have any questions please do not hesitate to call xxxxxxxxx. Thank you for your assistance and prompt attention to this request.

Sincerely,