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Percutaneous screw fixation for scaphoid non-union

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UNIVERSITY OF THE WITWATERSRAND

Department of Orthopaedic Surgery

Percutaneous screw fixation for scaphoid non-union

DR NABIL KHAN

A research report submitted to the Faculty of Health Sciences, University of Witwatersrand in partial fulfillment of the requirements for the Degree of Master of Medicine in the branch of Orthopaedic Surgery.

Johannesburg, 2017

Declaration

I, Nabil Khan, declare that this research report is my own work. I am willingly submitting it for the degree of Master of Medicine in the University of Witwatersrand, Johannesburg. It has not previously been submitted for examination or degree purposes to this or other Universities.

Signature _____

This day, _____ 2017

Abstract Study

design:

A retrospective study of all scaphoid non-unions treated with percutaneous screw fixation at the Rosebank Hospital.

Background:

The Scaphoid plays a key role in the stability of the wrist joint, it acts as a strut bridging both carpal rows and is therefore continuously subjected to shearing and bending forces.

Scaphoid fractures occur commonly in injuries involving the wrist joint. These fractures account for 60-70% of all carpal bone fractures and these mostly occur in young men. Non-union occurs most commonly in middle third fractures. The bony trabeculae are thinnest at the scaphoid waist and therefore most fractures occur at this region.

The current treatment modality for scaphoid non-unions is open reduction, bone grafting and internal fixation. Few reports of percutaneous fixation without bone grafting have emerged as a treatment modality.

Objective:

To determine the treatment outcome and time to union of scaphoid non- unions fixed with a percutaneous screw.

Methodology:

This study was a hospital-based retrospective study using six month – follow up x-rays of all patients treated with percutaneous fixation using a Herbert screw for scaphoid non-unions; during the period covering 2010 to 2014. The final outcome of radiological union at six months post fixation was recorded.

Results:

There were 19 patients (13 males and 6 females) included in the study. The average age of the patients was 41 years (range 18–72 years).

The approach used was dorsal in all cases, 17 patients had achieved union at six months, one patient had persistent non-union and one was lost to follow- up. There were no serious complications recorded.

Discussion and Conclusion:

The current study showed a successful union rate of 94.7% for scaphoid fractures treated with a percutaneous approach. This is comparable to the mean 100% success rates achieved by Finsen and Krimmer (1999) using open reduction internal fixation and bone grafting.

In conclusion the percutaneous approach is a minimally invasive approach showing low morbidity and is thus recommended as a treatment modality for scaphoid non-unions.

Acknowledgements

I am thankful to God Almighty for his graciousness, provision and good health without which nothing is possible.

I wish to express my sincere gratitude to Dr. Michael Carides, for guidance, support and access to patient records to conduct this study. I am truly indebted to him for all his support and advice throughout the process.

I would like to thank my wife, Dr. Olivia Antos, for all her support and guidance throughout this whole process.

I am truly in debt for the time and input from Dr. Brenda Milner. Thank you for all your support throughout this process.

Finally I would like to thank my Supervisors Prof. Thomas Ramokgopa and Dr. Susan Van Deventer for dedicating their time and effort, and above all their guidance throughout the whole process.

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Abbreviations

AO – Arbeitsgemeinscaft für osteosynthesefragen

A.S.I.F – Association for the study of internal fixation

C.T - Computerized tomography

DASH – Disabilities of the arm, shoulder and hand score K-Wire

– Kirschner wire

M.R.I - Magnetic Resonance Imaging Tech 99 -

Technetium 99

1. Introduction and Literature review

A large surface area of the scaphoid is covered by cartilage therefore limiting ligamentous attachment and vascular supply[1]. The scaphoid plane is tilted both volarly and radially with respect to the central forearm axis; adding to the complexity of surgical management[1].

The primary blood supply to the scaphoid is via the Radial artery. 80% of the blood supply to the proximal pole arises from branches running along the dorsal ridge while the rest (20%) via volar branches[2]. The dorsal branches enter along the scaphoid waist therefore fractures occurring in this region increase the risk of osteonecrosis. Factors associated with increased risk of non-union are[3]:

- Inadequate blood supply
- Displacement > 1mm
- Intrascaphoid angle > 45 degrees
- Height to length ratio > 0.6
- Delayed treatment
- Displacement
- Instability secondary to ligament injury

The risk of developing post traumatic arthritis in untreated non-unions have been reported to be as high as 100%[4,15]. Furthermore, patients with untreated non-unions have reduced wrist mobility and weakness. Surgical stabilisation is associated with improved pain relief, improvement in wrist function and this prevents the development of post traumatic arthritis [5].

The classification system that is used to define a non-union is based on a system by Slade and Dodds[57] as shown in Table 1.1 below.

Table 1.1: Classification of non-unions as defined by Slade and Dodds[57].

Grade	Category	Characteristics of Scaphoid Non-Unions.
1	Delayed presentation	Scaphoid fractures with delayed presentation (4-8 weeks).
2	Fibrous non-union	Intact cartilaginous envelope, minimal fracture line at non-union interface and no cyst or sclerosis.
3	Minimal sclerosis	Bone resorption at non-union interface <1mm with minimal sclerosis.
4	Cyst formation and sclerosis	Bone resorption at non-union interface <5mm, cyst formation and maintained scaphoid alignment.
5	Cyst formation and sclerosis	Bone resorption at non-union interface >5mm and <10mm, cyst formation and maintained scaphoid alignment.
6	Pseudoarthrosis	Separate bone fracture fragments with profound bone resorption at non-union interface. Gross fragment motion and deformity is often present.

Scaphoid non-union is defined radiologically by the presence of cystic formation, sclerosis and bone resorption. The diagnosis of non-unions can be made using plain radiography, Computerised tomography (C.T), Magnetic resonance imaging (M.R.I) and bone scans. C.T scans aid in surgical planning (using the intra-scaphoid angle and height to length ratio) whereas

M.R.I is used to assess viability of the fragment and evaluates non-union as evidenced by decreased signal intensity in the proximal pole fragment[7]. Bone scans are mainly used in acute injuries but to a lesser extent compared to M.R.I and a C.T scans; however, they may objectively highlight the area of non-union[8].

The non-operative management of scaphoid non-union involves casting for prolonged periods and is reserved for stable fractures with no collapse. Non- operative treatment is associated with decreased quality of life and decreased range of motion[9,10]. Faster recovery has been reported with surgical treatment compared to cast immobilisation[11].

Electrical stimulation has been used as a method of non-surgical treatment for scaphoid non-unions[12]. Results published by Frykman et al. (1986)[13] showed successful outcomes with pulsed electromagnetic therapy. A follow- up study using pulsed electromagnetic therapy however showed a decrease in the overall success rate and outcomes[14].

Few non-unions remain stable, non-displaced and free of arthritis after ten years. Ruby et al. (1985)[15] reviewed 56 scaphoid non-unions and showed that 97 percent of patients developed osteoarthritis, though this may not be painful.

Surgical intervention has been proposed for grossly displaced fractures, young healthy patients and injuries associated with ligamentous instability. A variety of operative techniques are available to address scaphoid non-unions and these include the use of Compression plates[16], Kirschner wires (K-wires) and Herbert Screws[17].

K-wire fixation ensures rotational stability; however the application of K-wires can only be achieved via an antegrade fashion. The use of this approach requires prolonged immobilisation, can cause skin irritation and requires a second procedure for removal[17].

Christodoulou et al. (2001) showed that K-wire fixation achieved lower union rates and required prolonged immobilization compared to screw fixation[17].

The scaphoid can be surgically approached through a volar or dorsal technique[18]. A dorsal approach is commonly used with fixation using a screw or pin[19]. With a dorsal approach the wrist is hyperflexed and the screw is inserted across the dorsal aspect of the capsule. Complications associated with this approach include failure of the screw to capture the distal fragment and guide wire breakage intra-operatively[20]. The volar approach is carried

out with the wrist in full extension or in neutral[21]; the difficulty being that the trapezium hinders guide wire insertion. The use of this approach may result in damage to the scapho-trapezoidal joint and subsequent osteoarthritis[22, 23, 24].

Open reduction and fixation using a plate system has been used for the treatment of scaphoid non-union[16]. Complications are associated with the need for removal and impingement.

Mc.Laughlin (1954)[25] was the first to recommend open reduction and screw fixation for the treatment of scaphoid non-unions. Streli (1970)[26] was the first to describe the use of percutaneous screw fixation for acute fractures of the scaphoid. Herbert and Fischer (1984)[27] later described the use of the Herbert screw in the fixation of scaphoid non-unions.

The Herbert screw has been successfully used to treat acute scaphoid fractures[28,29,30,31]. Biomechanical improvements have made this an attractive approach to treat scaphoid non-unions as the screw provides a stable and compressive construct. Over time different screw designs have been developed: Association for the study of internal fixation (A.S.I.F) cancellous screw and Heune screw. Biomechanical studies have shown different reports with regards to fixation capabilities and size[32,33], however there is no difference in terms of the compression achieved at the fracture

site and stability when comparing the Arbeitsgemeinscaft für osteosynthesefragen (AO) screw to the Herbert screw[17].

The use of percutaneous Herbert screws has successfully been used to treat scaphoid non-unions[10,34,35,36,37.] The advantage of the Herbert screw is the reduced incidence of impingement and early range of motion however, difficulty with central screw placement has been documented[38].

Recently Vascularised bone graft[39,40] has been used in an attempt to reduce the period of immobilisation and improve union rates. Authors have reported union rates of up to 100 percent with vascularised bone grafts[41,42,43]. Complications associated with the use of vascularised bone graft include graft extrusion, prominent metal work, and failure of the graft to take due to a lack of surgical expertise[44].

The current management of scaphoid non-union involves open reduction debridement and bone grafting and this has been a popular method of treatment of scaphoid non-unions with high success rates[45,46,47,48].

Minimally invasive fixation has the advantage of a short immobilisation period and faster recovery time[49]. Percutaneous techniques can avoid the morbidity of an open approach.

Scaphoid non-unions have been treated using a percutaneous technique by a variety of authors[50,51,52,55]. Capo et al. (2011)[50] described 12 cases with established scaphoid waist non-unions without collapse that were treated

percutaneously without supplementary bone grafting; 11 of the 12 fractures united successfully with union achieved at an average of four months.

Mahmoud et al. (2011)[35] reviewed 27 patients with established non-union and showed that regardless of the size of the gap, undisplaced fractures can heal without bone grafting provided that mechanical stabilisation and carpal alignment is maintained. They also showed that the delay between injury and fixation rather than the size of the gap was the determining factor in the time to union.

Using arthroscopy, Slade et al. (2011)[51] looked at fifteen patients with a fibrous union or non-union of the scaphoid treated using a dorsal percutaneous fixation technique without bone grafting. Patients had computed tomography scans 4–6 weeks postoperatively and thereafter every six weeks until union was achieved. All fractures healed without complications at an average time of 14 weeks.

Kim et al. (2010)[52] treated 12 patients with delayed union of the scaphoid waist using a volar percutaneous approach; all fractures united uneventfully with a mean DASH (Disabilities of the arm, shoulder and hand score) score of 9.

Numerous treatment modalities are available for scaphoid non-unions, each with unique success, failure and complication rates. Irrespective of the method chosen, the aim is to achieve a stable fixation, correct residual deformity and prevent the development of arthritis. Non operative treatment

in the form of casting is a tedious process that requires frequent patient follow-up, as well as the need for prolonged casting which leads to a higher risk of joint stiffness. Despite this method being a tedious process, it is appropriate for patients who cannot undergo surgery[10].

Surgical fixation has adopted various forms of fixation devices and the use of bone grafting. What is recommended is internal fixation with or without the use of bone grafting to achieve faster union rates and prevent prolonged immobilisation[11].

It is important to bear in mind that the outcomes of the procedures described were due to the procedures being performed by experienced senior authors and are therefore difficult to reproduce[35].

Percutaneous screw fixation without bone grafting is a relatively reproducible procedure in terms of outcomes and complications, but a learning curve is to be expected with regards to central screw placement. However, outcomes are favourable and reproducible[35].

1.2 Study Justification

The currently acceptable and recommended treatment modality for scaphoid non-union is open reduction and internal fixation with bone graft. Open procedures pose a risk of damage to the tenuous blood supply of the

scaphoid. An open procedure also requires carpal ligament division further adding to carpal instability.

Complications associated with bone grafting such as donor site morbidity and in the case of vascularised grafts; special expertise and instrumentation are some of the major drawbacks to open reduction and bone grafting. A percutaneous approach without the use of bone grafting proves to overcome these problems and provide a cheaper alternative.

1.3 Research Question

Can percutaneous screw fixation successfully be used to achieve union in scaphoid non -unions?

1.4 Objectives

The primary objective of the study was to determine the treatment outcome of scaphoid non-union using percutaneous screw fixation. The secondary objective was to determine the time to union.

Chapter 2 - Methodology

This was a short hospital-based retrospective study. Patients diagnosed with a non-union, surgically fixed with a percutaneous screw from January 2010 to December 2014 at the Rosebank Clinic Hospital formed the study population.

Nineteen patients, who satisfied the inclusion criteria outlaid in Table 2.1, were identified and had their six month follow up x-rays retrospectively reviewed.

The procedure was carried out by a single senior surgeon. The procedure was performed with the wrist in extension and a mini volar incision was used. Under fluoroscopy a guide wire was placed centrally, and a Herbert screw was inserted perpendicular to the fracture. Immediate post-operative x-rays were reviewed to confirm central placement and compression across the fracture site.

Furthermore, the following information of each patient was collected for data analysis: age, mechanism of injury, and six month post-operative x-rays.

The files, pre- and post-operative x-rays of the enrolled participants were reviewed for time to union and successful union following post-operative fixation. Union was determined based on the formation of new bone, as well as obliteration of the fracture line

Table 2.1: Patient selection criteria

Inclusion criteria:
• Patients ≥ 18 years • Scaphoid fractures with radiological features of type 2,3,4 and 5 according to Slade and Dodds[57] classification
Exclusion criteria
• Fractures not fitting the criteria of non-union according to Slade and Dodds[57] classification. • Presence of Pseudo-arthrosis (Slade and Dodds type 6)

2.1 Surgical procedure

A volar surgical approach was used in all cases. The procedure was performed under general anaesthesia. With the wrist in extension a stab incision was made just distal to the scaphotrapezial joint. A guide wire was advanced through the trapezium into the scaphoid ensuring central placement within the proximal pole of the scaphoid in all views.

With the guide wire in the optimal position a larger cannulated drill bit was used to bore through the trapezium to allow easier passage of the screw into the scaphoid. A second appropriately sized cannulated drill was advanced over the guide wire into the scaphoid, and an appropriately sized mini Acutrak headless cannulated compression screw was inserted.

The hand was placed in a thumb spica splint that was removed at two weeks post-operatively to allow for wound inspection and suture removal. Thereafter a removable splint was applied for six weeks.

Patients were referred to physiotherapy for gentle range of motion exercises after removal of thumb spica at two weeks post operatively, but were instructed to avoid contact sports or full loading until three months post operatively.

Final radiographs were taken six months post-operatively and bony union was verified by the presence of bony trabeculae across the fracture site in five scaphoid views.

Chapter 3- Results and Discussion

There were 19 patients (13 males and 6 females) with an average age of 41 years (range 18–72 years) who were included in the study (refer to Figure 3.1). There were 14 right-sided fractures and 5 left-sided fractures (refer to Figure 3.2). The mechanism of injury included fall (n=16), sporting injury (n=2) and a motorcycle accident (n=1) (refer to Figure 3.3).

Male patients are more likely to sustain a scaphoid fracture with injuries to the wrist fracture compared to their female counterparts' (M: F-3:1).

Seventeen patients had achieved union at six months, one patient had persistent non-union and one was lost to follow-up. There were no serious complications recorded.

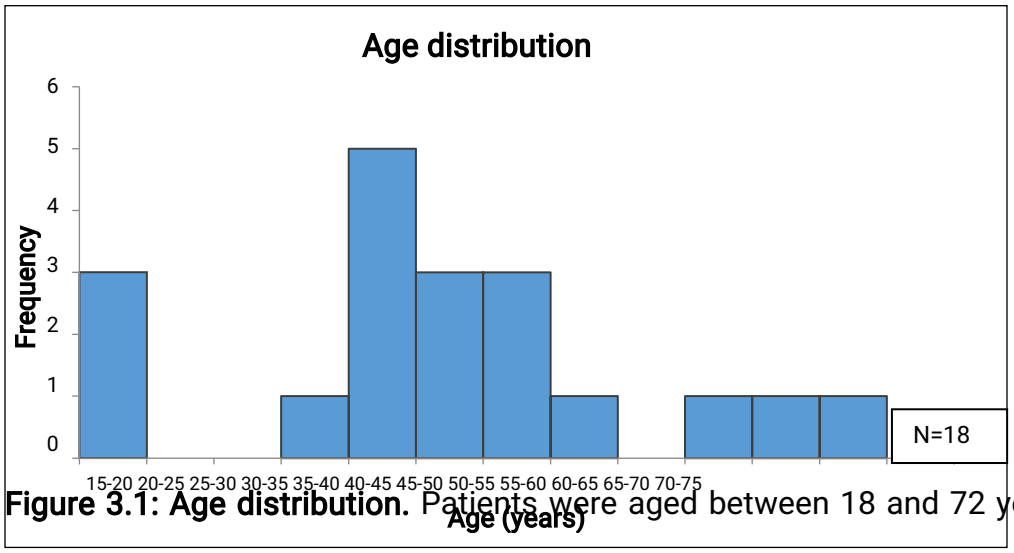


Figure 3.1: Age distribution. Patients were aged between 18 and 72 years (average 41 years).

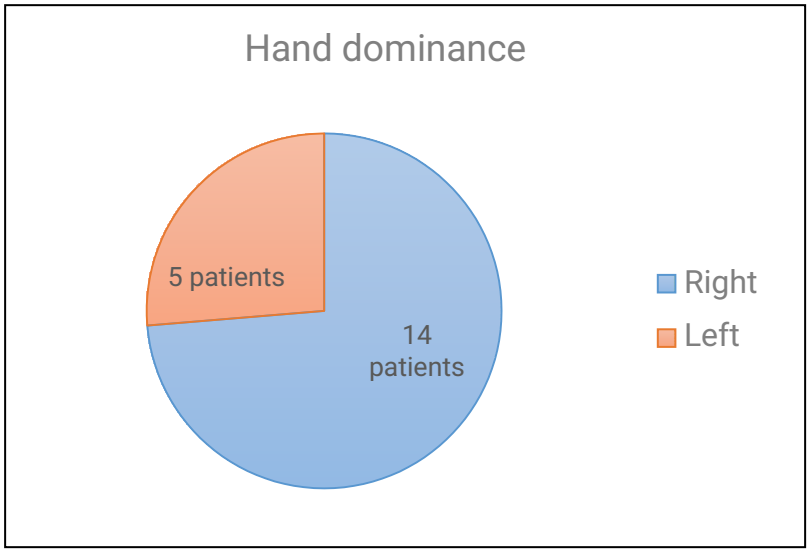


Figure 3.2: Hand dominance. Fourteen patients sustained a fracture on the right hand and were right hand dominant, while five patients sustained a fracture on the left hand and were left hand dominant.

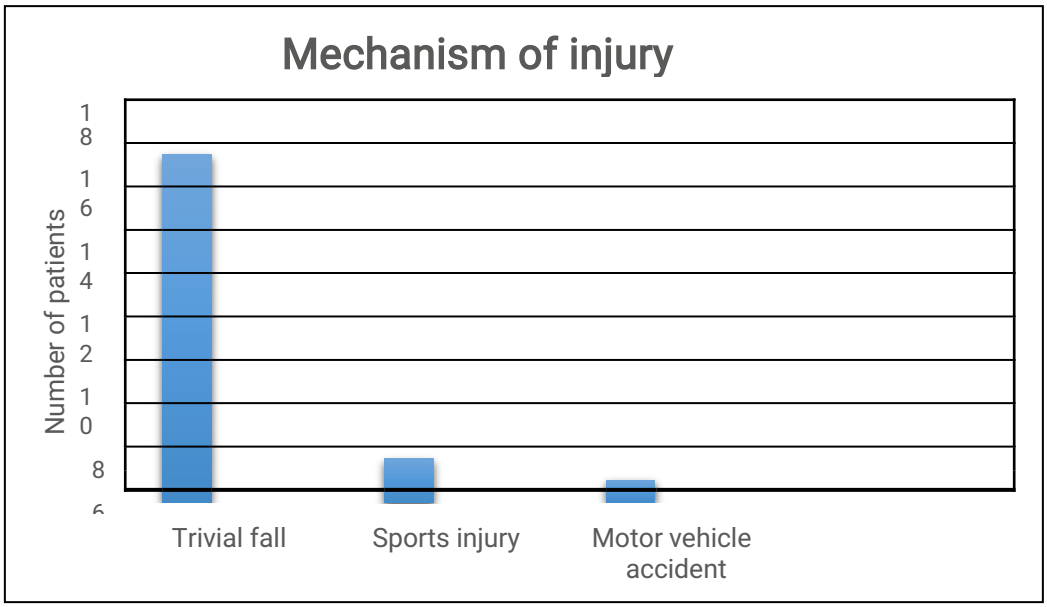


Figure 3.3: Mechanism of injury. Sixteen patients sustained their injury from a trivial fall, two during a sporting activity and one from a motorcycle accident.

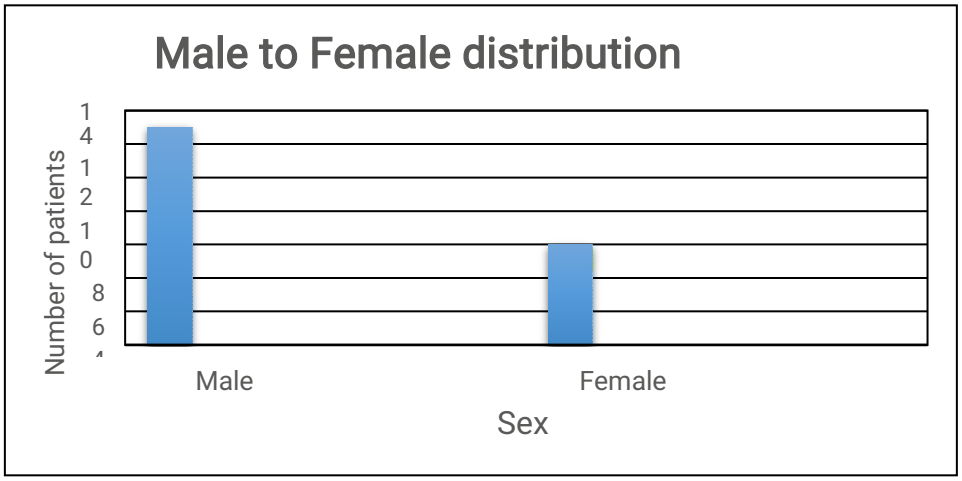


Figure 3.4: Male to female distribution. Nineteen patients (13 males and 6 females) were included

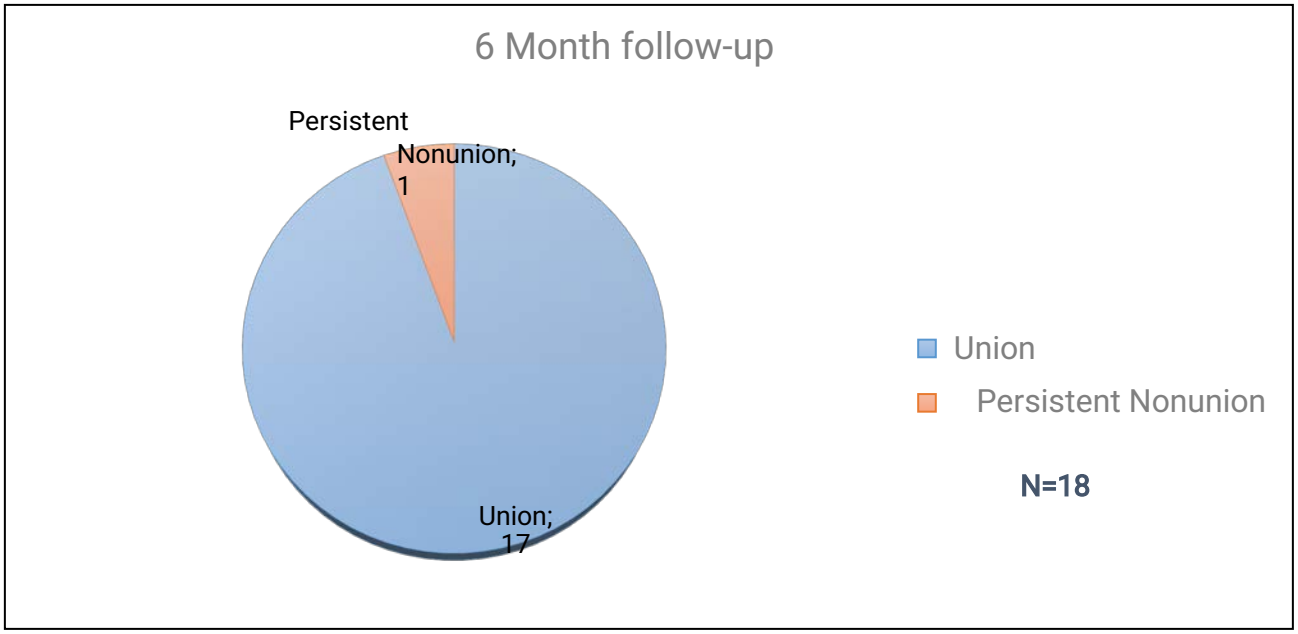


Figure 3.5: 6-Month X-Ray follow-up. Seventeen out of eighteen patients (94.7%) achieved union at six months, one patient had persistent non-union

3.1 Discussion

Percutaneous screw fixation for the treatment of scaphoid fractures was first described by the German author Streli (1970)[26]. A percutaneous approach has been shown to reduce complications and recovery associated with open techniques.

Bond et al. (2001)[10] showed patients had an earlier time to union (7 weeks vs 12 weeks) and return to work (8 weeks vs 15 weeks) when comparing percutaneous fixation versus casting in the management of acute scaphoid fractures.

Haddad (1998)[53] showed in his study that non unions with a gap or step of <1mm can still achieve bony union provided stable fixation is achieved. This compares to this current study where the selected patients falling into group 2, 3, 4 and 5 according to Slade and Dodds[57] classification went on to achieve bony union.

Slade et al. (2008)[51] and Geoghegan et al. (2009)[55] recommended the use of preoperative CT scans for the detailed assessment of non-unions. However in this study a clinical assessment of persistent pain around the wrist joint as well as sclerosis, persistent fracture gap and cystic formation as evidenced by plain x-ray films was used to define a non-union; and thereafter lack of pain and trabeculae across the fracture gap provided sufficient evidence for bony union at the six month postoperative review.

Screw placement can be carried out via a dorsal[18] or volar[21] approach each of which has its advantages and disadvantages[20,22,23,24]. In this study the volar approach was the preferred choice as it was easier to outline the bony anatomy as well as maintain alignment during fixation.

In the current study; seventeen of the nineteen patients (89%) sustained a scaphoid fracture after a fall onto an outstretched hand; and this compares to a published report by Radford et al. (1990)[34].

From the series of patients included in this study, a correlation could not be found between the outcome after surgery and the mechanism of injury, as it has been previously suggested that high energy injuries are more likely to cause non-union[56].

Percutaneous screw fixation was performed for patients who fell into the category of type 2, 3, 4 and 5 according to Slade and Dodds[57]. The consensus is that this approach when used without bone grafting yields higher rates of union in non-unions falling into these categories. Other authors have had similar successful union rates when applying this modality of treatment to these categories of patients[34,50].

The high rate of union observed in this study may be attributable to the proper case selection of patients, as is comparable to other reports in the

literature[6, 34,35,37,49,50] This study highlights the importance of patient selection in the application of this procedure[6].

3.2 Limitations

The limiting factor of this study was the small sample size used, as well as a steep learning curve to achieve central placement of the percutaneous wire and subsequent screw insertion.

This technique is also limited to a specific subset of chronic non-union cases and cannot be applied to all cases of non-union.

Patients found it difficult to recall the exact timing of the injury while others had no documentation in their reports. This made it difficult to determine the time from injury to surgery. This prevented us from making a conclusion on whether the timing from injury to surgery plays a role in fracture healing in a non-union.

A follow-up study that includes a larger patient population, as well as functional outcomes scores, would further strengthen the indications for percutaneous screw fixation over open procedures.

Chapter 4 - Conclusion

In this series, a 95% union rate, with a low morbidity, was achieved when the percutaneous minimally invasive approach was used. Therefore it is recommended as a modality of treatment for scaphoid non-unions without radiological evidence of pseudoarthrosis.

APPENDIX A. Ethics Approval

R14/49 Dr Nabil Khan

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M160115

NAME: (Principal Investigator)	Dr Nabil Khan
DEPARTMENT:	Orthopaedic Surgery Charlotte Maxeke Johannesburg Academic Hospital Rosebank Clinic Hospital
PROJECT TITLE:	Percutaneous Screw Fixation for Scaphoid Non-Unions
DATE CONSIDERED:	29/01/2016
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Susan Vandeventer
APPROVED BY:	Professor P. Cleaton-Jones,Chairperson, HREC (Medical)
DATE OF APPROVAL:	04/04/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004, 10th floor, Senate House/2nd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix B1. Hospital permission letter - Rosebank

Dr. Michael Carides

ORIGINAL

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Fax: (011) 447-4488

9th November 2015

To Whom it may Concern,

This letter serves to confirm that Dr Nabil Khan has been granted my permission to access my patient records with regard to his study on the management of delayed and non-union of scaphoid fractures. These patients have all been under my personal treatment and have undergone surgery at the Netcare Rosebank Hospital.

This permission is granted provisionally and on instruction that all information so accessed must remain strictly confidential and will be used for statistical and analytical purposes only. No personal and/or patient treatment information will be disclosed or released to any third party during the course of or as a result of this study.

Yours sincerely,

Dr MICHAEL CARIDES

Appendix B2. Hospital permission letter – Charlotte Maxeke Johannesburg Academic Hospital

Dear Sir/Madam

RE: Permission for research

Date: 6th may 2015

Name: Dr. Nabil Khan

Contact details: Dr. Nabil Khan

Cell: 0721453970

Email: dr.nabilk@yahoo.com

Title of research project: Percutaneous screw fixation for scaphoid non-unions.

Objectives:

To determine the union rate of scaphoid non-unions using percutaneous screw fixation.

To determine the time to union after fixation with percutaneous screw.

Methodology:

X-rays of patients treated with a percutaneous screw, over a period from 2010 to 2014, will be evaluated for signs of radiological union.

Confidentiality of patients will be maintained.

No cost to the hospital will be incurred.

The head of Orthopaedic department has approved the study.

SUPERINTENDENT PERMISSION

Signature _____ Date 06/05/2015

Appendix C

Data Collection Sheets

C.1 A Retrospective study of percutaneous screw fixation for scaphoid non- unions

DATA COLLECTION SHEET (MMed Project)

Participant study number:

Date of operation:

Two week follow up:

Six week follow up: Six

month follow up:

Complications:

C.2 A Retrospective study of percutaneous screw fixation for scaphoid non- unions

DATA LINK SHEET (MMed Project)

Study code:

Forename:

Surname:

Age:

Sex:

Date of operation: Two

week follow up: Six

week follow up Six

month follow up:

Complications:

Study code	Sex	operation date	2-week follow-up	6-week follow-up	6-month follow-up	complications	Hand dominance	Mechanism of injury	Age
P001	F	1/2/2012	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	18
P002	M	23/2/2012	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	18
P003	M	18/1/2011	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	18
P004	M	6/7/2011	Stitch removal	Physio + splinting	union	Nil	L	FOOSH	33
P005	M	25/11/2011	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	34
P006	F	24/4/2012	Stitch removal	Physio + splinting	Non-Union	Persistent non union	L	FOOSH	35
P007	M	30/6/2013	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	38
P008	F	8/1/2011	Stitch removal	Physio + splinting	union	Nil	L	FOOSH	38
P009	M	9/12/2013	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	38
P010	M	25/11/2013	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	41
P011	F	12/2/2013	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	42
P012	M	20/05/2013	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	42
P013	M	4/12/2012	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	44
P014	M	8/10/2013	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	46
P015	M	6/7/2010	Stitch removal	Physio + splinting	union	Nil	L	SI	46
P016	M	9/4/2011	Stitch removal	Physio + splinting	union	Nil	L	SI	52
P017	M	15/6/2012	Stitch removal	Physio + splinting	union	Nil	R	FOOSH	60
P018	M	24/8/2013	Stitch removal	Physio + splinting	union	Nil	R	MVA	64
P019	F	26/7/13	Lost to follow up				R	FOOSH	72

Appendix D. Data spreadsheet.

Abbreviations:

FOOSH: Fall onto an outstretched hand; MVA: Motor vehicle accident; SI: Sporting injury

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