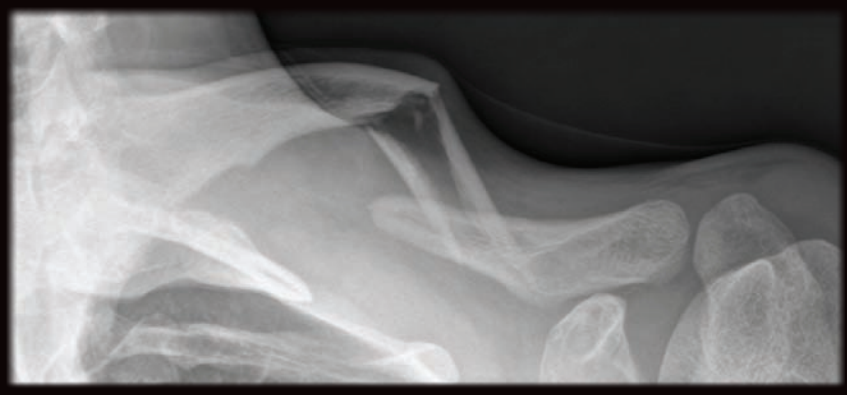
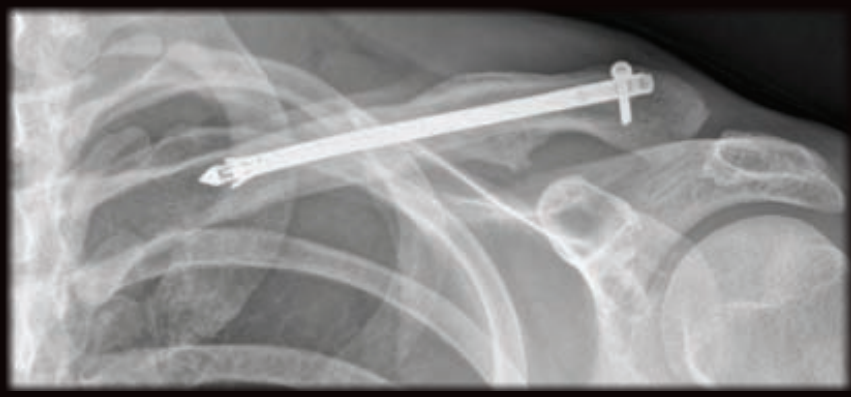
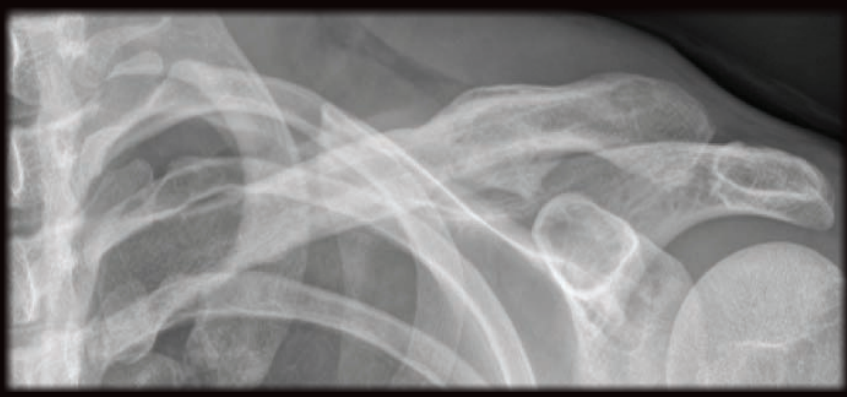
Sports-Trauma Clavicle Repair



A compendium of sports-trauma clavicle cases utilizing the SONOMA CRx™ Clavicle Fracture Repair Device





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Volume I

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Sports-Trauma Clavicle Case Series

Foreword

Sports-trauma clavicle injuries pose unique challenges to physicians. Active patients often poorly receive conservative treatments, and operative treatments of the past have provided satisfactory outcomes at the cost of cosmesis, hardware prominence, and the concern for re-fracture after hardware removal.

The Sonoma CRx™ is the first clavicle fracture solution designed for athletes. It minimizes incisions, minimizes hardware prominence, and minimizes potential for stress risers created by screws. The biomechanical benefit of locked intramedullary fixation and its unique ability to conform to the anatomic curve gives patients the best potential for a quick return to activity.

Physicians throughout the United States and across the world have helped Sonoma Orthopedic Products® compile this compendium of clavicle cases for the purpose of education. These case summaries are written and presented by the operating physicians, and have not been altered or edited.

These summaries describe the physicians' techniques, reasons for operative repair, post-operative protocols, and results. The cases and results are unique to these surgeries, physicians, and patients. Individual results and post-operative activity levels vary and depend on many factors.

Sonoma Orthopedic Products® sincerely thanks the many physicians that have contributed to this compendium.

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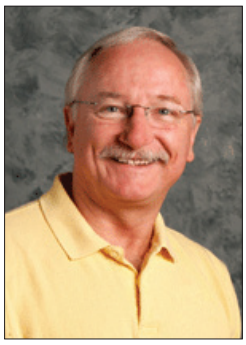
Simple Fractures

Acute clavicle fractures with a single fracture line. These are transverse, short oblique, or oblique fractures.

CLAVICLE FRACTURE CASE SERIES



CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

Midshaft clavicle fracture, severe shortening of the clavicle and more than 100% displacement in an 18 year old male

Patient History

An 18 year old male presented with an injury to his right clavicle sustained after a fall onto his shoulder. A midshaft clavicle fracture was confirmed with AP and 45° cephalic tilt radiographs. The radiographs showed severe shortening of the clavicle and more than 100% displacement. As such, the patient was recommended to undergo internal fixation of his clavicle.

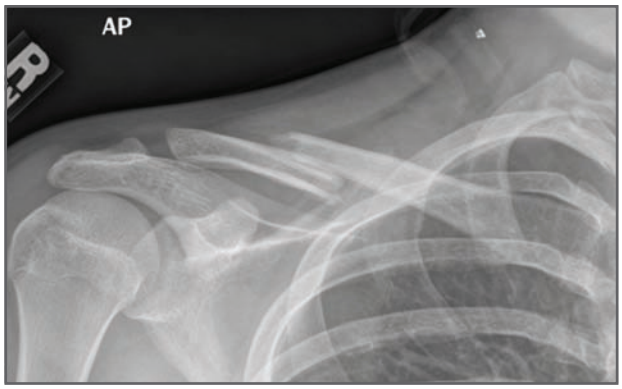
Treatment Method

The patient was recommended to undergo open reduction internal fixation with the Sonoma CRx™. This implant clavicle device was selected because of its ability to rigidly support the fracture, maintain length, and be completely intramedullary..

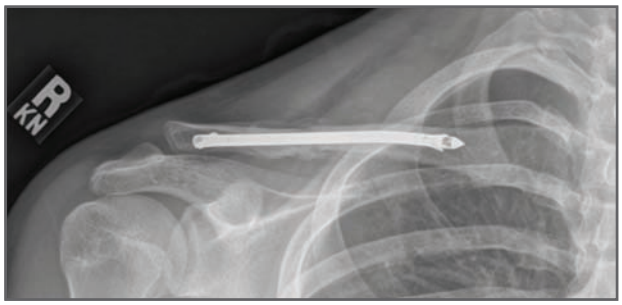
Post-Operative Results

The patient was sent home the same day as surgery, and allowed to immediately begin non weight bearing ADLs. Due to the patient's high activity level and young age, it was recommended that the implant be removed after healing. The implant was removed after healing was confirmed by radiographs, at which time the patient had full range of motion and had returned to full activity.

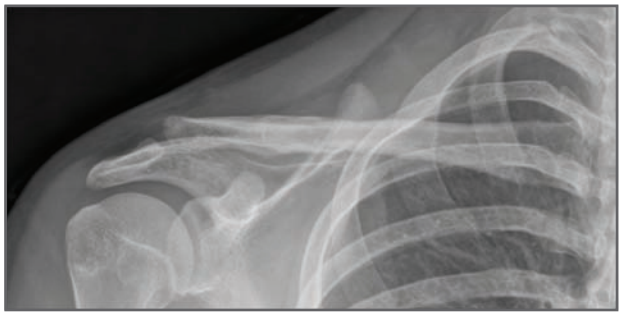
Pre-Operative



Post-Operative



Post Hardware Removal



CLAVICLE FRACTURE CASE SERIES

CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

Long oblique midshaft clavicle fracture with severe shortening and displacement

Patient History

A 44 year old male sustained a right shoulder injury after falling while playing soccer. He presented a long oblique midshaft clavicle fracture with severe shortening and displacement confirmed by AP and 45° cephalic tilt view radiographs. He was recommended to undergo ORIF of his right clavicle.

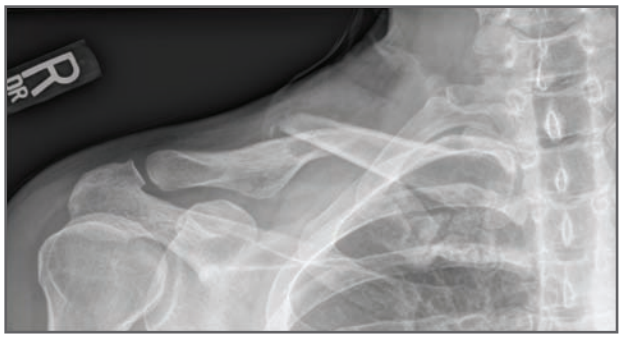
Treatment Method

The patient presented with a long oblique fracture of the midshaft clavicle. Because of the length of the fracture, it is necessary to provide internal fixation to maintain the length of it and prevent further shortening. The Sonoma CRx™ was selected to repair the fracture because it is able to maintain anatomical length and provide rigid intramedullary support.

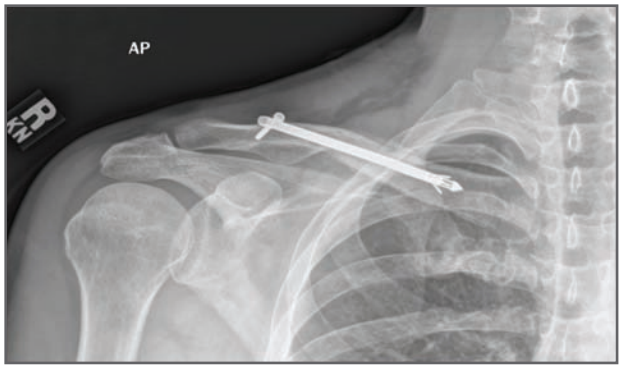
Post-Operative Results

The patient was allowed to return home after surgery and instructed to perform passive ROM as tolerable. Five days post-operative, the patient was able to return to work as an engineer. At five weeks post-operative, callus formation was evident by radiographs, and the patient had full range of motion.

Pre-Operative



5 Weeks Post-Operative



CLAVICLE FRACTURE CASE SERIES

CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

Short oblique midshaft clavicle fracture more than 100% displaced with approximately 1.5-2cm of shortening.

Patient History

A 15 year old male presented with an injury to his left clavicle sustained after a skiing accident. A short oblique, midshaft clavicle fracture was confirmed with AP and 45° cephalic tilt radiographs. The fracture was more than 100% displaced with approximately 1.5-2cm of shortening. The patient was recommended to undergo internal fixation of his clavicle.

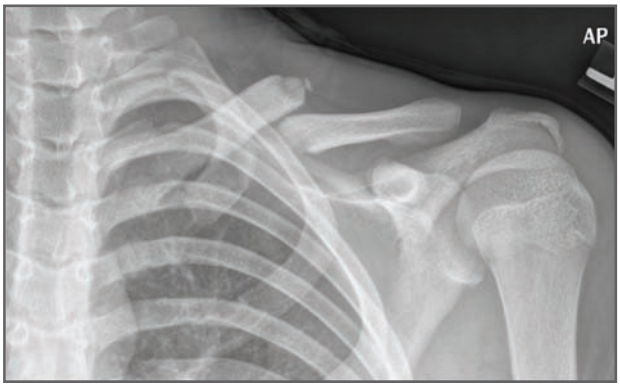
Treatment Method

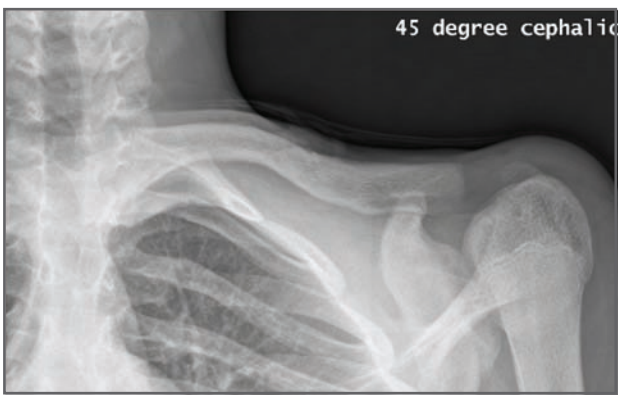
The patient presented a short oblique midshaft fracture of his left clavicle. By nature, short oblique fractures do best in compression as it enhances fracture stability. The Sonoma CRx™-CWG clavicle compression device was selected because of its ability to apply up to 10mm of compression.

Post-Operative Results

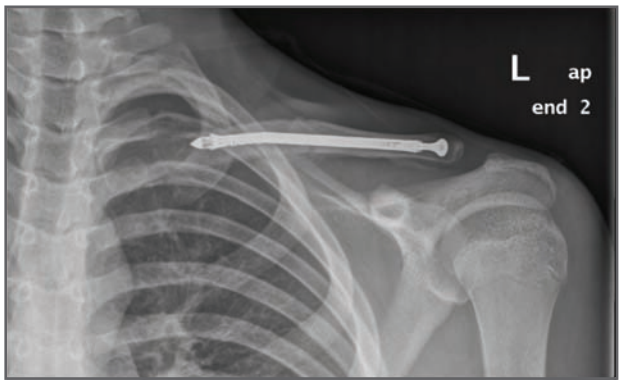
The patient was sent home the same day as surgery, and allowed to immediately begin non weight bearing ADLs. At six weeks post-op, the patient had full range of motion and presented a well-healing fracture with callus formation evident by radiographic images.

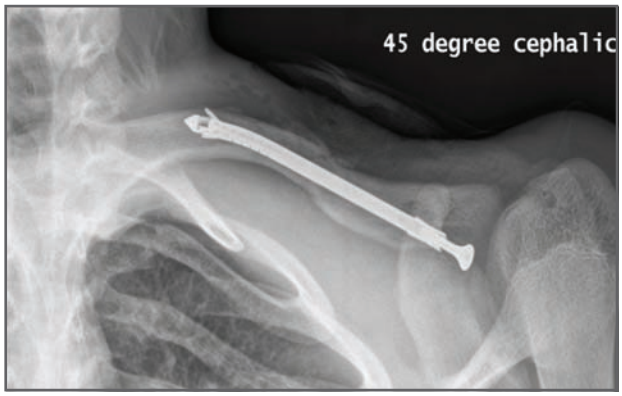
Pre-Operative





6 Weeks Post-Operative





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CLAVICLE FRACTURE CASE SERIES

CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

Relatively short, oblique, displaced and severely shortened lateral clavicle fracture with no comminution

Patient History

A 17 year old male

AP and 45° cephalic tilt view confirmed a displaced, severely

relatively short oblique, with no comminution. The patient was recommended to undergo internal fixation of his clavicle to

Treatment Method

fracture, compression is recommended because it not only aids in stability, but also ensures solid bony contact to promote healing. The Sonoma CRx™-CWG clavicle compression device

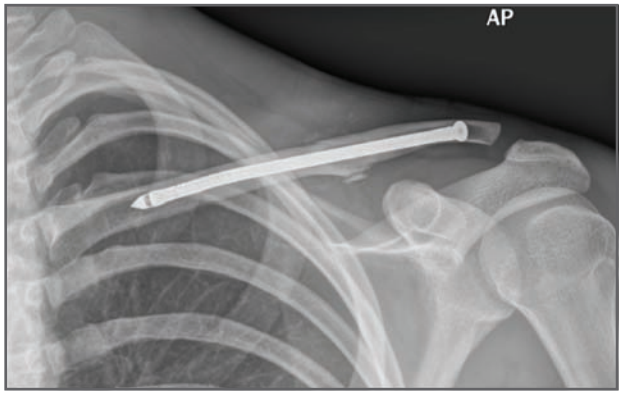
fixation and apply compression of the fracture site without

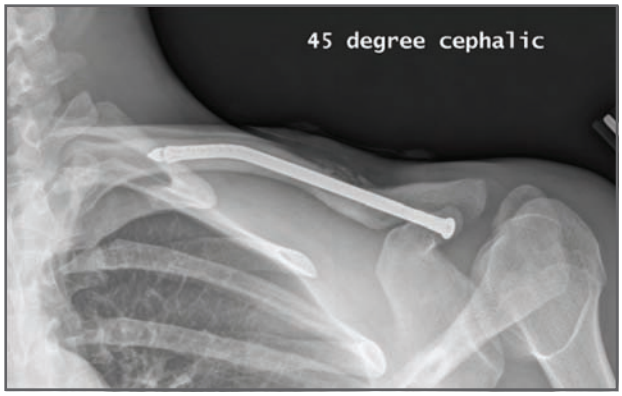
Post-Operative Results

activities immediately. The patient was seen at 12 weeks, at which time he had returned to full activity, with a healed fracture confirmed by his radiographs.

Pre-Operative

Post-Operative





CLAVICLE FRACTURE CASE SERIES

Midshaft displaced clavicle fracture in a 37 year prosthodontist

MICHAEL HUANG, M.D.
Rocky Mountain Orthopaedic Associates
Grand Junction, CO

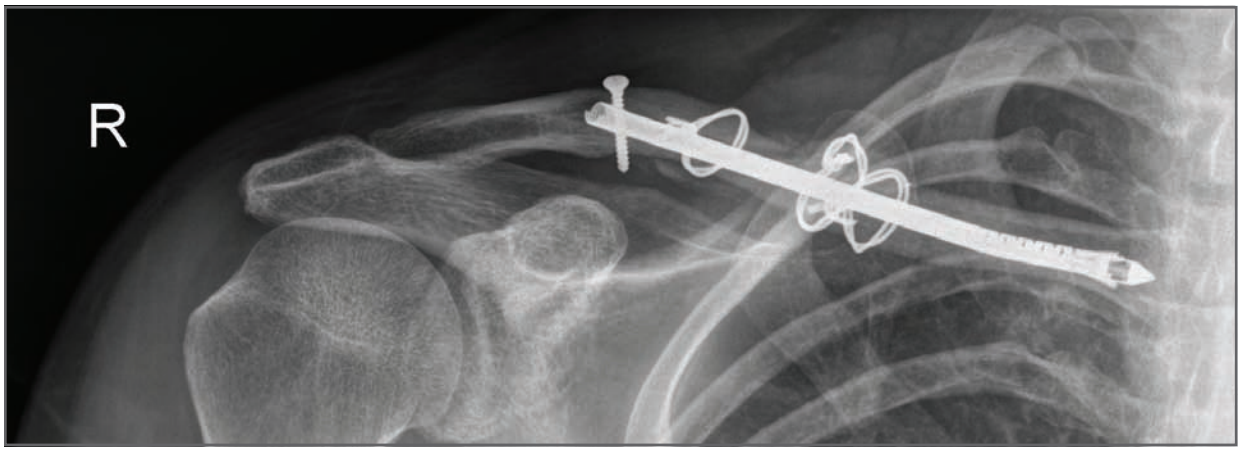
Patient History

A 37 year old right hand dominant prosthodontist who went over his handle bars mountain biking suffered a midshaft displaced clavicle fracture on the right side.

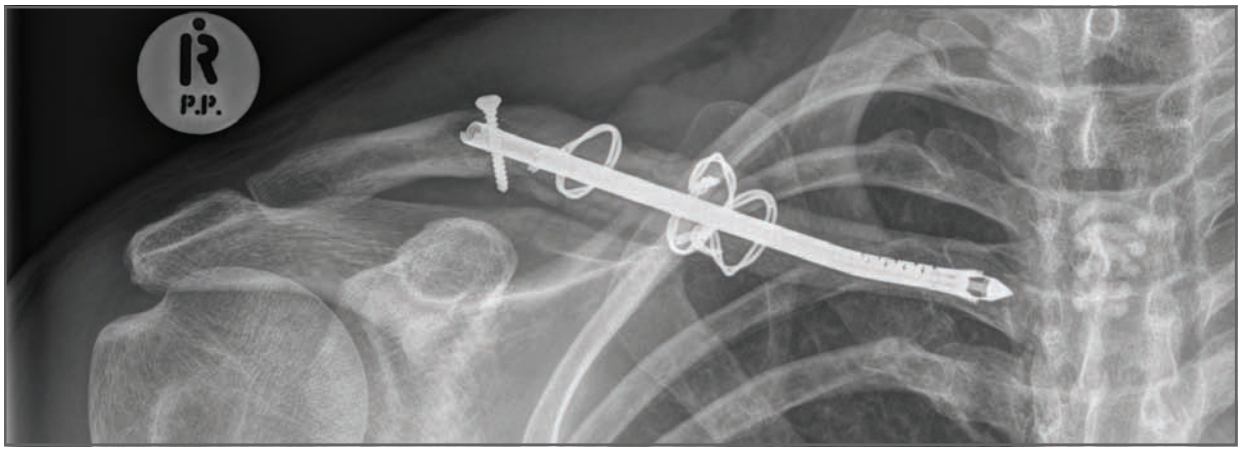
Treatment Method

□□□

6 weeks Right



3 months Right



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CLAVICLE FRACTURE CASE SERIES

Allman I (middle third), Simple fracture – oblique, AP displacement – 23 mm, Shortening – 22 mm

REGGIE KING, M.D.
Cape Town
South Africa

Patient

21-year-old male

Mechanism of injury

Motorbike accident

Implant removal

Scheduled for 9 months post-op – high level rugby player.

Restoration of length

11mm shortening post fracture healing compared to normal contralateral clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

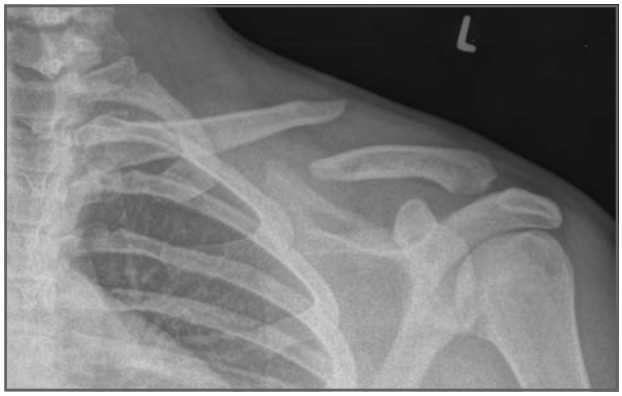
Outcome of treatment

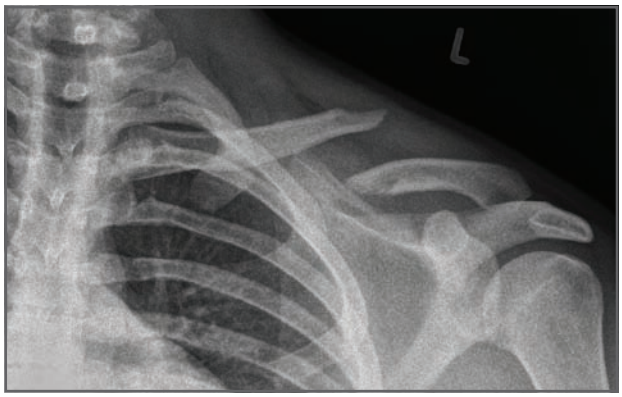
- ROM - full
- Dash score – 3 at 3 months
- Fracture united

Additional fracture stabilization

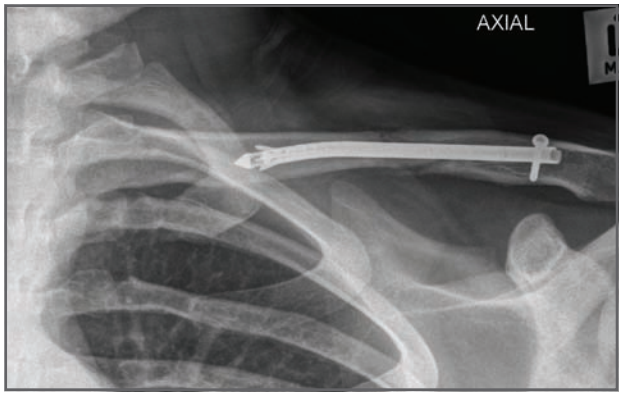
None

Pre-op



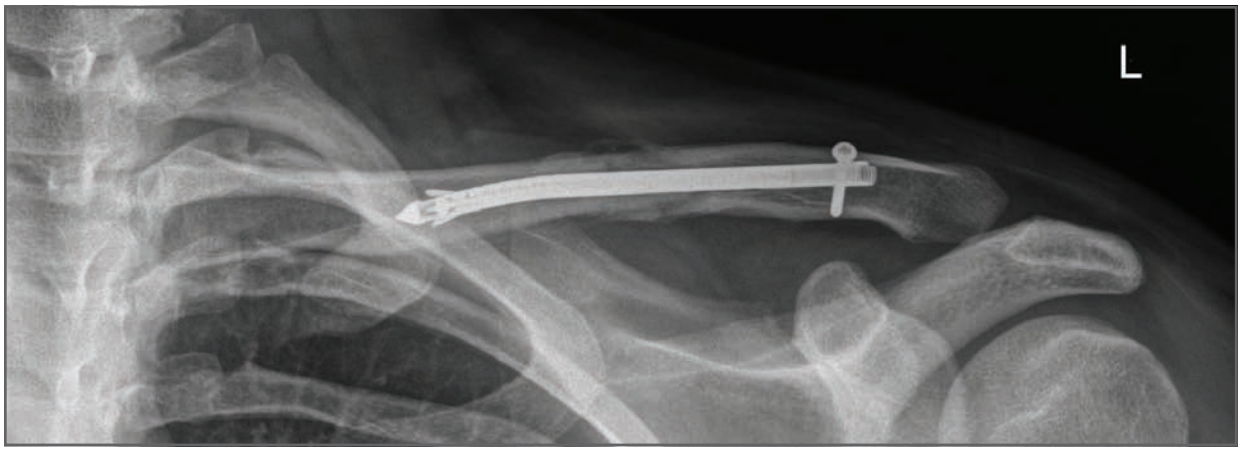


Immediate post-op

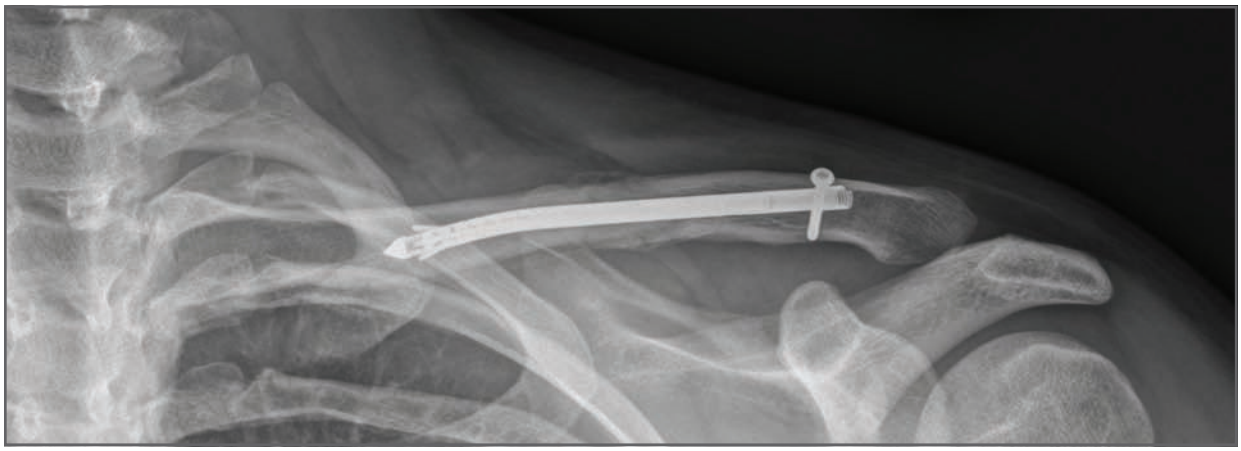


Over >

6 weeks



3 months



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CLAVICLE FRACTURE CASE SERIES

Allman I (middle third), Simple fracture – transverse, AP displacement – 22 mm, Shortening – 15 mm

REGGIE KING, M.D.
Cape Town
South Africa

Patient

28-year-old female

Mechanism of injury

Motor vehicle accident

Restoration of length

0mm shortening post fracture healing compared to normal contralateral clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

Outcome of treatment

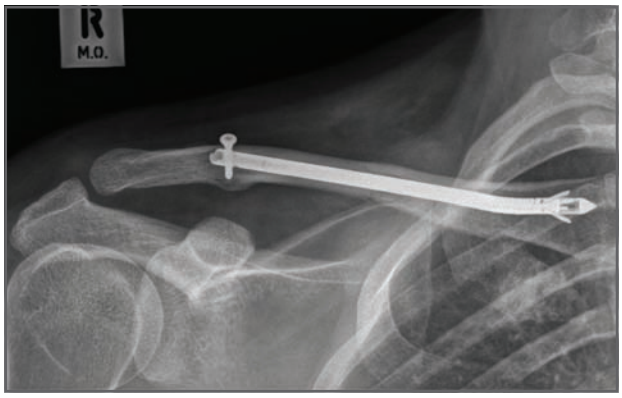
- ROM - full
- Dash score – 0 at 3 months
- Fracture united

Additional fracture stabilization

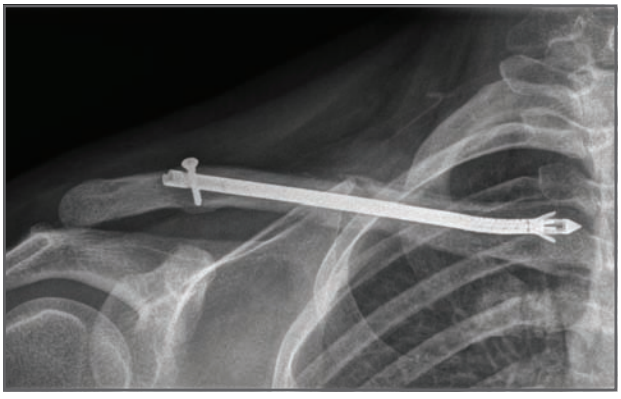
None

Pre-op

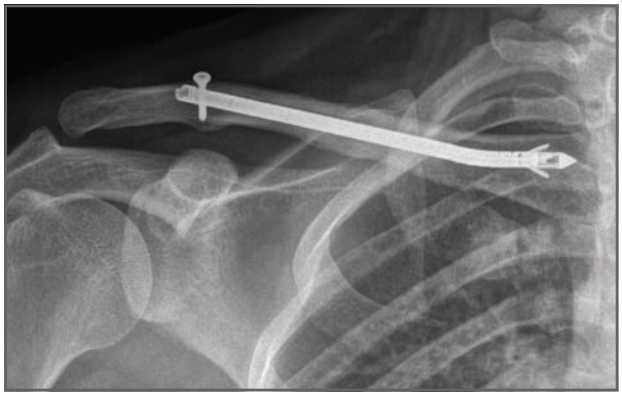
Immediate post-op



6 weeks



3 months



CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), Simple fracture – spiral, AP displacement – 27 mm, Shortening – 39 mm

Patient

22-year-old male

Mechanism of injury

Motor vehicle accident

Restoration of length

0mm shortening post fracture union compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

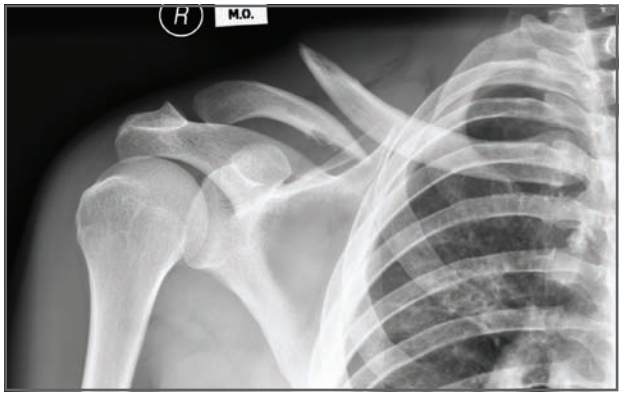
Outcome of treatment

- ROM - full
- Dash score – 0 at 3 months
- Fracture united

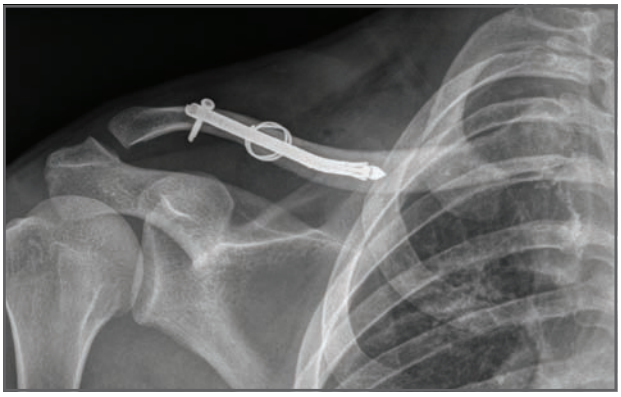
Additional fracture stabilization

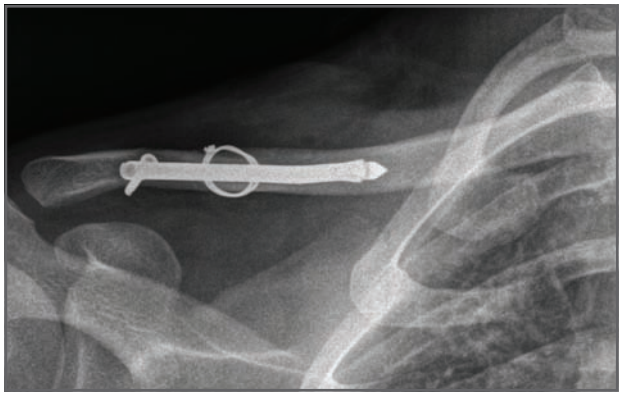
Circlage dental wire securing fragments at fracture site.

Pre-op



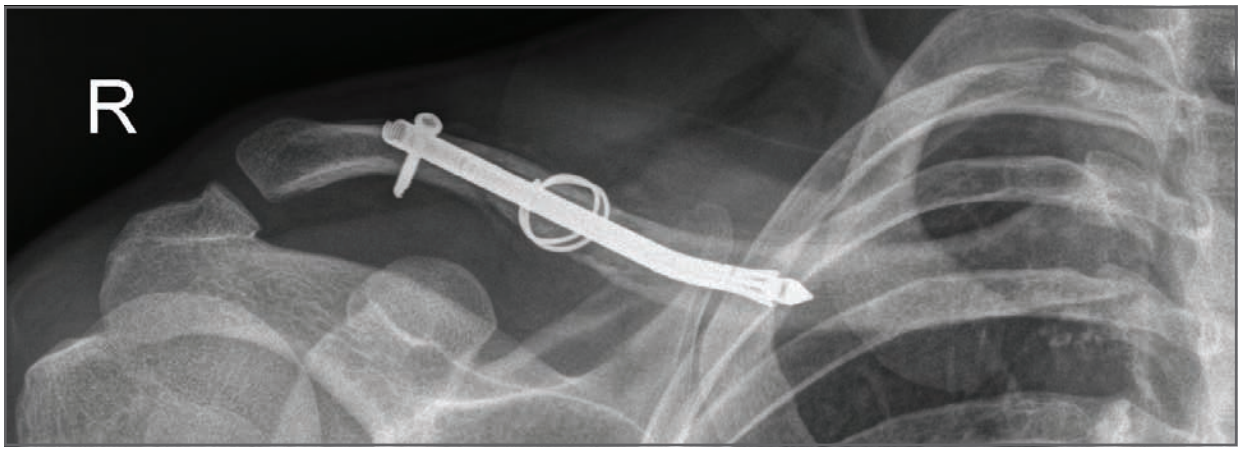
Immediate post-op



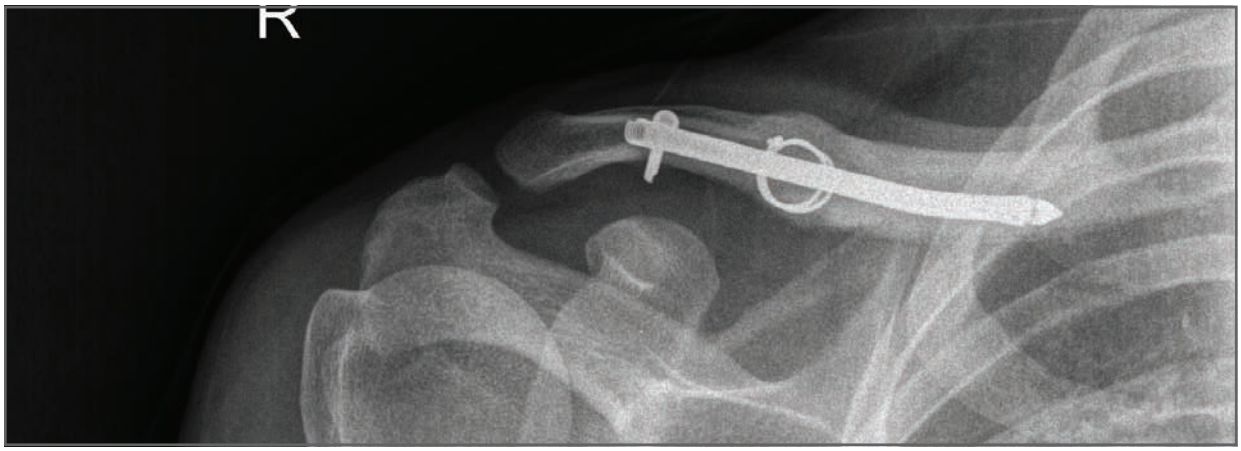


Over >

6 weeks



6 months



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CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), Simple fracture – oblique, AP displacement – 18 mm, Shortening – 28 mm

Patient

21-year-old male

Mechanism of injury

Direct blunt trauma

Associated injuries

Ipsilateral Monteggia fracture (prox ulna fracture with dislocated radial head) – ORIF done at same sitting

Restoration of length

0mm shortening post fracture union compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

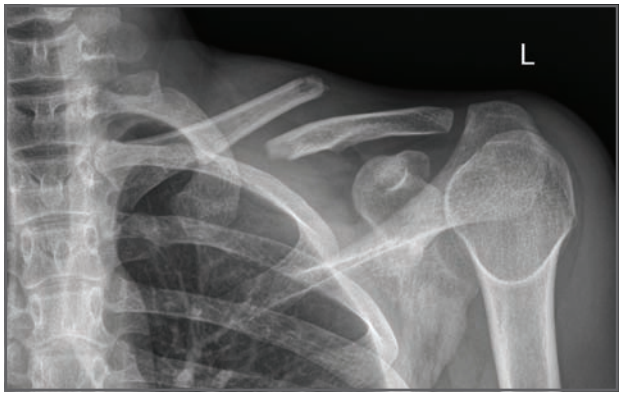
Outcome of treatment

- ROM - full
- Dash score – 0 at 3 months
- Fracture united

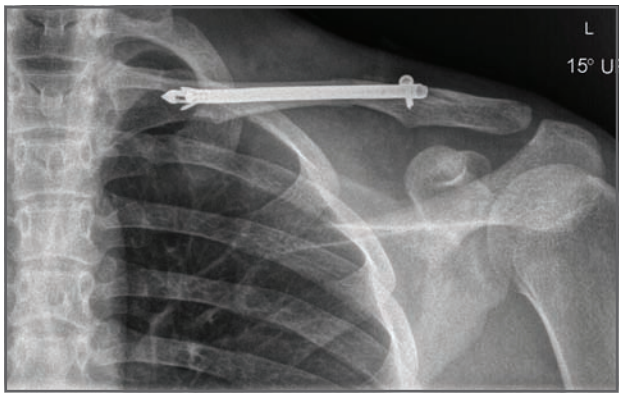
Additional fracture stabilization

None

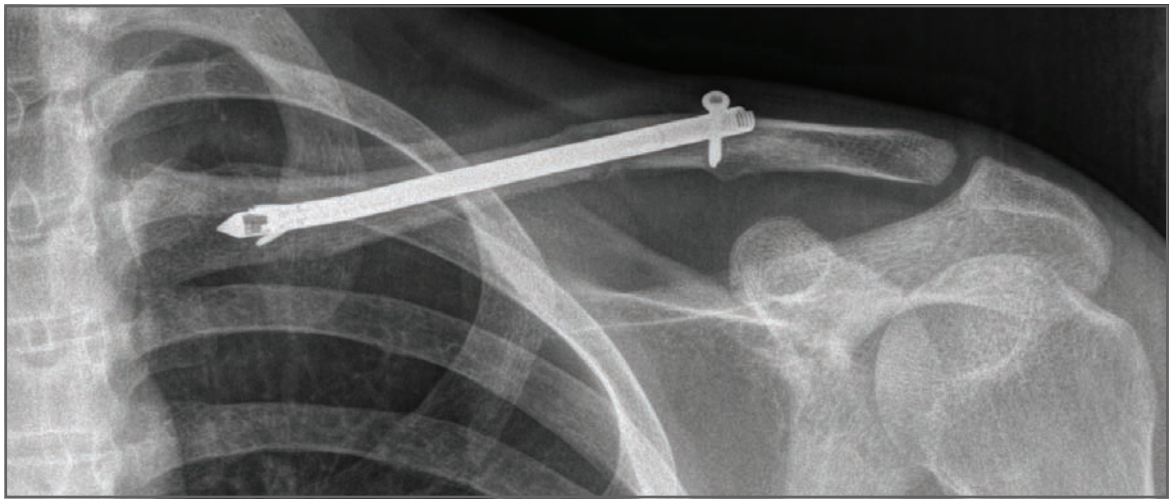
Pre-op



Immediate post-op



2 months



CLAVICLE FRACTURE CASE SERIES

Midshaft fracture with 2cm shortening and 100% displacement

MATHEW POMBO, M.D.
The Sports Medicine & Orthopaedic Institute of Gwinnett
Duluth, GA

Patient History

The patient is a 14 year old male who presented in clinic with left shoulder pain that occurred four days previous. He states that he was playing football for his high school freshman team and was running down the field when he was tripped and fell, landing on his left side.

He reports feeling a crack and was taken to the emergency room. X-rays were taken and revealed a midshaft clavicle fracture with 2cm shortening and 100% displacement. Operative versus nonoperative measures were discussed with the patient and his father.

Treatment Method

The patient's family was educated on the options of surgical versus nonsurgical treatment given his young age. The family decided on surgical fixation given his high activity level and wanting to return to sport.

Again the Sonoma nail was the device of choice because it is completely intramedullary and its ability to provide rigid fixation of the fracture. Allograft bone was also required to fill a small cortical defect superiorly.

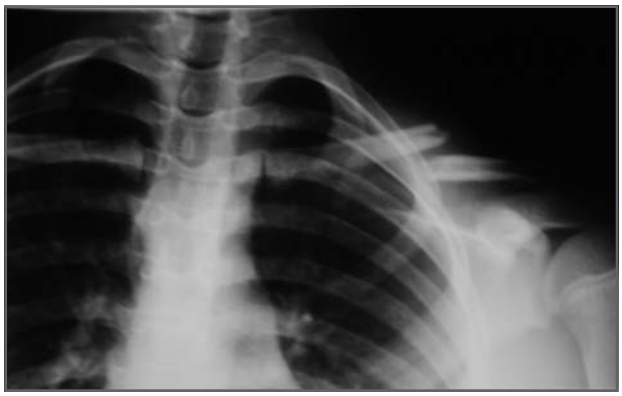
Post-operative Results

The patient was sent home same day as surgery and followed up on week post-op for wound check and dressing change. X-rays revealed restoration of length of the clavicle and well aligned fracture.

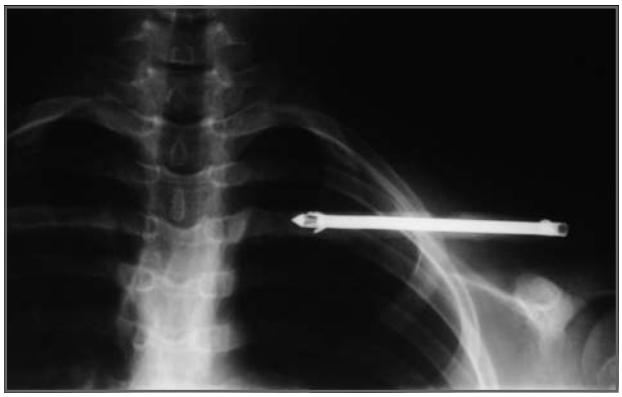
Physical therapy was ordered for active and active-assisted range of motion of his shoulder. He was to be non weight bearing for the first few weeks and progress to lifting 5-10 pounds as tolerated.

His final follow up appointment was ten weeks post-surgery and x-rays revealed good callus formation and excellent healing of the Sonoma nail. He was released to return to football as tolerated without restrictions. It was recommended that the nail remain in unless it began to cause pain or infection.

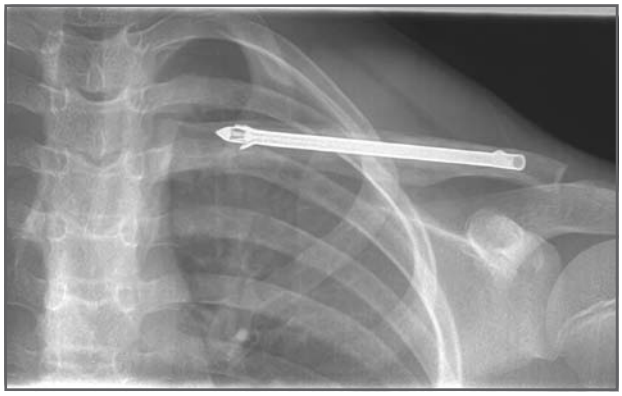
Pre-Operative



1 week



2 months



CLAVICLE FRACTURE CASE SERIES

HYTHEM P. SHADID, M.D.
Genesis Orthopedics
& Sports Medicine
St. Charles, IL

Significant pain and swelling over the mid-shaft of the L clavicle with a palpable bayoneted fracture

Patient History

18 YO white female rugby player who injured her shoulder during a match when she was thrown to the ground on her Left Shoulder. Physician exam demonstrated significant pain and swelling over the mid-shaft of the L clavicle with a palpable bayoneted fracture. Motor and sensory exams were otherwise intact.

The patient is an active young woman who desires to continue playing rugby and keep her scheduled summer job in Yellowstone National Park. In lieu of her lifestyle demands and increased risk of a delayed union or nonunion, she opted for IM fixation, so as to avoid a cosmetic deformity and keep her summer employment opportunity.

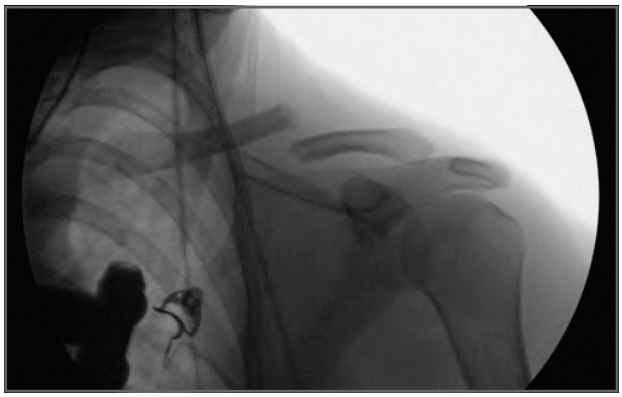
Post-op Results

Rehab Protocol: **0-4 weeks** — sling immobilization prn. No overhead use of the L arm or adduction. Clerical Work only.
4-6 weeks — Physician directed Home Exercises. No weightlifting. ADLs.
6-12 weeks — May introduce exercise as tolerated with slow progression. No impact activities.

ROM: 1 month post-surgery: Full, active flexion
5 months post-surgery: Full range of motion without pain or tenderness

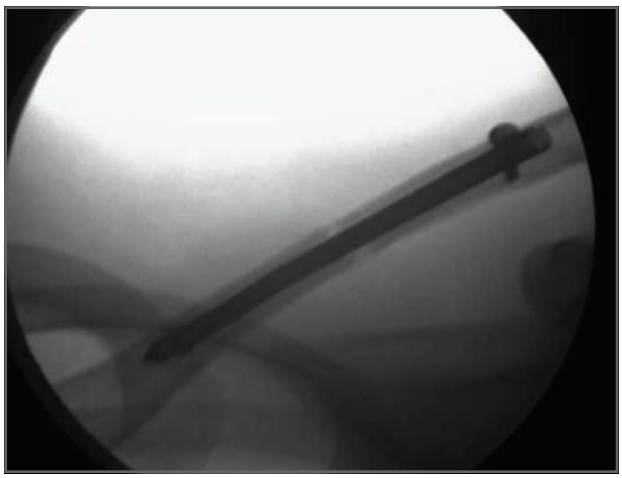
First sign of radiographic healing: 1 month post-surgery
Full demonstration of radiographic healing: 5 months post-surgery
Return to full activity: 5 months post-surgery

Pre-operative



Follow-up

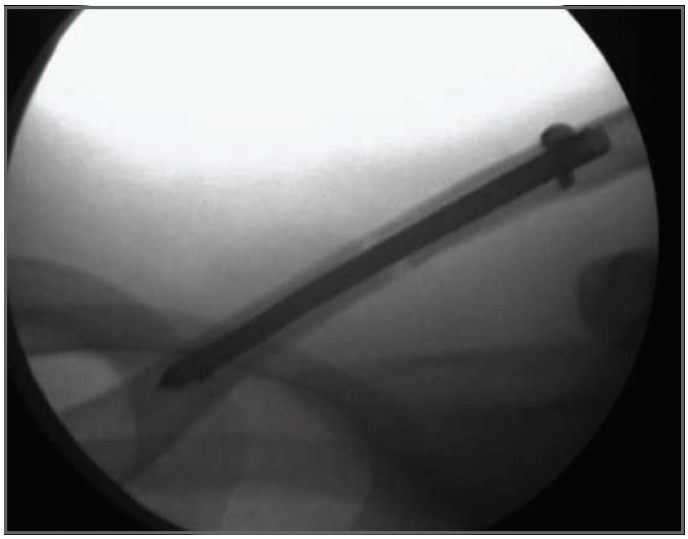
3 days post-surgery



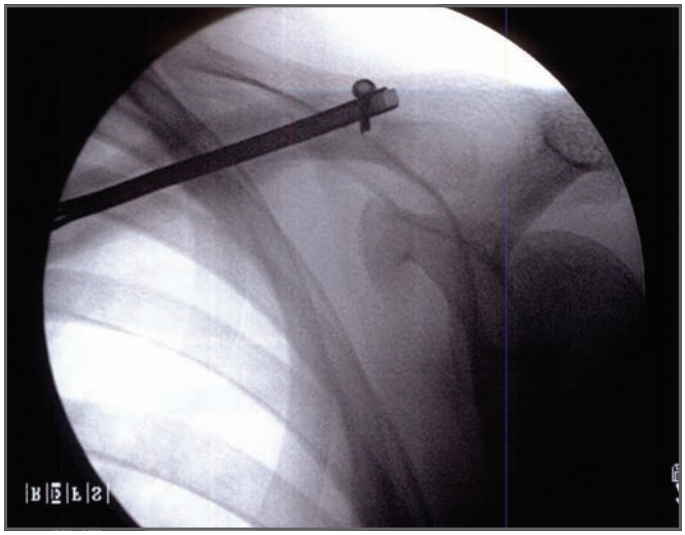
Over >

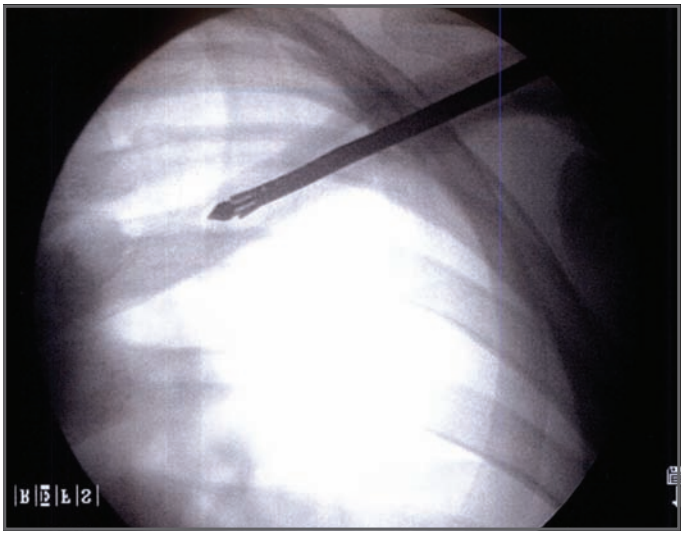
Follow-up (continued)

1 month post-surgery



5 months post-surgery





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Multiple Fragment Fractures

Acute clavicle fractures with multiple fragments. These may be single butterfly fragments, or exhibit greater degrees of comminution.

CLAVICLE FRACTURE CASE SERIES

CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

Oblique, midshaft, comminuted clavicle fracture with a large butterfly fragment, with gross displacement and shortening

Patient History

A 56 year old female presented with right clavicle fracture sustained when she crashed her scooter. A comminuted midshaft clavicle fracture was confirmed with AP and 45° cephalic tilt radiographs. The radiographs showed a long oblique fracture with a large butterfly fragment, along with gross displacement and shortening. The patient was recommended to have surgical repair of her clavicle.

Treatment Method

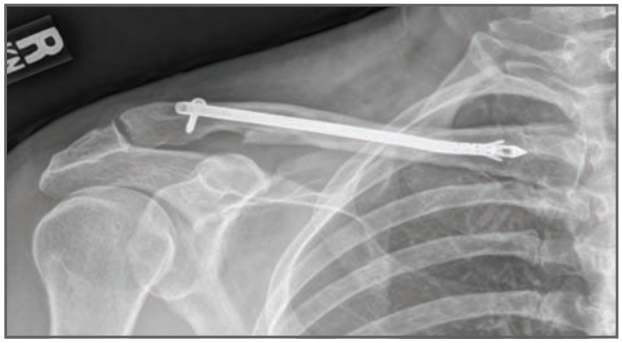
The Sonoma CRx™ was selected to repair the fracture because of its unique ability to provide completely intramedullary fixation, maintain length, and provide rotational stability. Because of the severe comminution, it was imperative to be able to provide rigid fixation and maintain length during healing. To provide additional stability, the butterfly fragment was cerclaged to using #1 PDS suture.

Post-Operative Results

Outpatient surgery was performed and the patient was allowed to perform non weight bearing activities and passive ROM immediately. The patient returned for normal checkups, and was demonstrating healing at 6 weeks post-operative. The patient had returned to full activity and had full ROM by 14 weeks post-operative.

Pre-Operative

Post Operative



CLAVICLE FRACTURE CASE SERIES

CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

Severely comminuted midshaft clavicle fracture tenting the skin over the fracture, more than 100% displaced and shortened by several centimeters

Patient History

A 25 year old male sustained a left clavicle fracture after a bike accident. He presented with a severely comminuted midshaft clavicle fracture which was tenting the skin over the fracture. Radiographs in AP and 45° cephalic tilt views confirmed that the fracture was more than 100% displaced and shortened by several centimeters. Internal fixation of the patient's left clavicle was recommended.

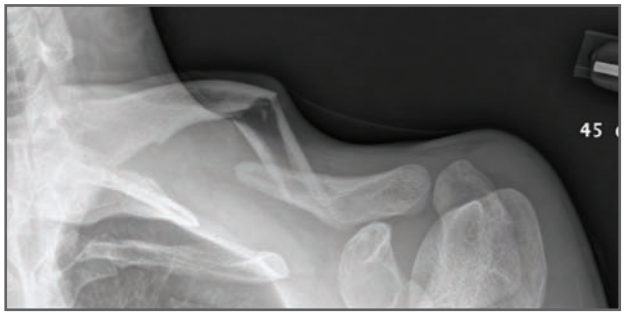
Treatment Method

Due to the high degree of comminution, it was necessary to utilize an implant that can rigidly support the fracture and maintain anatomical length. The Sonoma CRx™ was selected to repair the fracture because it is able to maintain length while rigidly supporting the fracture.

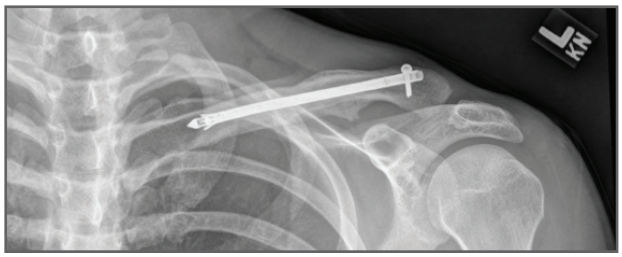
Post-Operative Results

The patient underwent outpatient surgery and was allowed to return home and perform non weight bearing ADLs and passive ROM as tolerated. Due to the young age of the patient and his high level of activity, he was recommended for hardware removal after healing. After eight months post-op, the patient underwent outpatient hardware removal.

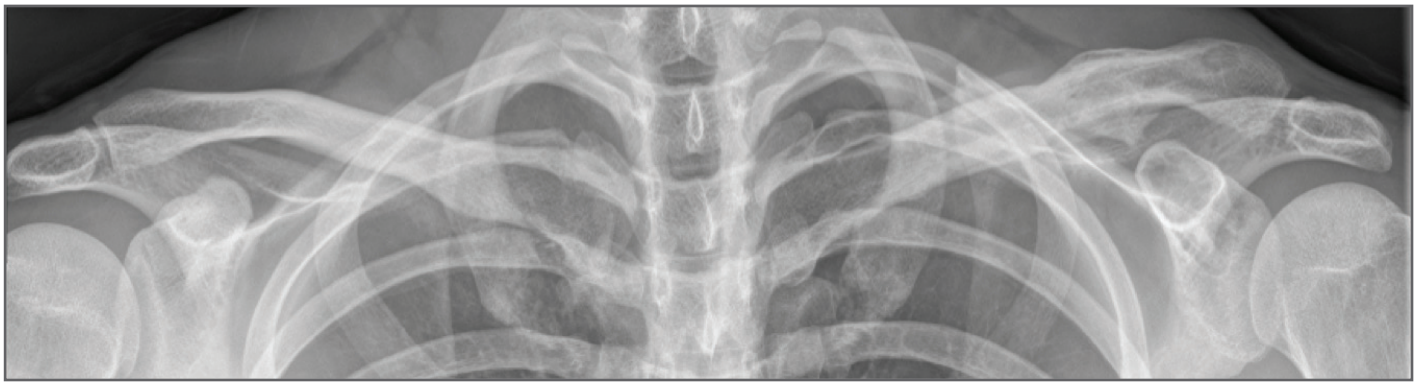
Pre-Operative



8 months Post-Operative



Post Hardware Removal



CLAVICLE FRACTURE CASE SERIES

Acute, 100% displaced and segmental complex

HEATHER GULISH-GLADWELL, M.D.
Henry County Orthopaedic Surgery and Sports Medicine
Paris, Tennessee

Patient History

This is a 15 year old male who initially presented to the emergency room after a motocross accident in which he sustained a right mid shaft femur fracture and a left clavicle fracture. Initially treatment provided for the femur fracture with intramedullary fixation, and conservative treatment for the left clavicle fracture. After fixation of his left femur fracture, he continued to complain of pain in the left clavicle area and wished to proceed with surgical intervention.

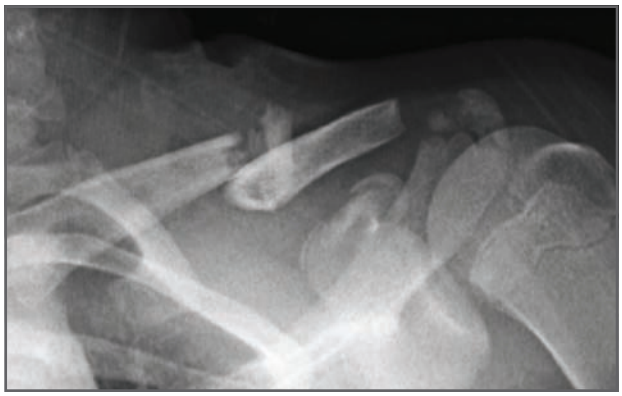
Treatment Method

Approximately five weeks post injury he underwent open reduction and internal fixation. A Sonoma CRx™ was chosen because of its minimal soft tissue trauma and intramedullary fixation. The fracture was found to be segmental but anatomic alignment was obtained.

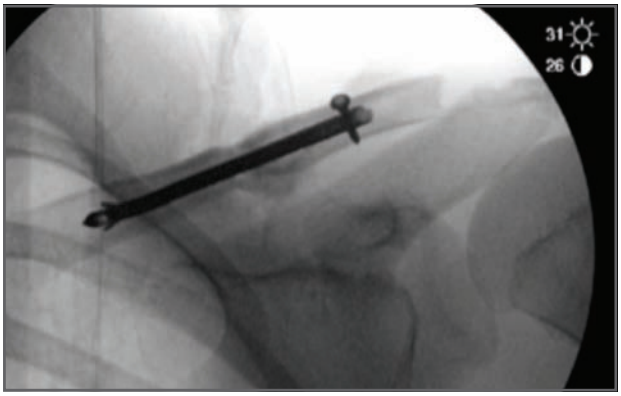
Post-operative Results

The patient underwent surgery as an outpatient and was placed into a sling and swathe with immediate post-operative range of motion but no lifting activities. At four weeks post-op he was completely asymptomatic with full range of motion. The x-ray examination showed anatomic alignment of the fracture with healing..

Pre-operative



Post-operative



Incision site with posterior instrumentation incisions

Over >

4 weeks post-op

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CLAVICLE FRACTURE CASE SERIES

Mid clavicular, segmental fracture with 100% displacement

HEATHER GULISH-GLADWELL, M.D.
Henry County Orthopaedic Surgery and Sports Medicine
Paris, Tennessee

Patient History

This is a 17 year old male who presented a right clavicle fracture after being thrown from a bull. X-rays were taken and he was placed in a sling. X-rays showed a mid clavicular, segmental fracture with a 100% displacement.

Treatment Method

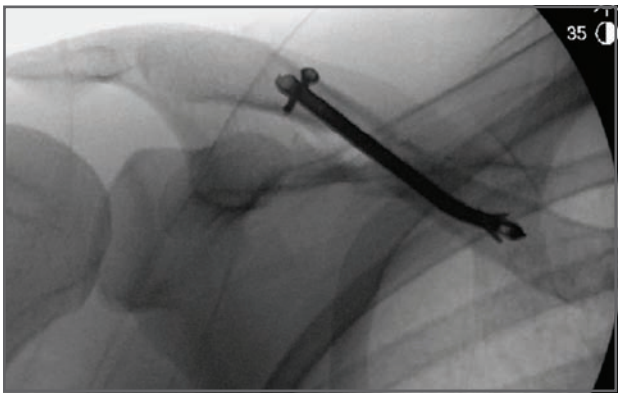
The patient underwent an open reduction, internal fixation with Sonoma CRx™. The implant clavicle device was selected because of its ability to rigidly support the segmental fracture and because of its intramedullary capabilities, smaller incision, and soft tissue trauma.

Post-operative Results

The patient underwent successful intramedullary fixation and was released as an outpatient in a sling and swathe. He was allowed to begin gentle range of motion activities immediately post-op. On his first initial post-operative evaluation, he reported minimal pain. At six weeks post-op his x-ray showed anatomic alignment of intramedullary device and abundant healing. He had no pain and full range of motion and full strength. He was allowed to return to his normal activities and bullriding.

Pre-operative

Post-operative



Right clavicle incision site with posterior instrumentation incisions

Over >

Right clavicle incision site

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CLAVICLE FRACTURE CASE SERIES

Left clavicle fracture in a 50 year old violinist

THOMAS HACKETT, M.D.
The Steadman Clinic
Vail, Colorado

Patient History

A 50 year old right-hand dominant male presented to the clinic complaining of a left clavicle injury caused by a hard fall to his left side while skiing. He was treated in the clinic and a fracture of his left clavicle was confirmed with X-rays. The patient is a professional violinist who uses his left shoulder as a rest for his violin.

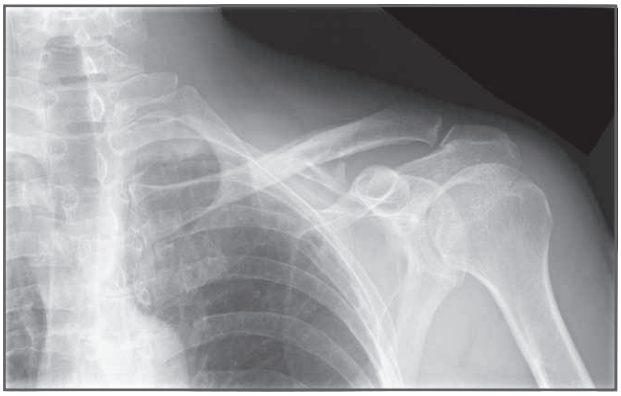
Treatment Method

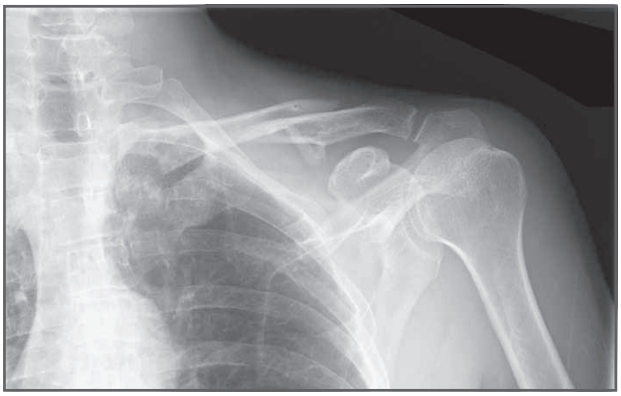
He was advised to undergo ORIF of his left clavicle and underwent fixation using the Sonoma CRx intramedullary nail. The patient tolerated the surgery well and was released home from outpatient surgery.

Post-Operative Results

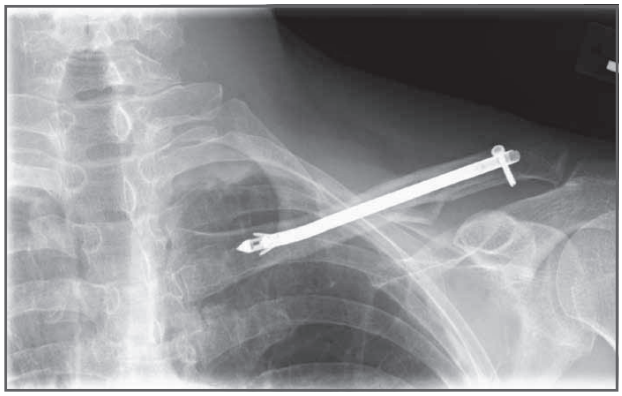
He was seen for initial follow-up nine days post-op with appropriate anatomic reduction confirmed by X-ray, and a well healing incision. At 6 weeks post-op, appropriate anatomic alignment and a healed fracture were evident by X-ray. He reported no pain or discomfort at that time and had resumed violin and recreational activities.

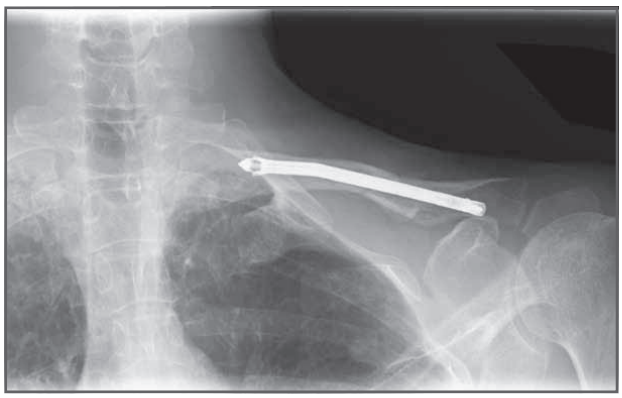
Pre-Operative





6 Weeks Post-Operative





CLAVICLE FRACTURE CASE SERIES

Midshaft displaced clavicle fracture in a 24 year old firefighter

MICHAEL HUANG, M.D.
Rocky Mountain Orthopaedic Associates
Grand Junction, CO

Patient History

A 24 year old firefighter who went over his handle bars mountain biking suffered a midshaft displaced clavicle fracture on the left side.

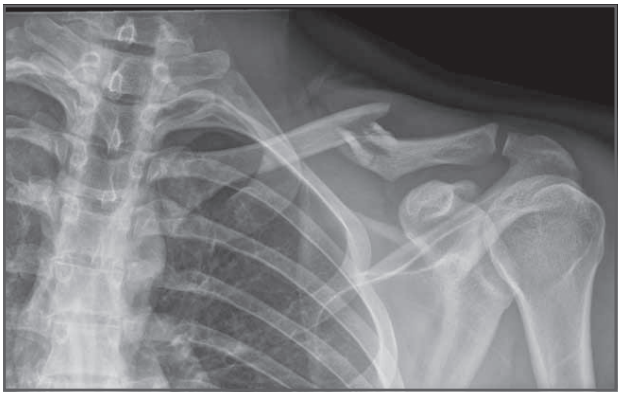
Treatment Method

He underwent open reduction and fracture fixation with the Sonoma CRx intramedullary nail as an outpatient surgery to decrease pain and restore alignment.

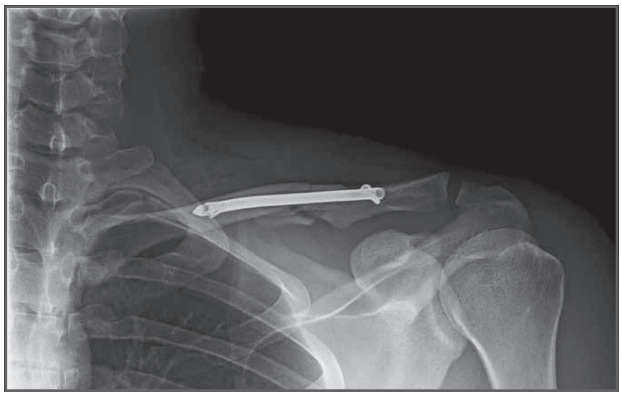
Post-Operative Results

On post-operative day one, the patient reported resolution of his fracture pain. By his second post-operative visit at 12 days, he demonstrated full active and passive range of motion. His fracture healed uneventfully and he resumed full firefighting duties at 8-10 weeks. At 3 months post-operatively, he was back on his mountain bike.

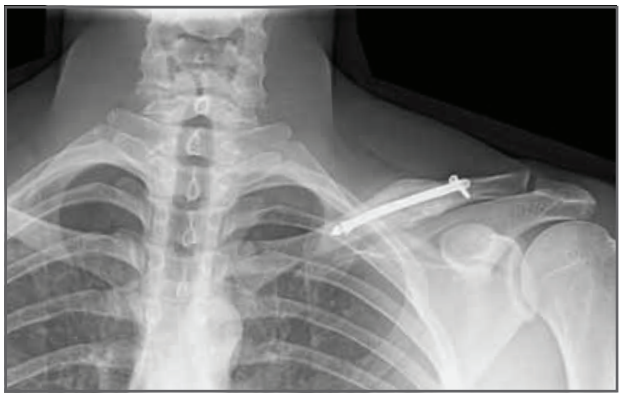
Pre-Operative



Immediately Post-Operative



12 Week Follow Up



CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman 1 (middle third), Single fragment – butterfly segment, AP displacement – 28 mm, Shortening – 10 mm

Patient

21-year-old male

Mechanism of injury

Pedestrian vehicle accident

Restoration of length

3mm shortening post reduction and union compared to normal contralateral clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

Outcome of treatment

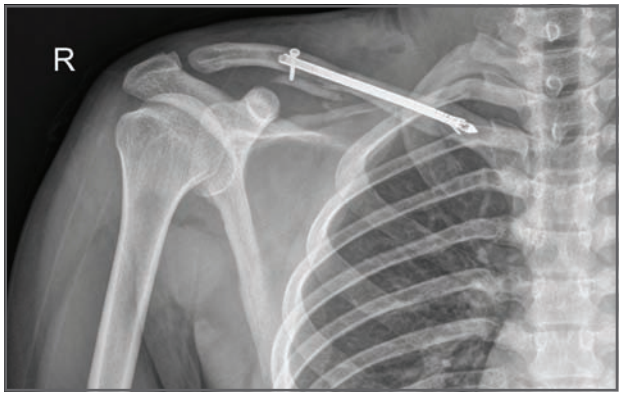
- ROM - full
- Dash score – 5 at 3 months
- Fracture united

Additional fracture stabilization

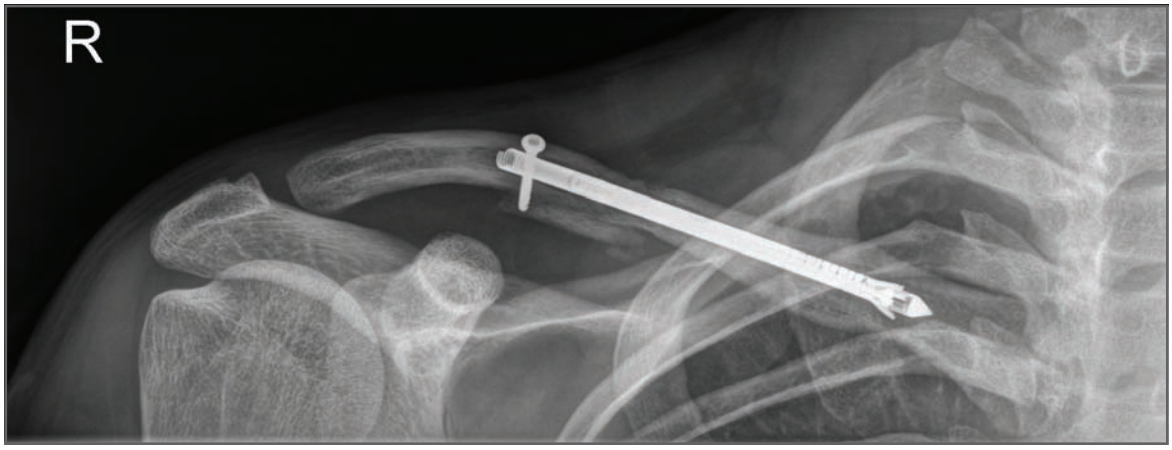
Circlage braided suture to secure butterfly segment in position

Pre-op

Immediate post-op



Six weeks



CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), Single fragment – butterfly segment at fracture site, AP displacement – 26 mm, Shortening – 20 mm

Patient

42-year-old male

Mechanism of injury

Direct blunt trauma

Restoration of length

5 mm shortening post union compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

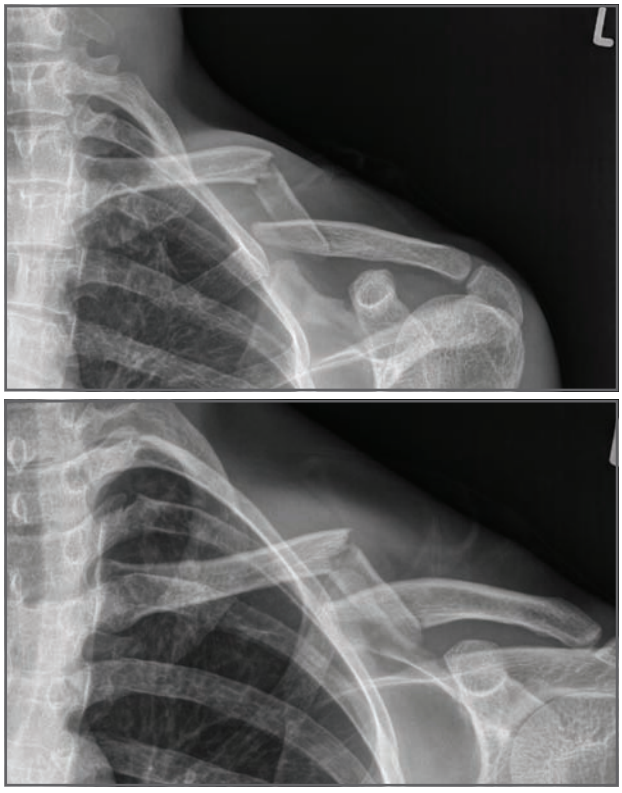
Outcome of treatment

- ROM - full
- Dash score – 0 at 3 months
- Fracture united

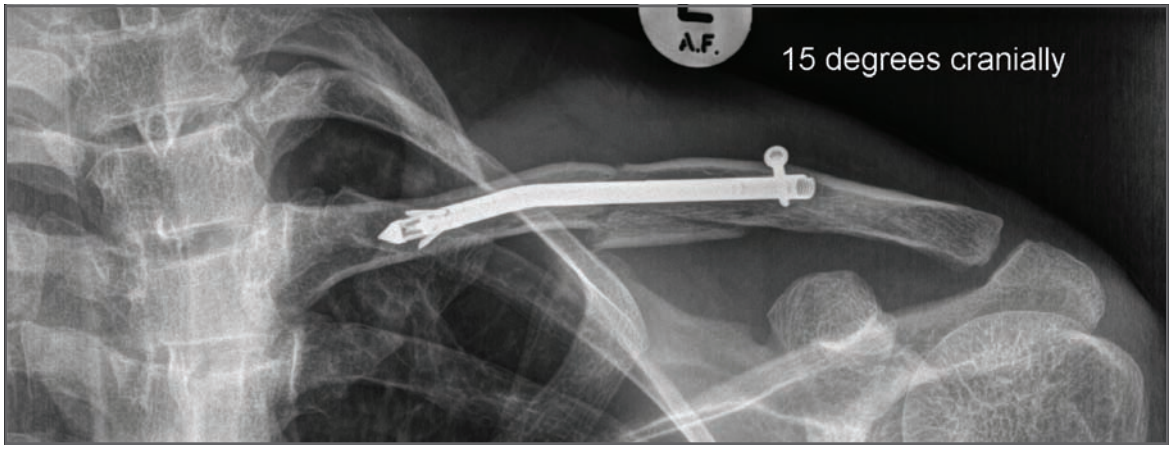
Additional fracture stabilization

Circlage braided suture securing fragments at fracture site

Pre-op

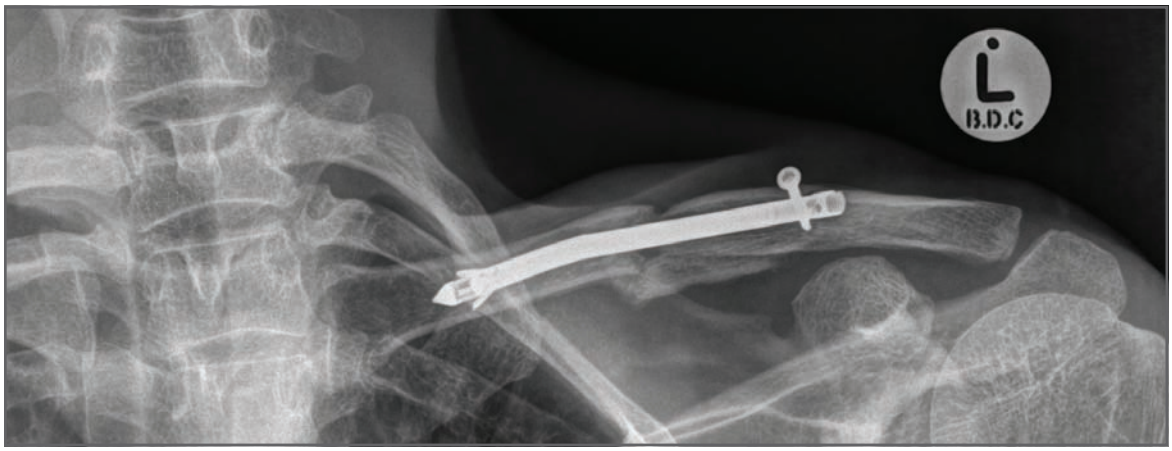


Immediate post-op

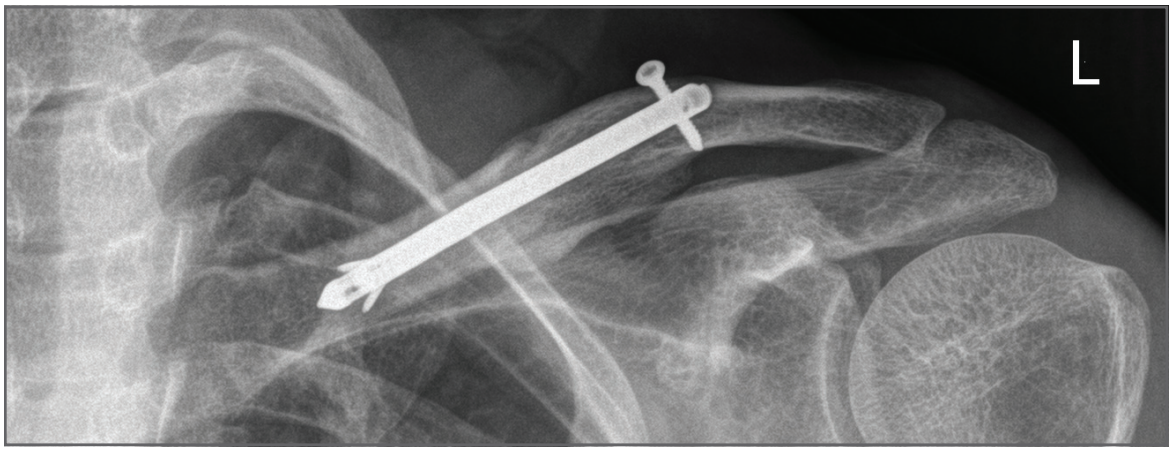


Over >

6 weeks



4 months



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CLAVICLE FRACTURE CASE SERIES

Allman I (middle third), 2 or more fragment – comminution at fracture site, AP displacement – 5 mm, Shortening – 5 mm

REGGIE KING, M.D.
Cape Town
South Africa

Patient

28-year-old female

Mechanism of injury

Motor vehicle accident

Restoration of length

1mm shortening post reduction and fracture healing compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

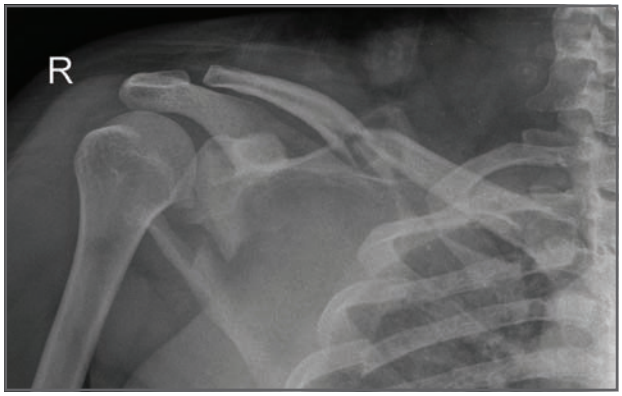
Outcome of treatment

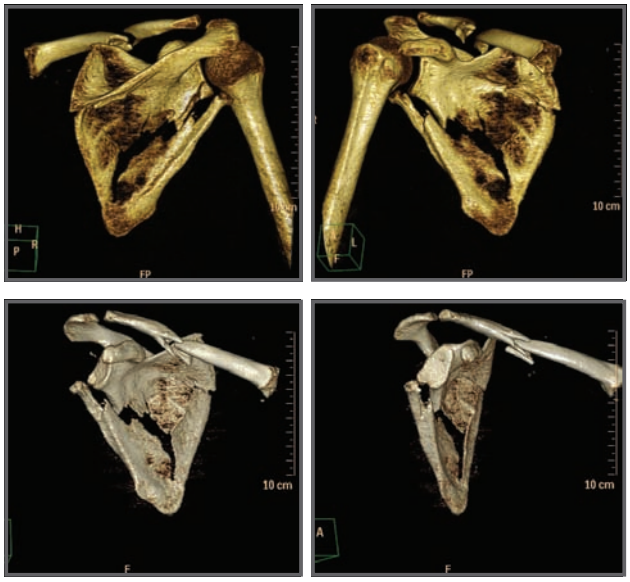
- ROM - 90% of normal in all planes shoulder ROM
- Dash score – 70 at 6 months
- Fracture united

Additional fracture stabilization

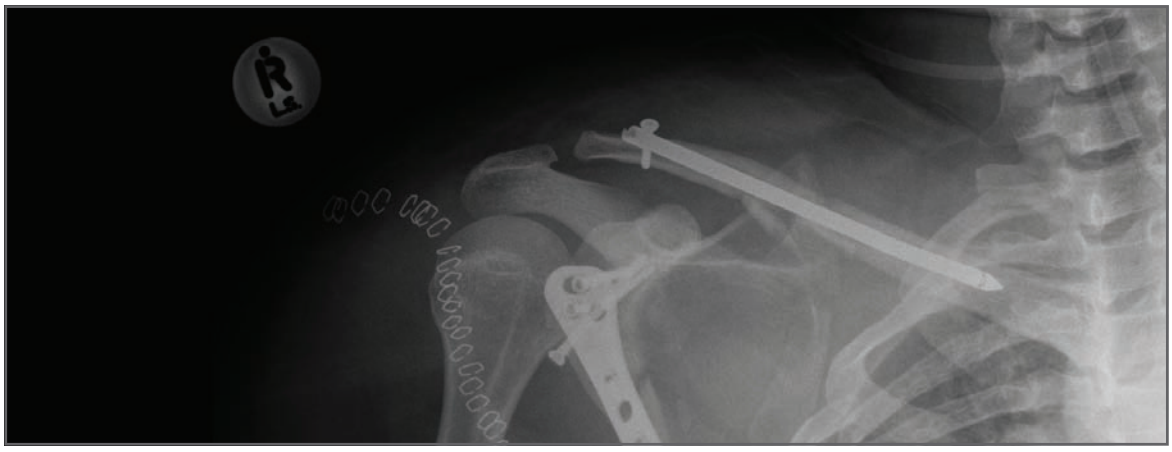
None

Pre-op



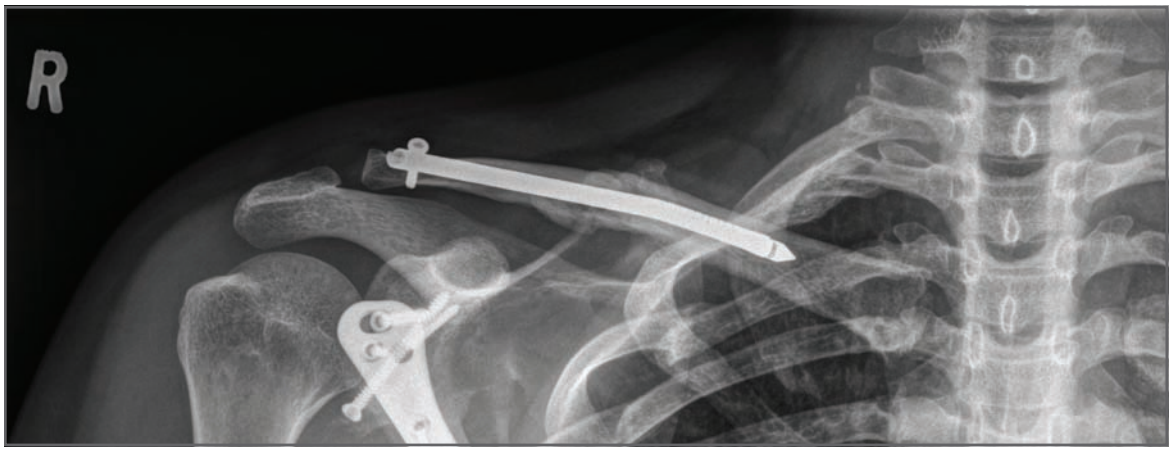


Immediate post-op

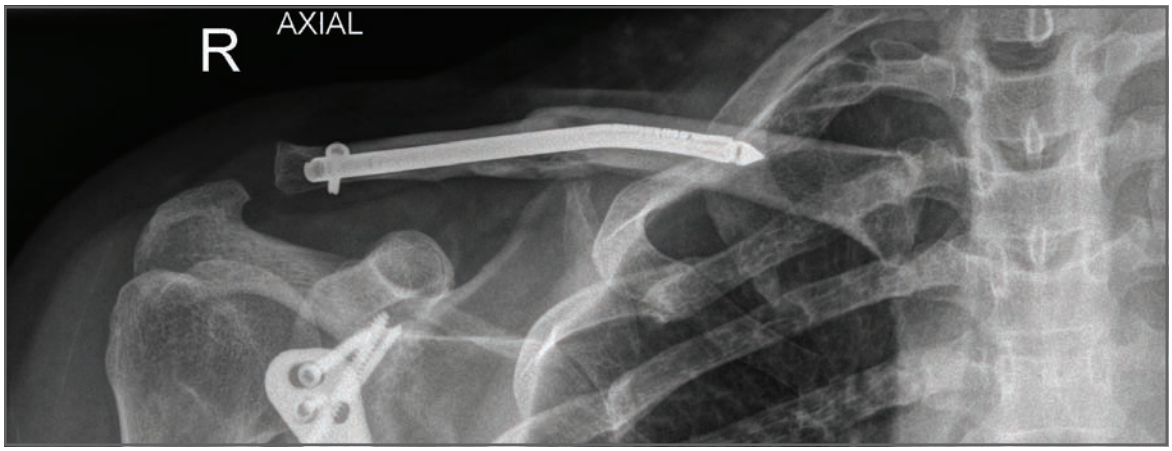


Over >

4 months



10 months



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CLAVICLE FRACTURE CASE SERIES

Allman I (middle third), Single fragment – butterfly segment at fracture site, AP displacement – 25 mm, Shortening – 25 mm

REGGIE KING, M.D.
Cape Town
South Africa

Patient

38-year-old male

Mechanism of injury

Motorbike accident

Restoration of length

10 mm shortening post fracture healing compared to normal contralateral clavicle

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

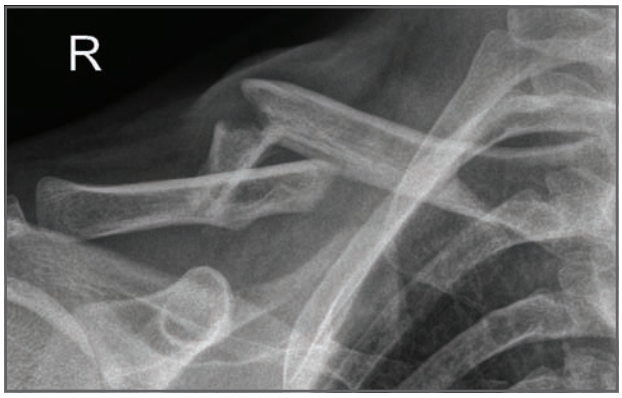
Outcome of treatment

- ROM - full
- Dash score – 7,5 at 3 months
- Fracture united

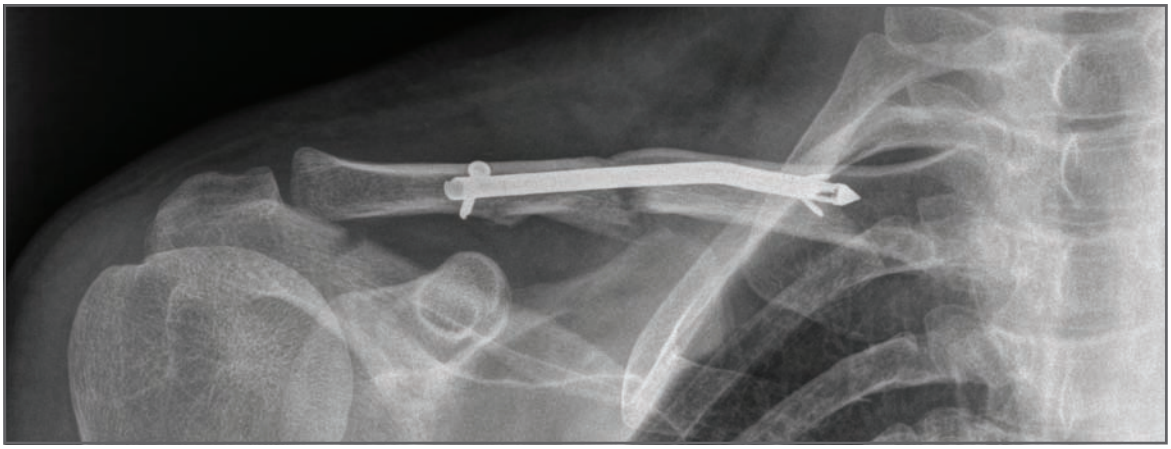
Additional fracture stabilization

Circlage braided suture securing butterfly segment

Pre-op

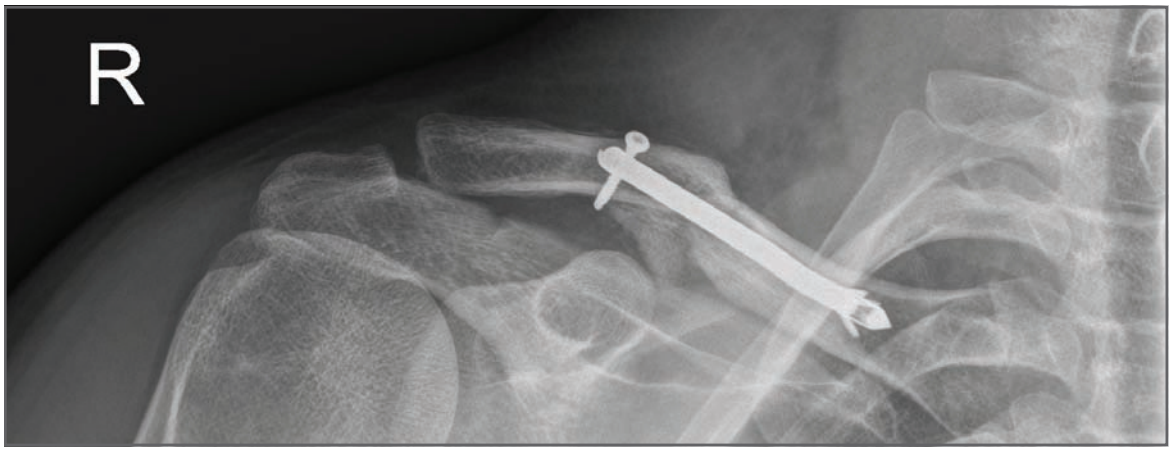


Immediate post-op

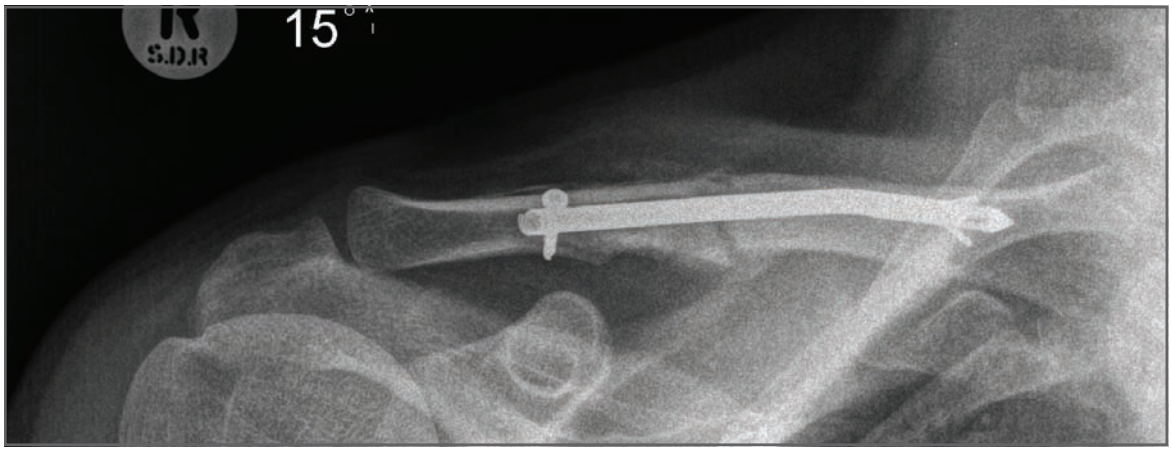


Over >

6 weeks



3 months



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CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I bilateral fractures: Simple – transverse left, Single fragment fracture – butterfly segment right; AP displacement – left 8 mm, right 6mm; Shortening – left 10 mm, right 12 mm

Patient

26-year-old female

Mechanism of injury

Motor vehicle accident

Associated injuries

- Acetabulum fracture
- Severe lung contusion
- ICU admission due to ventilation problems – clavicles fixed in order to improve ventilation (accessory breathing muscles attach to clavicles – fractures cause pain while breathing)

Post op regime

Patient was prone for first 6 weeks – had ORIF of acetabulum. Normal activity of shoulders commenced after 6 weeks.

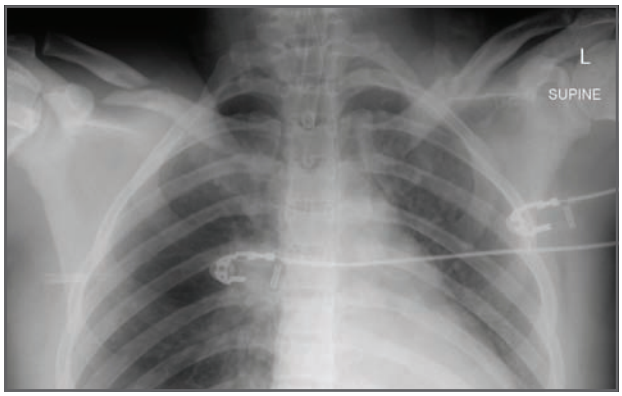
Outcome of treatment

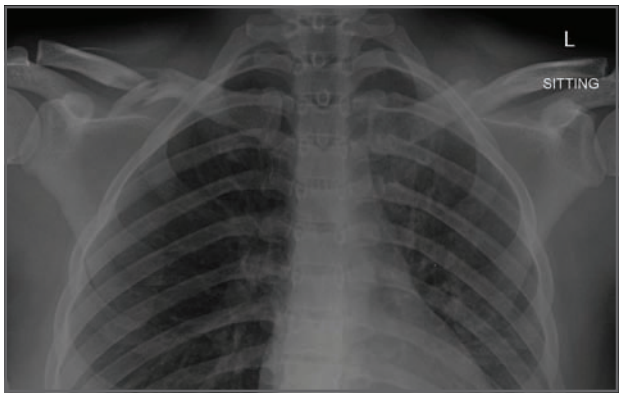
- ROM - full
- Dash score – 0 at 6 months
- Fractures united bilateral
- Gone back to previous employment as manual labourer on a farm!

Additional fracture stabilization

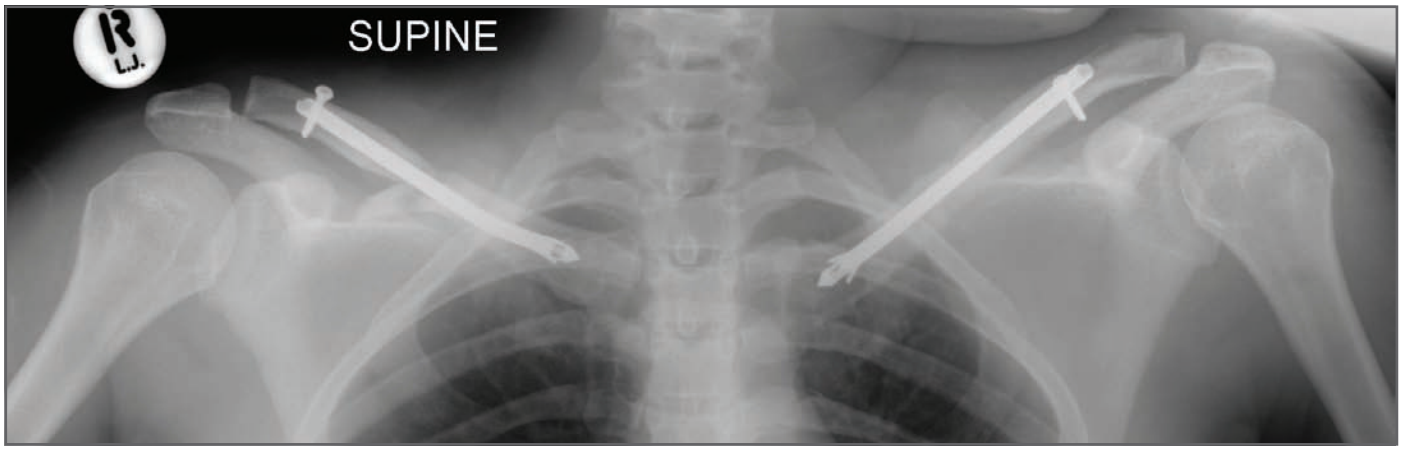
None

Pre-op





Immediate post-op



Over >

CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), Single fragment – butterfly segment at fracture site, AP displacement – 18 mm, Shortening – 18 mm

Patient

38-year-old female

Mechanism of injury

Motor vehicle accident

Restoration of length

2mm shortening post fracture healing compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

Outcome of treatment

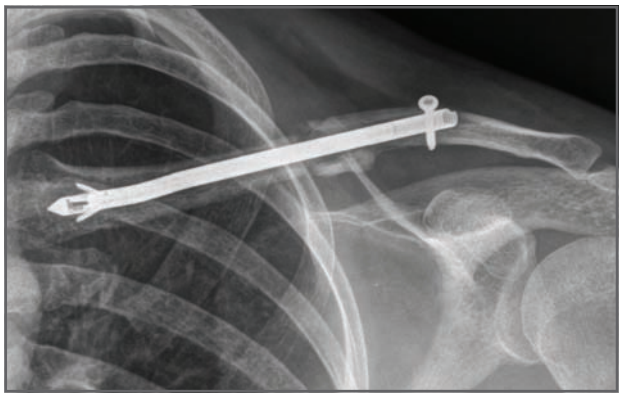
- ROM - full
- Dash score – 10 at 3 months
- Fracture united

Additional fracture stabilization

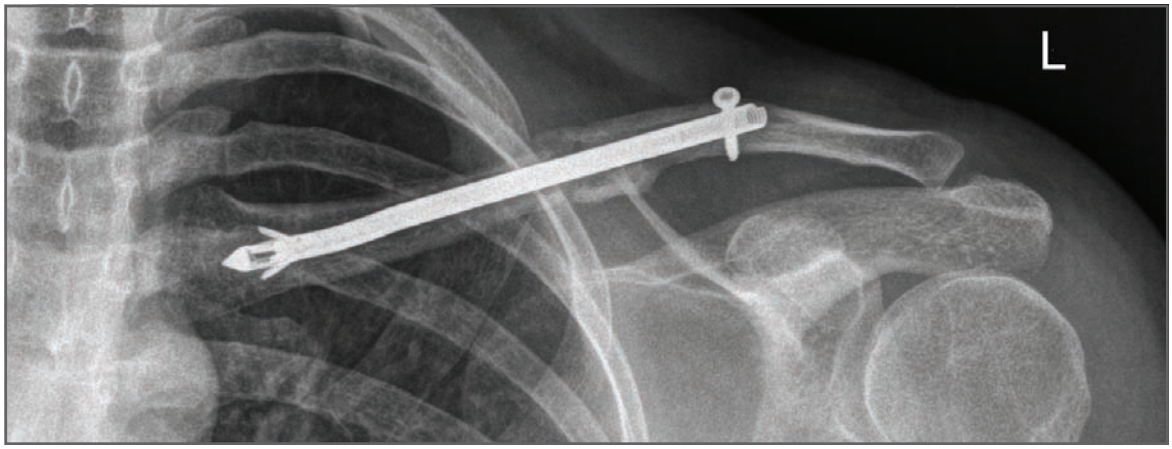
Circlage braided suture securing butterfly segment after reduction.

Pre-op

Immediate post-op



3 months



CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), 2 or more fragment – comminuted fracture, AP displacement – 14 mm, Shortening – 35 mm

Patient

24-year-old male

Mechanism of injury

Motorbike accident

Restoration of length

1mm shortening post fracture healing compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

Outcome of treatment

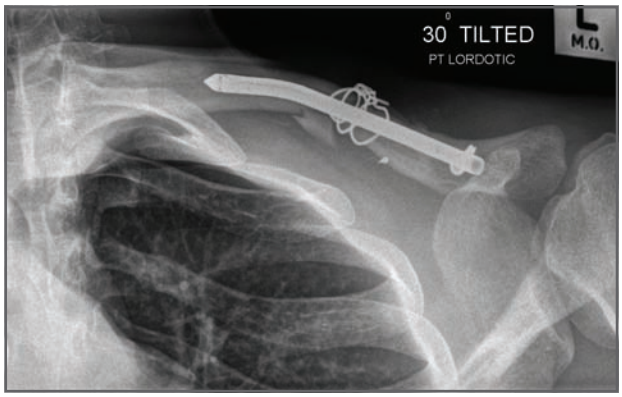
- ROM - full
- Dash score – 9 at 3 months
- Fracture united

Additional fracture stabilization

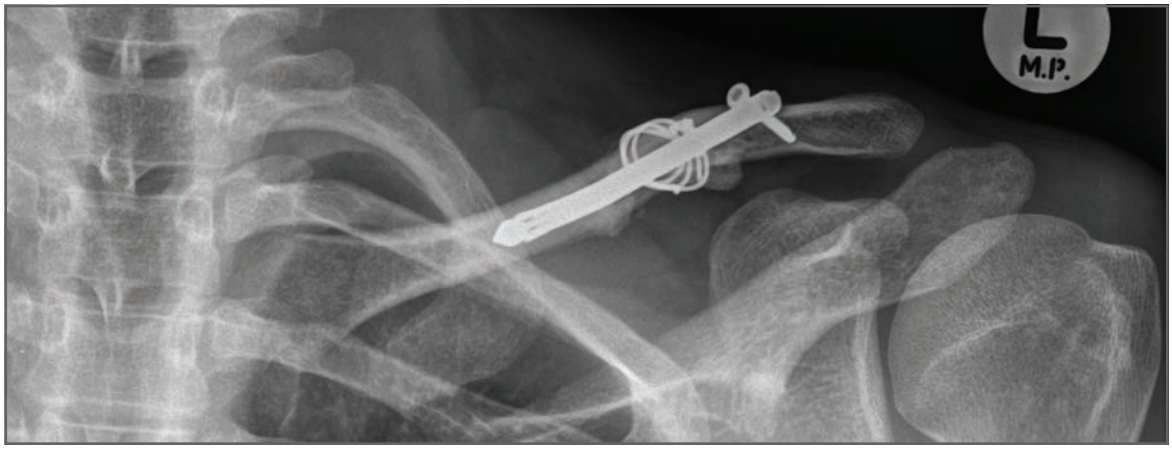
Circlage dental wire securing fragments at fracture site after reduction..

Pre-op

Immediate post-op

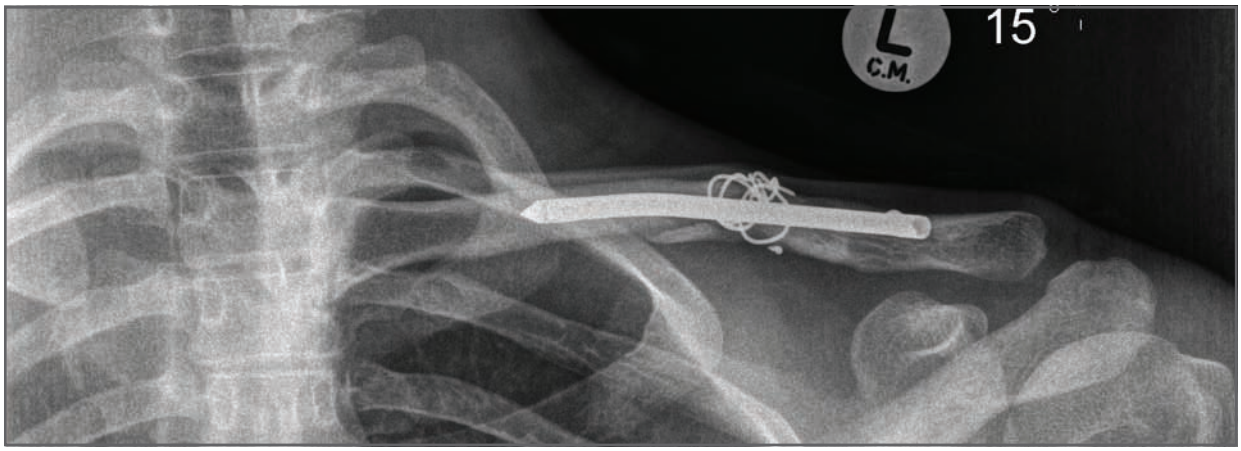


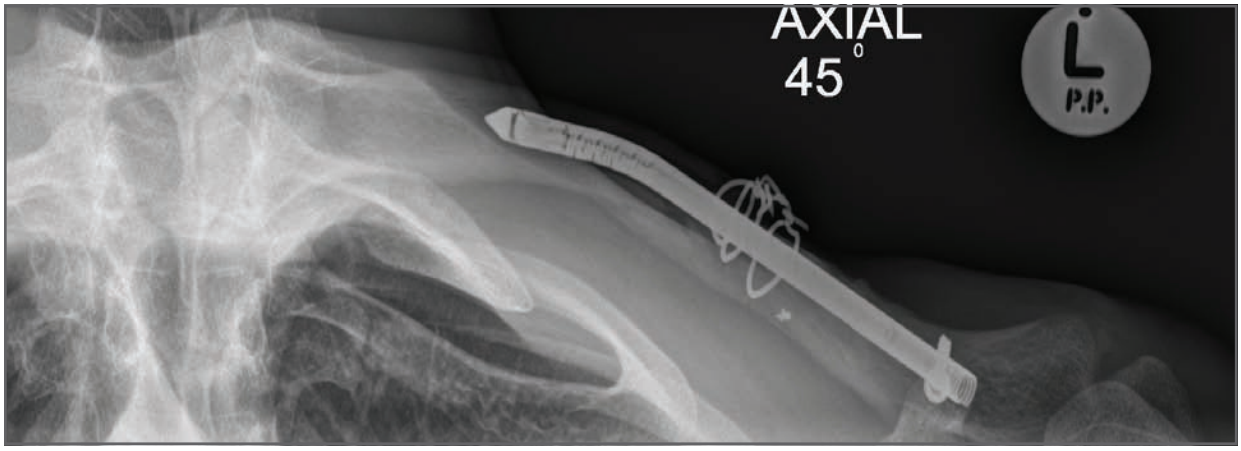
6 weeks



Over >

3 months





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CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), Single fragment – butterfly segment at fracture site, AP displacement – 20 mm, Shortening – 30 mm

Patient

28-year-old female

Mechanism of injury

Motor vehicle accident

Restoration of length

0mm shortening post fracture healing compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

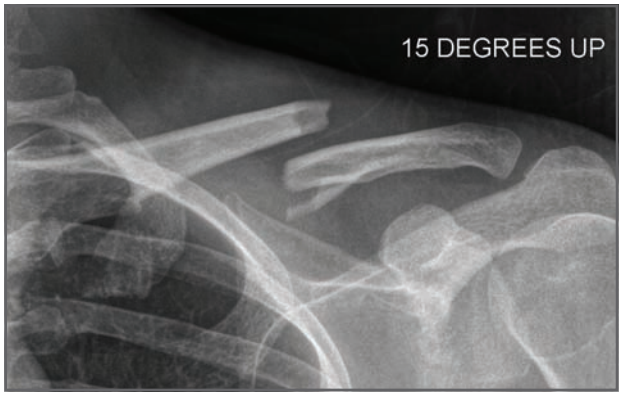
Outcome of treatment

- ROM - full
- Dash score – 19 at 3 months
- Fracture united

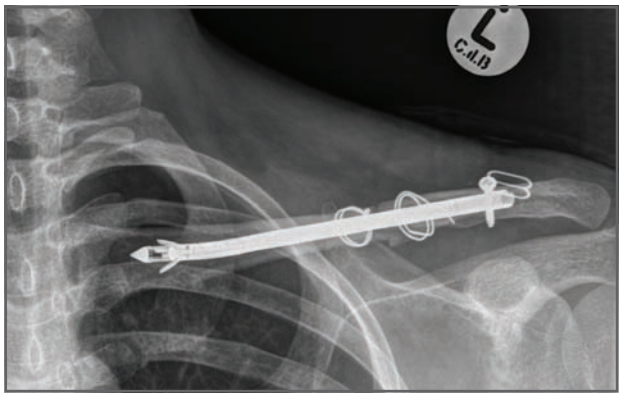
Additional fracture stabilization

Circlage dental wire securing butterfly segment at fracture site after reduction..

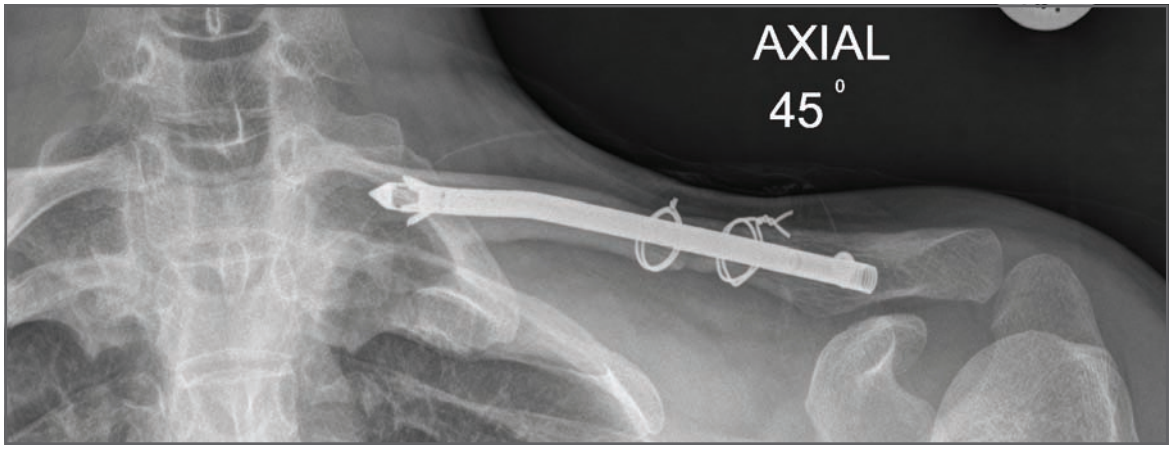
Pre-op



Immediate post-op

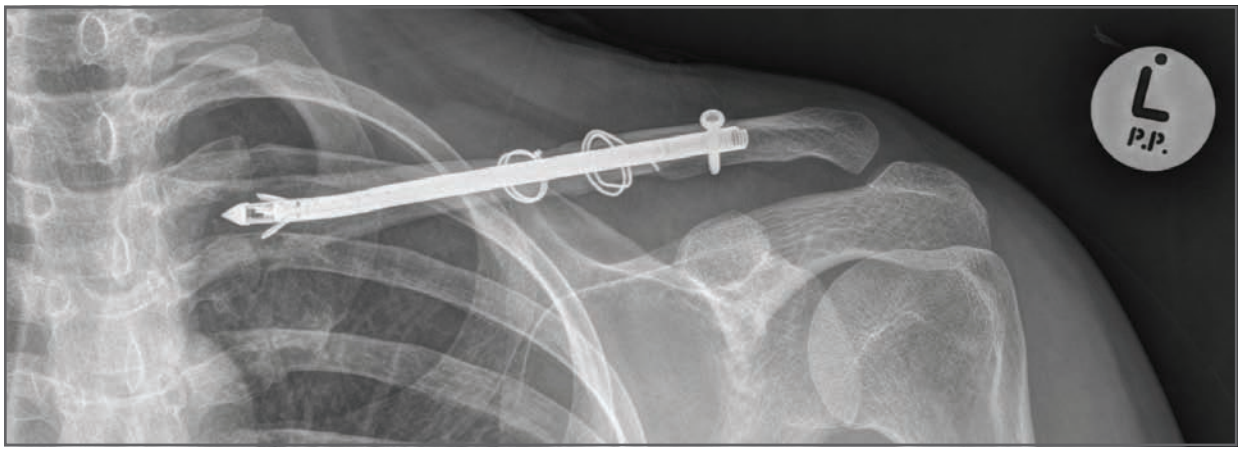


5 months



Over >

5 months



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CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), 2 or more fragment – comminuted fracture, AP displacement – 28 mm, Shortening – 14 mm

Patient

32-year-old female

Mechanism of injury

Motor vehicle accident

Restoration of length

4mm shortening post fracture healing compared to contralateral normal clavicle

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

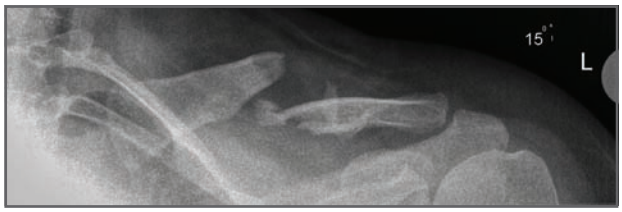
Outcome of treatment

- ROM - full
- Dash score – 15 at 3 months
- Fracture united

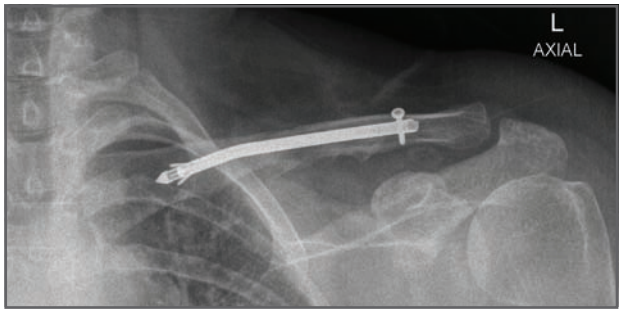
Additional fracture stabilization

None

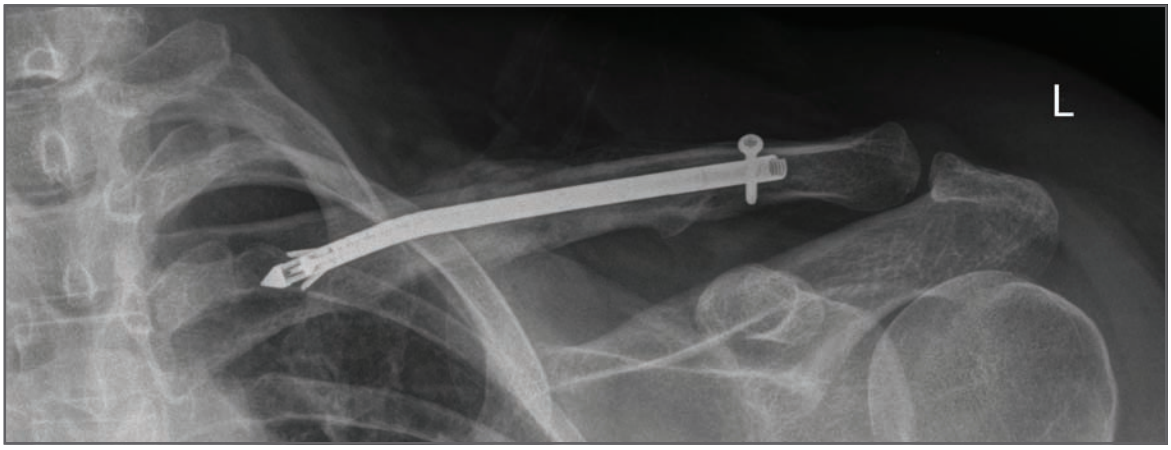
Pre-op



Immediate post-op

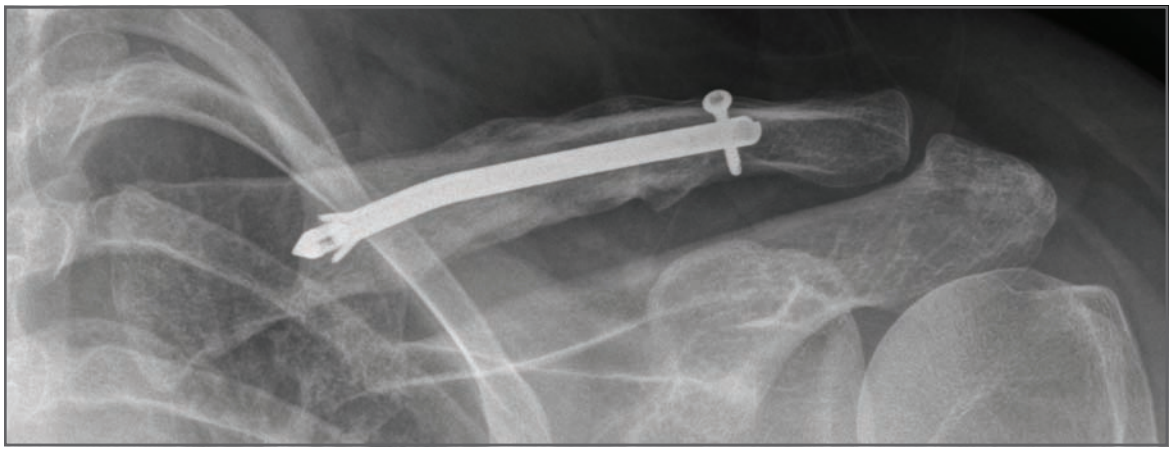


6 weeks

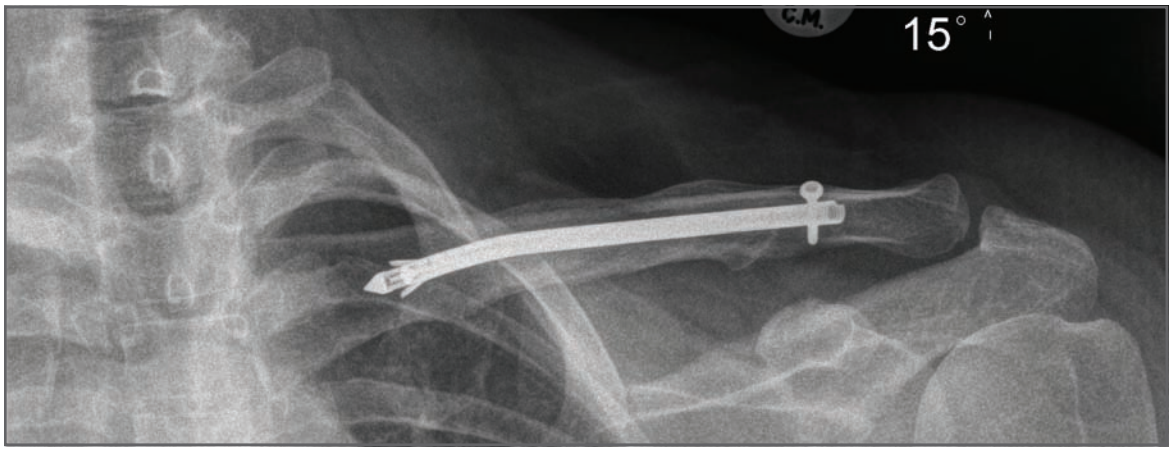


Over >

3 months



8 months



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CLAVICLE FRACTURE CASE SERIES

Allman I (middle third), 2 or more fragment – comminuted fracture, AP displacement – 14 mm, Shortening – 17 mm

REGGIE KING, M.D.
Cape Town
South Africa

Patient

38-year-old male

Mechanism of injury

Motorbike accident

Restoration of length

13mm post fracture healing compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

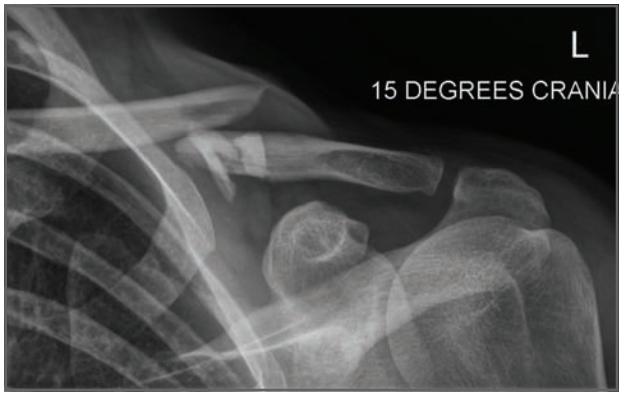
Outcome of treatment

- ROM - full
- Dash score – 1 at 3 months
- Fracture united

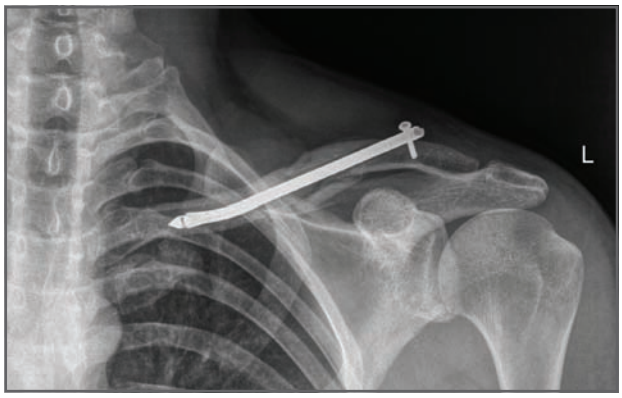
Additional fracture stabilization

Circlage braided suture securing butterfly segment post reduction..

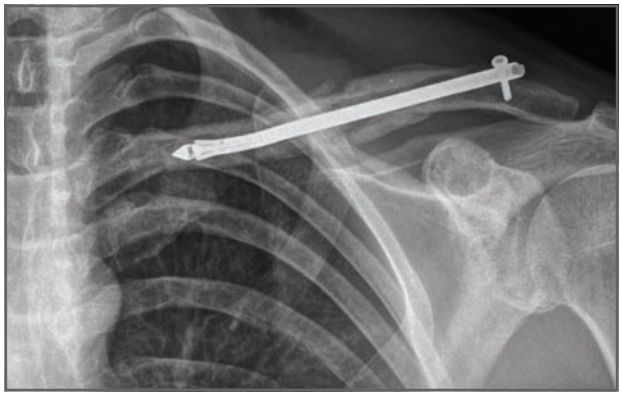
Pre-op

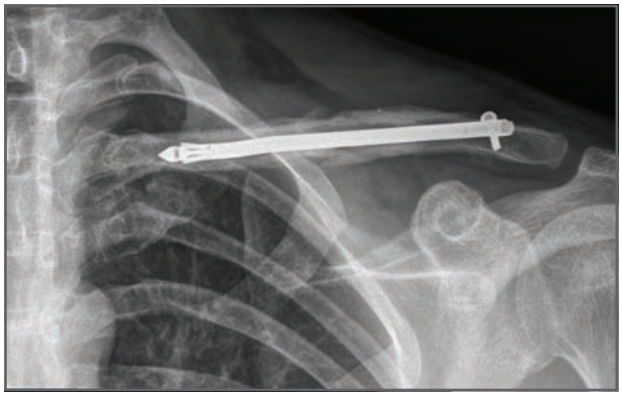


Six Weeks



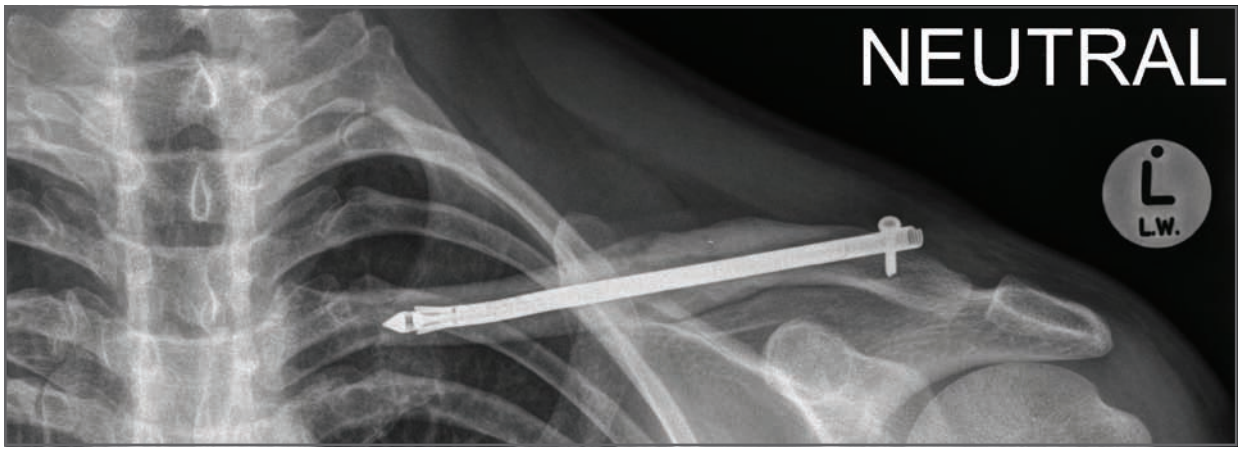
3 months

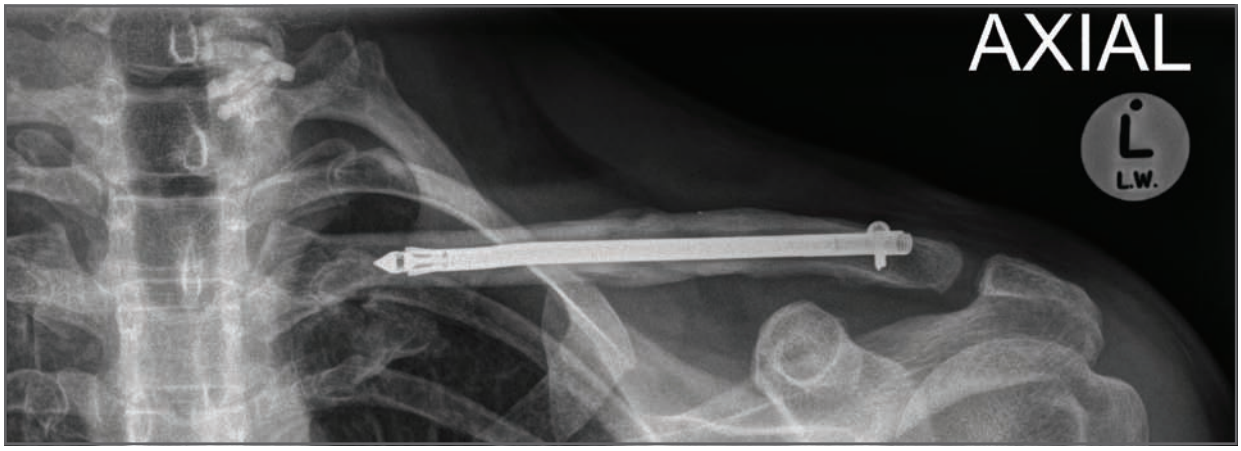




Over >

6 months





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CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), 2 or more fragment – comminuted fracture, AP displacement – 13 mm, Shortening – 22 mm

Patient

32-year-old male

Mechanism of injury

Mountain bike accident

Implant removal

Scheduled for 9 months post-op – wants to return to mountain biking.

Restoration of length

5mm shortening post fracture union compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

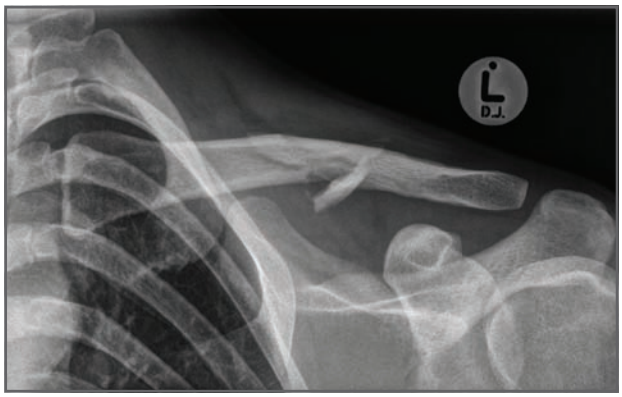
Outcome of treatment

- ROM - full
- Dash score – 0 at 6 months
- Fracture united

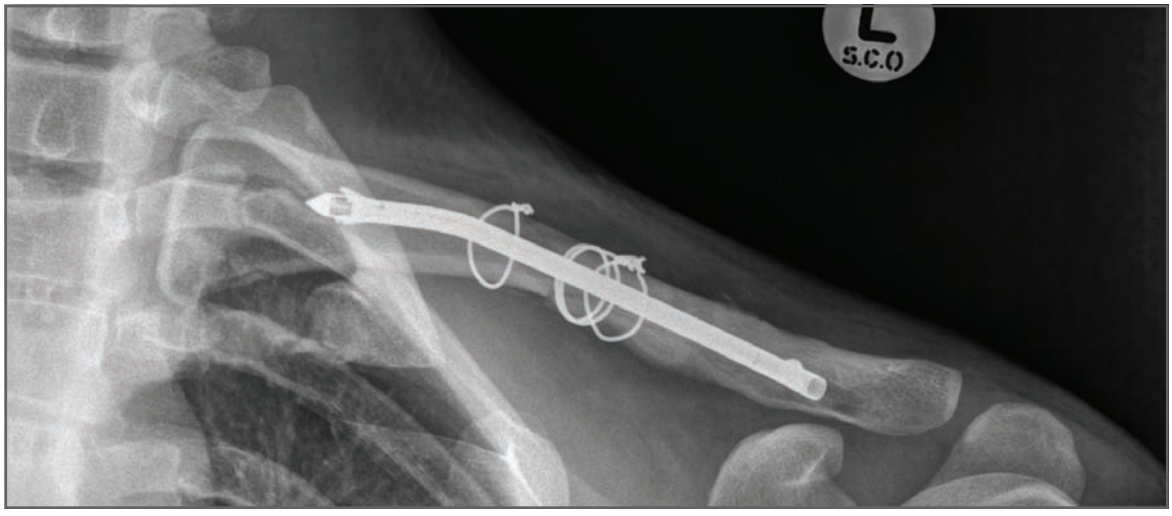
Additional fracture stabilization

Circlage dental wire securing fragments at fracture site.

Pre-op

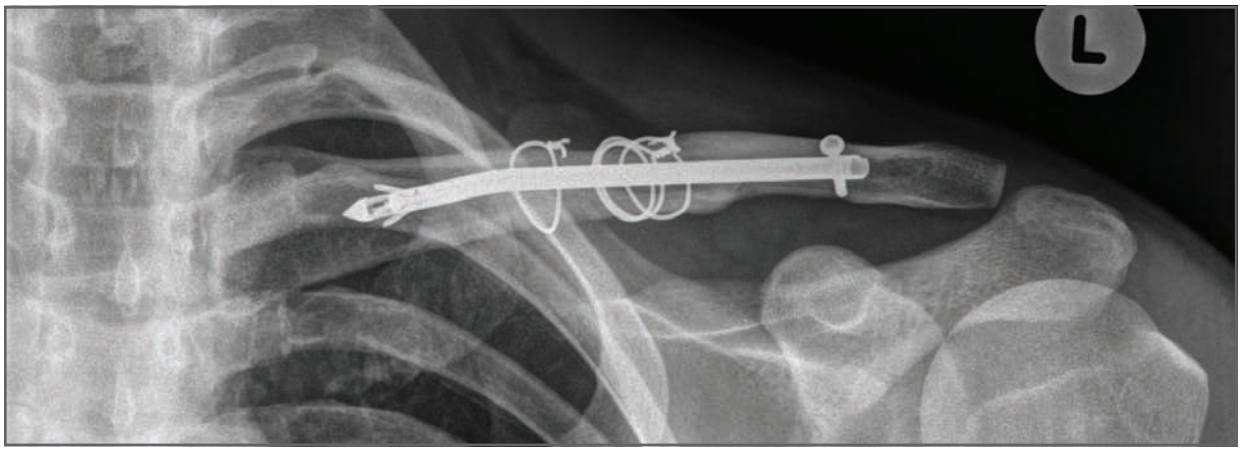


Immediate post-op

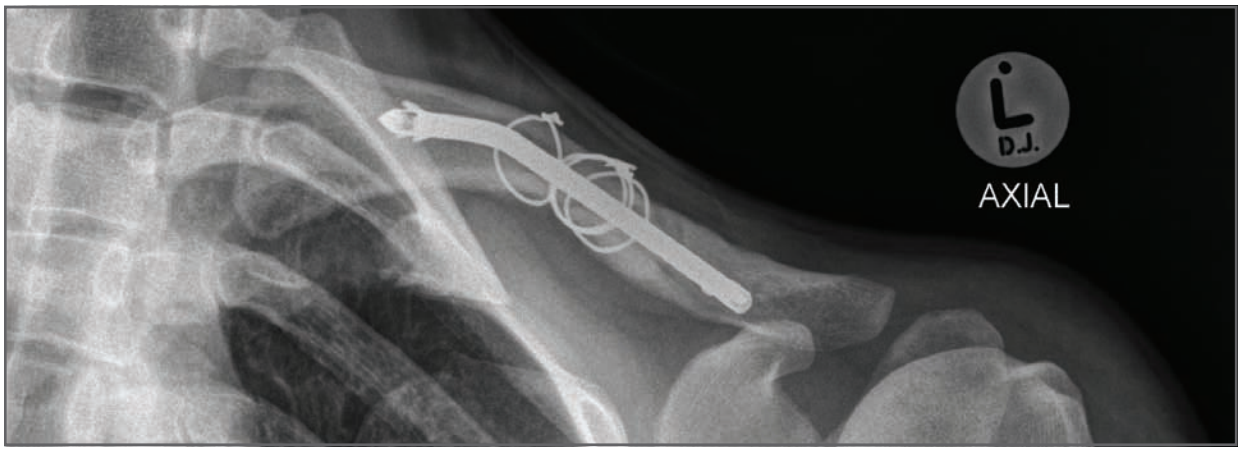


Over >

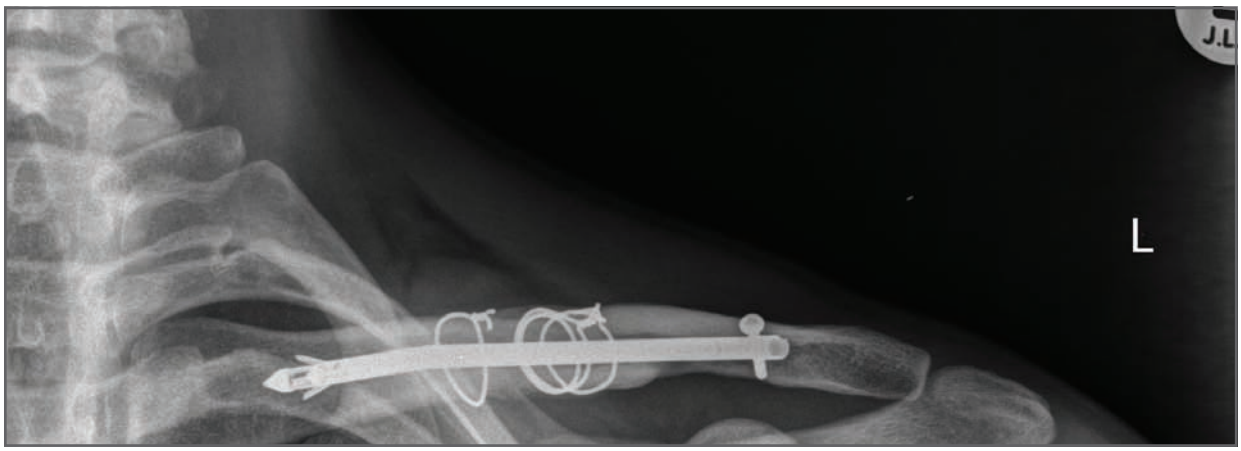
6 weeks



3 months



6 months



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CLAVICLE FRACTURE CASE SERIES

Allman I (middle third), ingle fragment fracture – butterfly segment, AP displacement – 23 mm, Shortening – 18 mm

REGGIE KING, M.D.
Cape Town
South Africa

Patient

31-year-old male

Mechanism of injury

Motor vehicle accident

Restoration of length

4mm shortening post fracture union compared to contralateral normal clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

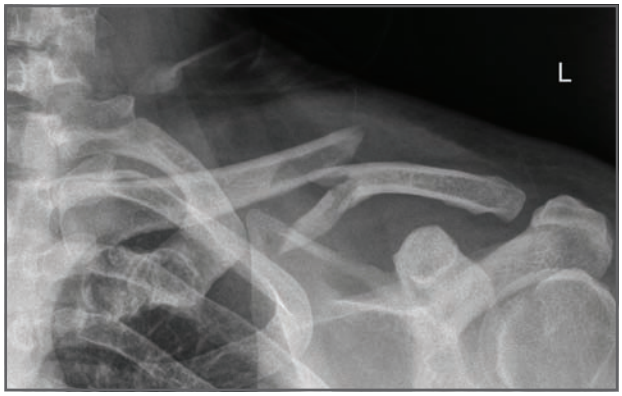
Outcome of treatment

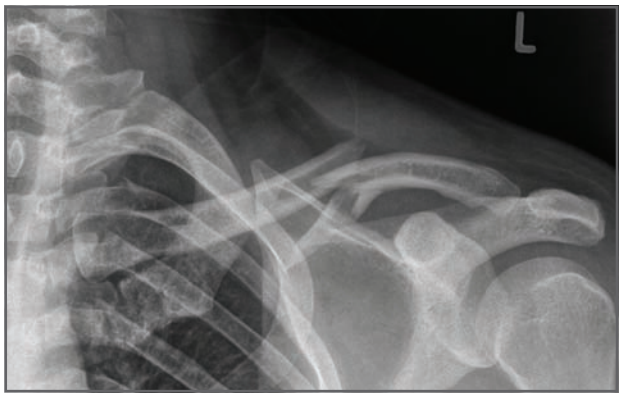
- ROM - full
- Dash score – 12 at 6 months

Additional fracture stabilization

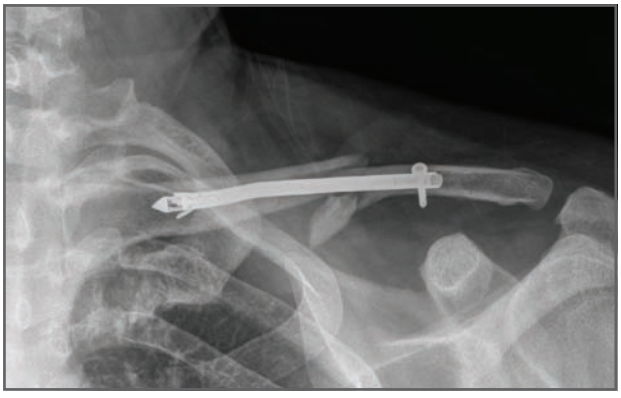
Circlage braided suture securing fragment at fracture site.

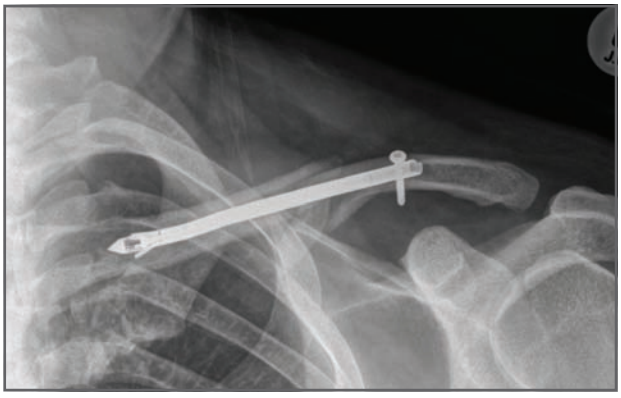
Pre-op





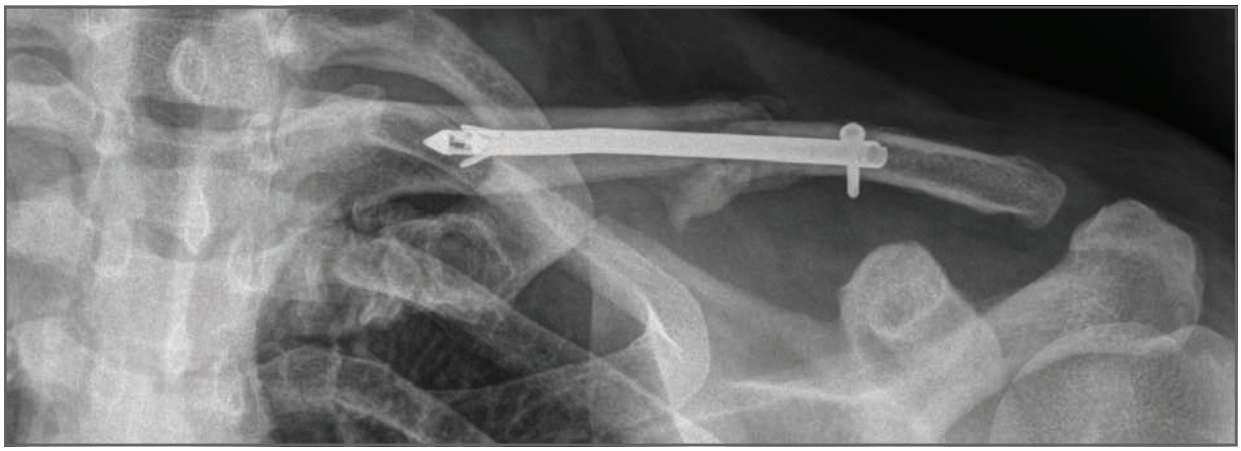
Immediate post-op



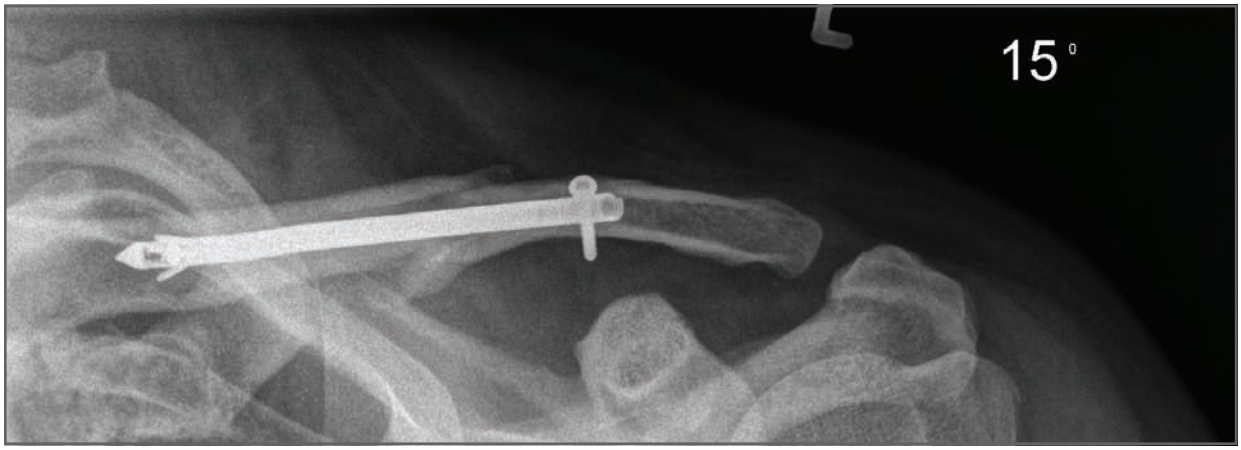


Over >

3 months



7 months



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CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), Single fragment fracture– butterfly segment at fracture site, AP displacement – 18 mm, Shortening – 15 mm

Patient

15-year-old male

Mechanism of injury

Rugby injury

Implant removal

Removed at 9 months – uneventful

Indication – young person playing contact sport (rugby)

Restoration of length

3mm shortening post fracture union compared to normal contralateral clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

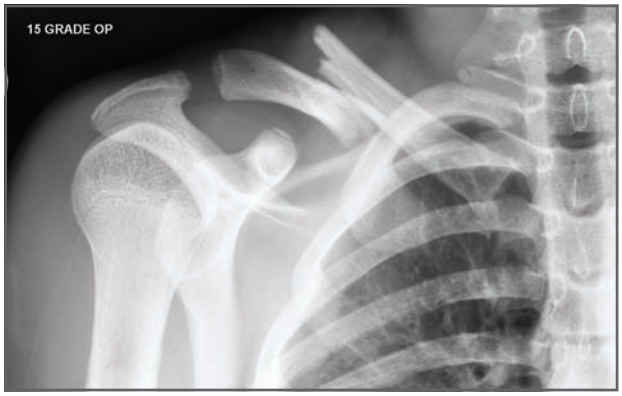
Outcome of treatment

- ROM - full
- Dash score – 0 at 3 months
- Fracture united

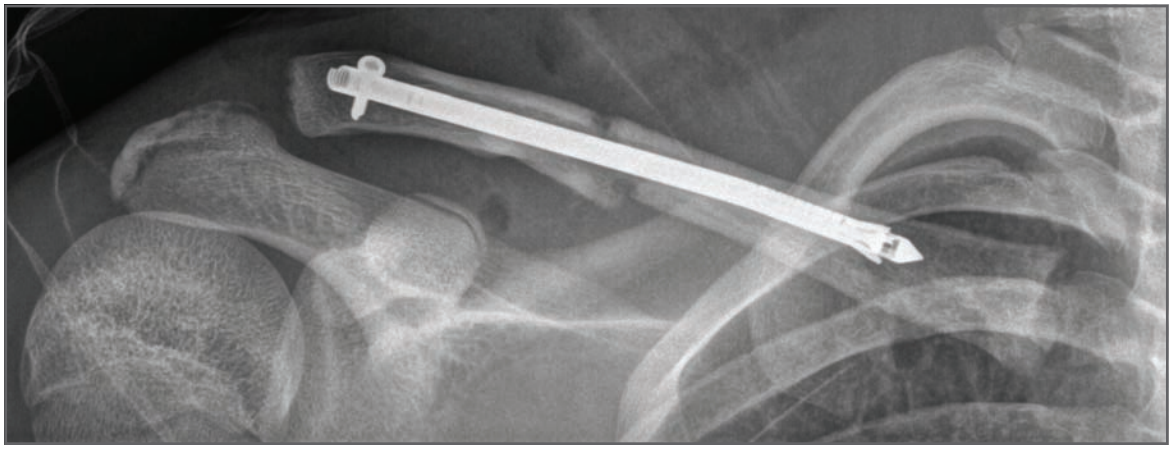
Additional fracture stabilization

None

Pre-op

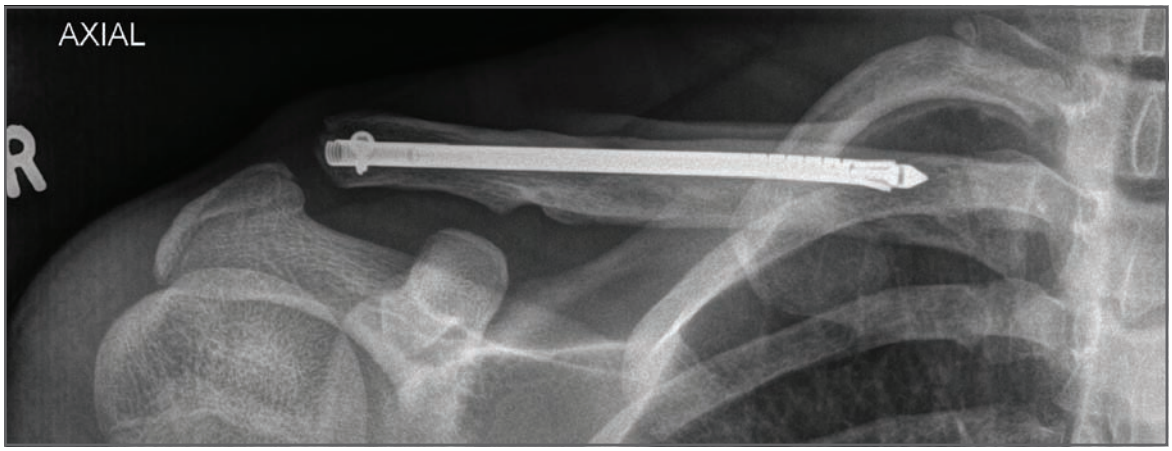


Immediate post-op



Over >

8 months



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CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), Single fragment fracture– butterfly segment at fracture site, AP displacement – 25 mm, Shortening – 19 mm

Patient

29-year-old female

Mechanism of injury

Fall on point of shoulder

Restoration of length

2mm shortening post fracture union compared to contralateral intact clavicle .

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

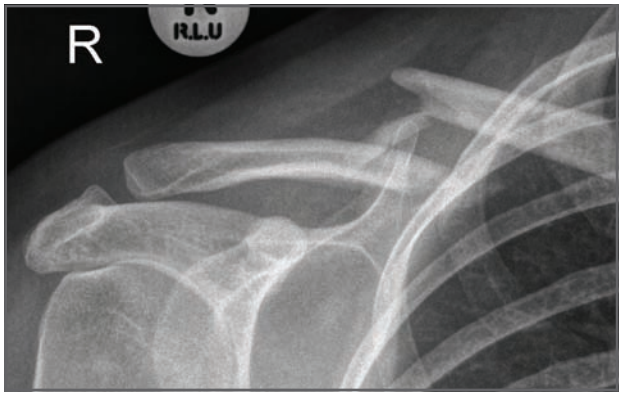
Outcome of treatment

- ROM - full
- Dash score – 12.5 at 3 months

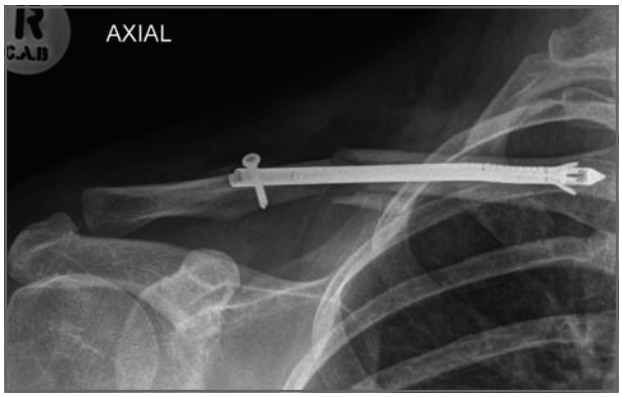
Additional fracture stabilization

Circlage braided suture securing butterfly fragment.

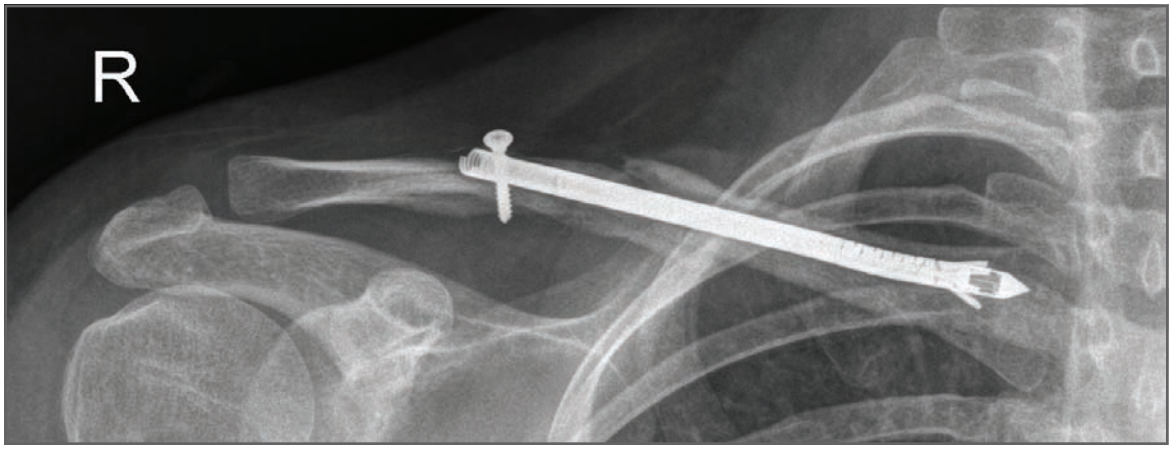
Pre-op



Immediate post-op



2 months



CLAVICLE FRACTURE CASE SERIES

REGGIE KING, M.D.
Cape Town
South Africa

Allman I (middle third), Single fragment – butterfly segment at fracture site, AP displacement – 24 mm, Shortening – 22 mm

Patient

21-year-old male

Mechanism of injury

Fall on point of shoulder

Restoration of length

3mm shortening post fracture union compared to intact contralateral clavicle.

Post op regime

- Master sling 6 weeks
- Ipsilateral elbow ROM exercise 6 x/day immediately
- Pendular exercises shoulder 6x/day immediately
- Full ROM shoulder exercises with physio after 6 weeks

Outcome of treatment

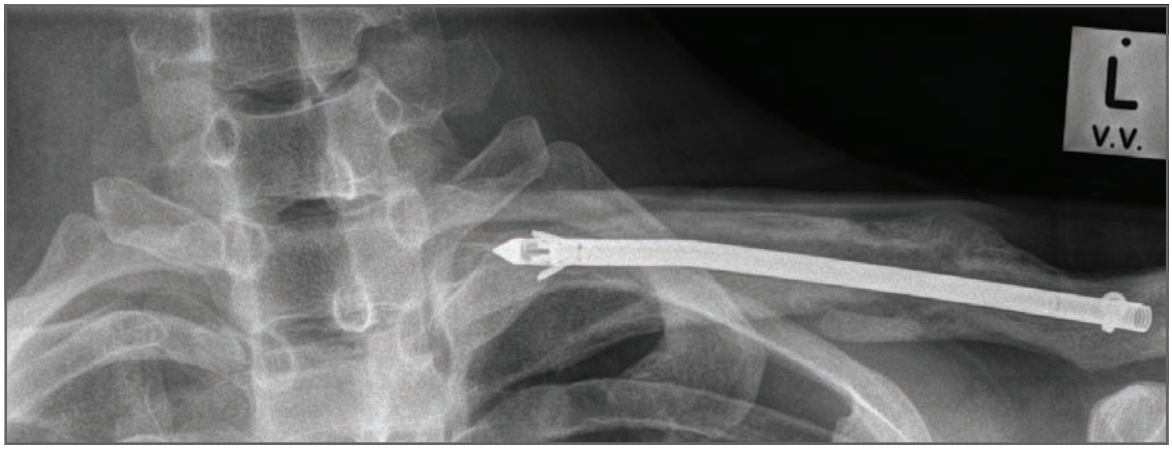
- ROM - full
- Dash score – 0 at 3 months

Additional fracture stabilization

Circlage braided suture securing fragments at fracture site.

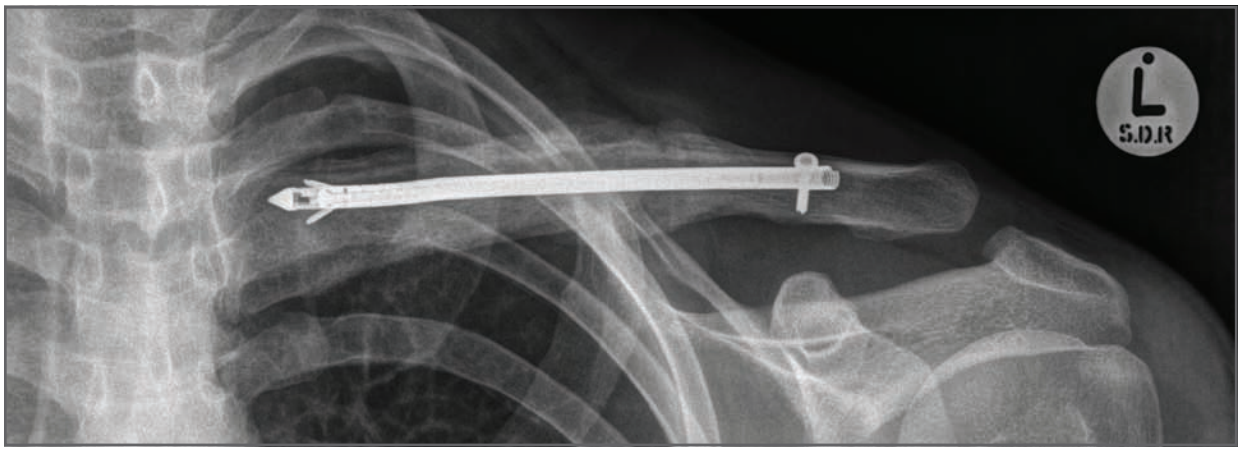
Pre-op

4 months



Over >

4 months



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CLAVICLE FRACTURE CASE SERIES

MATHEW POMBO, M.D.
The Sports Medicine & Orthopaedic Institute of Gwinnett
Duluth, GA

Transverse fracture with 200% displacement.

Patient History

A 33 year old female presented in clinic with left clavicle pain and deformity following a bicycle accident on a trail 3 days prior. She had fallen off her bike landing on her left side when another person fell on top of her.

She was seen in the emergency room where x-rays revealed a transverse fracture of the left clavicle with 200% displacement. A CT scan was also performed and revealed multiple left rib fractures and a 2% pneumothorax in her left lung. It was recommended that she undergo surgical internal fixation due to the severe displacement.

Treatment Method

The patient was consented to undergo left clavicle ORIF with sonoma nail because of its ability to be completely intramedullary. The patient is a tall and thin female, therefore a plate and screws had the potential to cause irritation.

Post-operative Results

The patient was sent home same day as surgery and followed up one week post op for xrays and dressing change. Physical therapy was prescribed for passive and active assisted range of motion only for the first month due to the complexity of the fracture.

Patient returned two months status post-surgery complaining of increase pain and redness at incision site. We felt it necessary to be aggressive with this and consented patient for an incision and drainage the next day.

Cultures were obtained and sent to the lab for testing. It was decided at the time to leave the hardware in place to attempt to get full healing of the fracture. The patient again followed up one week post op and had pic line placed by infectious disease. The plan was to keep hardware in for one more month to allow bone healing, however patient presented one week later with open wound with drainage.

She was consented for a third time for irrigation and debridement with hardware removal. A bone stimulator was ordered five months post-surgery to aid in the formation of callus. The patient is currently six months out from original surgery and x-rays reveal good progression of her callus formation with good alignment of the fracture.

Pre-Operative

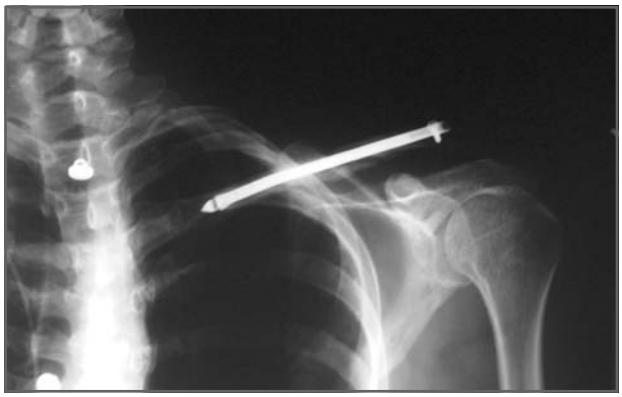
Post-Operative

1 week

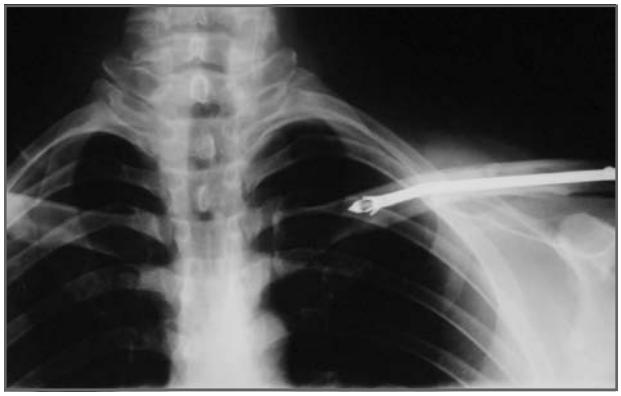
Over >

5 weeks

9 weeks

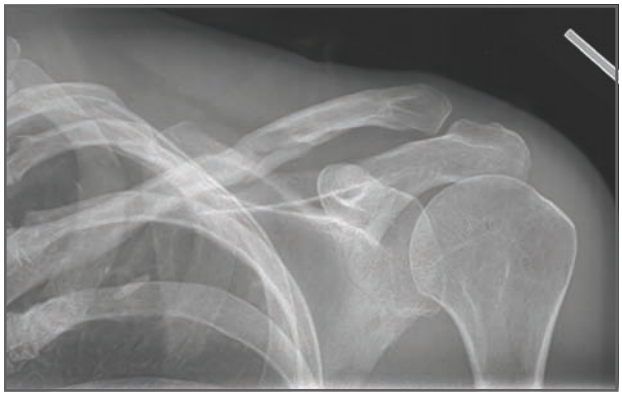


3 months

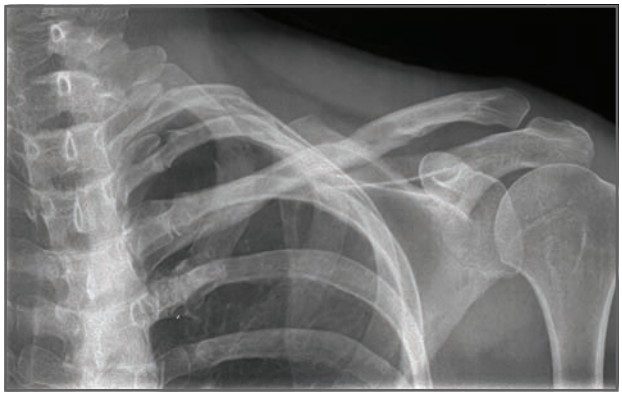


4 months

5 months



6 months



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CLAVICLE FRACTURE CASE SERIES

Comminuted fracture with butterfly fragments, 100% displacement and 2cm of shortening.

MATHEW POMBO, M.D.
The Sports Medicine & Orthopaedic Institute of Gwinnett
Duluth, GA

Patient History

The patient is a 36 year old male who presented in clinic with left clavicle pain. He stated that he was riding his bike a few days earlier when he crashed and landed on his left side and recalled hearing a crack.

He was taken to the ER where x-rays revealed a clavicle fracture with 100% displacement and 2cm of shortening. He also had significant comminution with butterfly fragments. It was recommended that the patient undergo internal fixation due to his high activity level.

Treatment Method

The patient was recommended to undergo left clavicle ORIF with the Somona nail. This device was selected because of the support of the fracture, ability to maintain length and be completely intramedullary.

The amount of comminution of the butterfly fragments also prompted us to use allograft bone grafting at the fracture site.

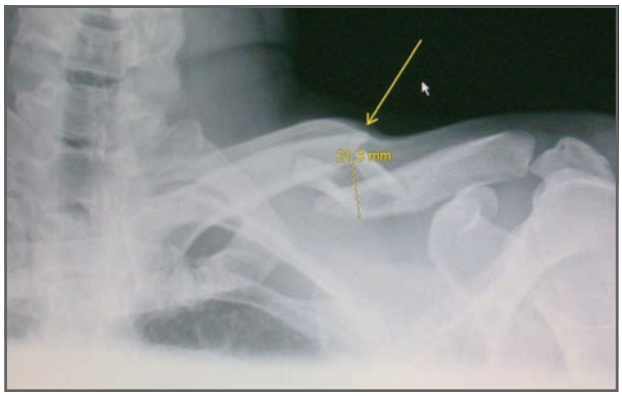
Post-operative Results

The patient was sent home same day as surgery and followed up one week post-op for wound check and dressing change. X-rays revealed well placed intramedullary hardware and good alignment of the fracture.

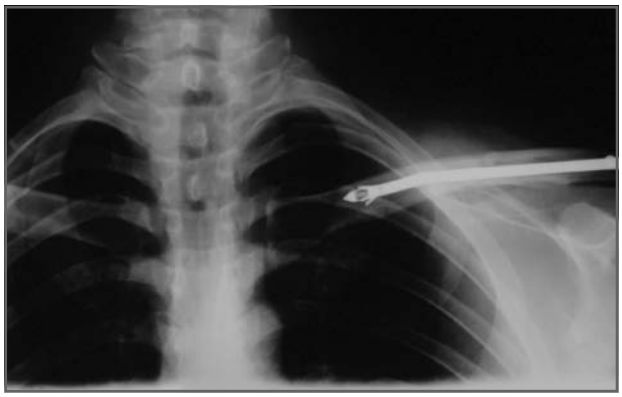
Physical therapy was initiated for range of motion and progression through to a strengthening program. The final post-operative visit was performed four months after surgery and he was doing well with no complaints.

He was released to full activity at that time without restrictions. It was suggested that the implant remain in unless it caused pain or infection.

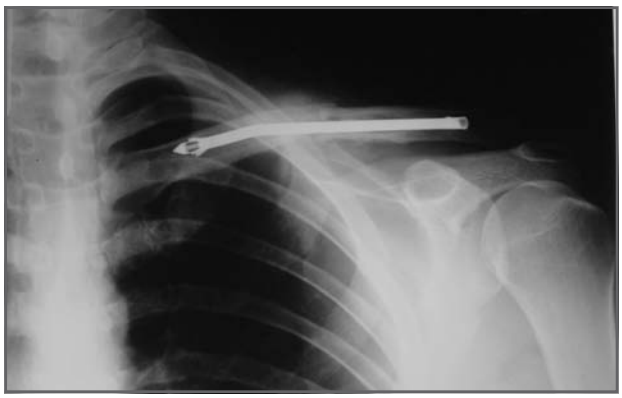
Pre-Operative



1 week

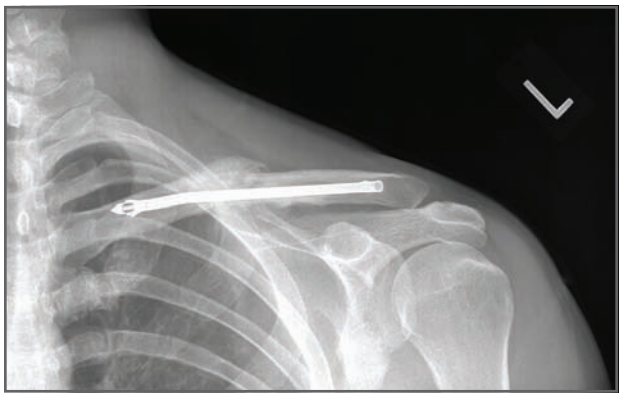


5 weeks

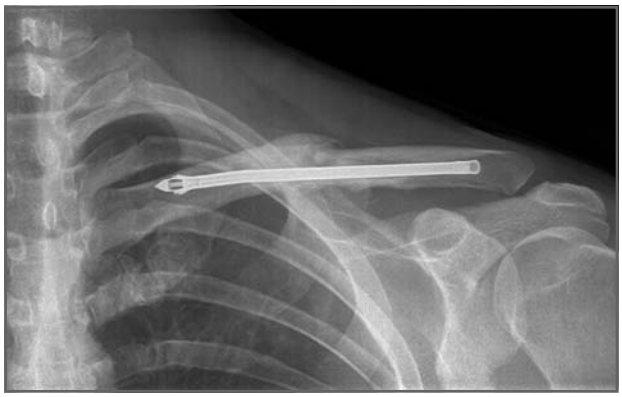


Over >

10 weeks



4 months



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CLAVICLE FRACTURE CASE SERIES

MATHEW POMBO, M.D.
The Sports Medicine & Orthopaedic Institute of Gwinnett
Duluth, GA

Midshaft fracture with over 100% displacement, 3 cm of shortening, butterfly fragment and three part comminuted deformity

Patient History

The patient is a 17 year old male who presented in clinic with right clavicle pain. He states that 5 days prior he was playing soccer when he was pushed from behind and fell, landing on his right shoulder.

He was seen in the emergency room where x-rays revealed a midshaft clavicle fracture with over 100% displacement, 3 cm of shortening and butterfly fragment and three part comminuted deformity. Options were presented to the patient and his family and they elected to proceed forth with surgical fixation.

Treatment Method

The patient elected to undergo right clavicle ORIF with Sonoma nail. This device was selected because of its ability to be completely intramedullary, the support of the fracture and the rigidity.

After the nail was placed the inferior butterfly piece was sutured into place and bone graft had to be placed around the fracture fragment.

Post-operative Results

The patient was sent home same day as surgery and followed up one week post-op for wound check and dressing change. X-rays revealed well placed IM nailing with comminution and good fracture alignment.

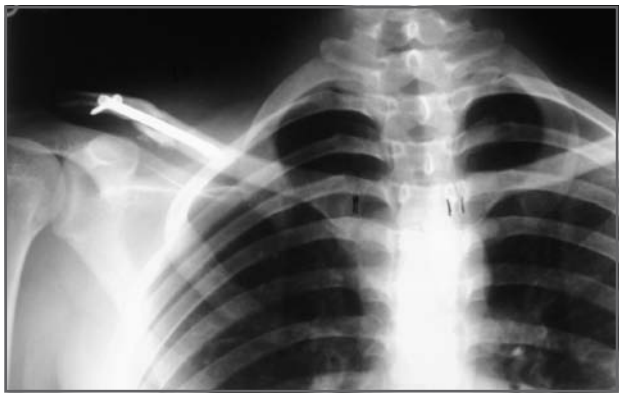
Physical therapy was ordered for passive and active assisted range of motion. At his 5 week post-op visit he presented with redness and edema around the anterior incision. He was scheduled at that point for an irrigation and debridement with removal of hardware.

The patient followed up one week following procedure and x-rays showed hardware removed with good alignment of the clavicle. A bone stimulator was ordered to assist in bone healing and callus formation.

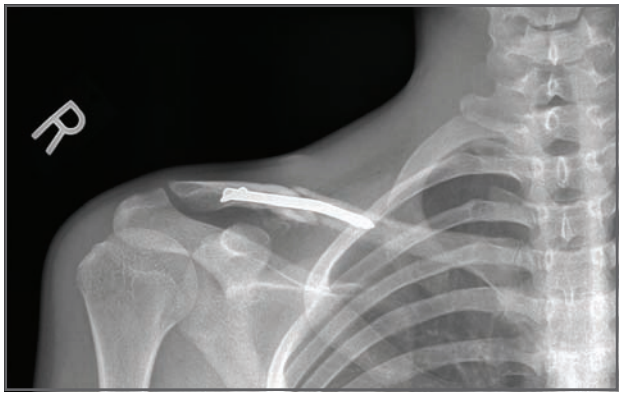
At 6 weeks post hardware removal and 3 months post ORIF, he was permitted to ease into soccer drills and conditioning but no contact. At the most recent visit 4 months after ROH and 5.5 months post ORIF he was released to full activity without restrictions.

Pre-Operative

1 week

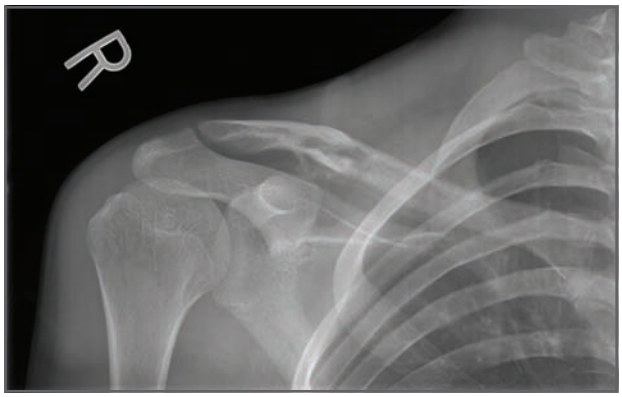


4 weeks

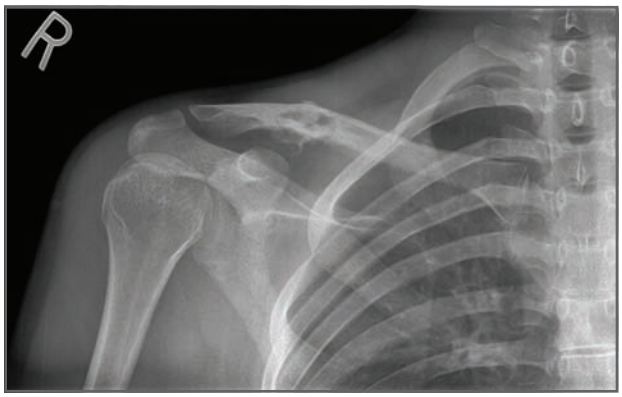


Over >

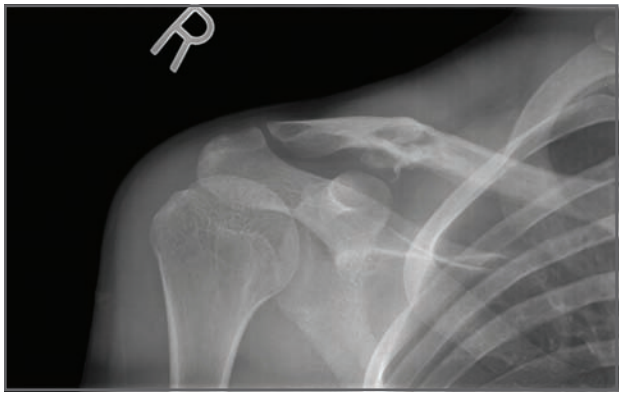
6 weeks



10 weeks



3 months



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CLAVICLE FRACTURE CASE SERIES

Oblique fracture of the mid-shaft clavicle, over 150% displaced

KENNAN VANCE, D.O.
Western Orthopedics and Sports Medicine
Grand Junction, CO

Patient History

14 y/o right hand dominant male was snowboarding when he fell and injured his right shoulder. The x rays showed an oblique fracture of the mid-shaft clavicle that was 150% displaced.

Treatment Method

We discussed non-operative and operative options and they wanted to have it fixed due to his active lifestyle. We thought it was a perfect candidate for the nail due to the simple fracture pattern and the ease for removal once it had healed.

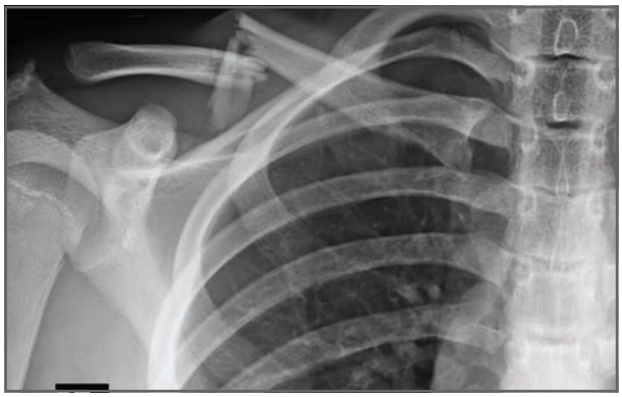
The surgery allowed for a less invasive incision on this simple fracture pattern and the nail was successfully implanted.

Post-Operative Results

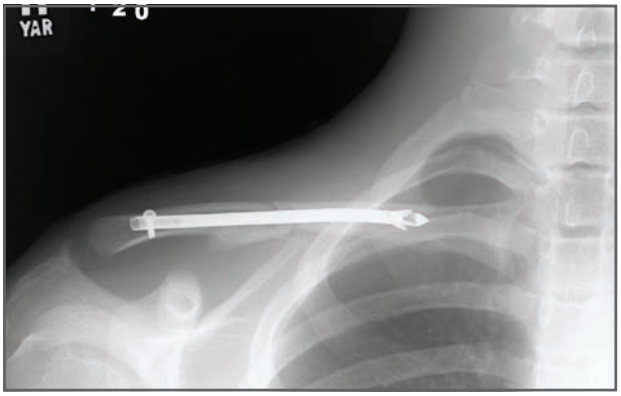
The patient felt more comfortable staying in a sling for about a week; then he came out of it and started to work on ROM. By 3 weeks, he had mild discomfort with full active ROM. He was back to full activity by 2 months postoperatively.

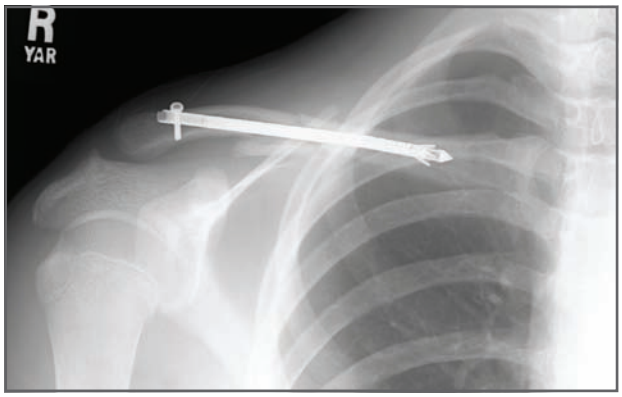
I counseled the patient to have it removed due to his young age and we removed it about 4 months after implantation. He required no pain meds after the second surgery and immediately returned to bowling and other non-contact activities.

Pre-op



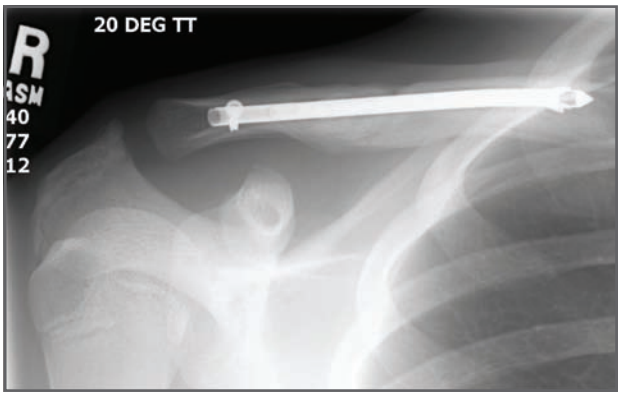
Post-op

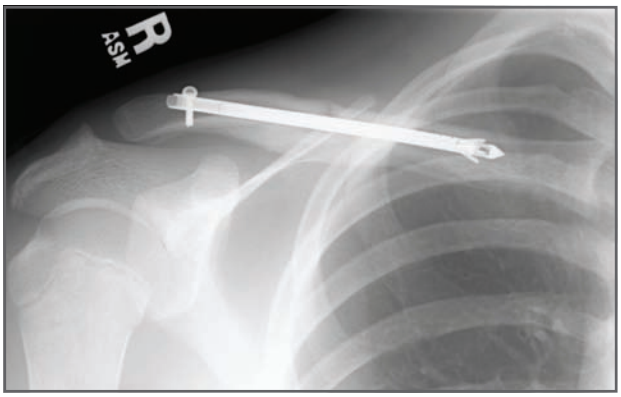




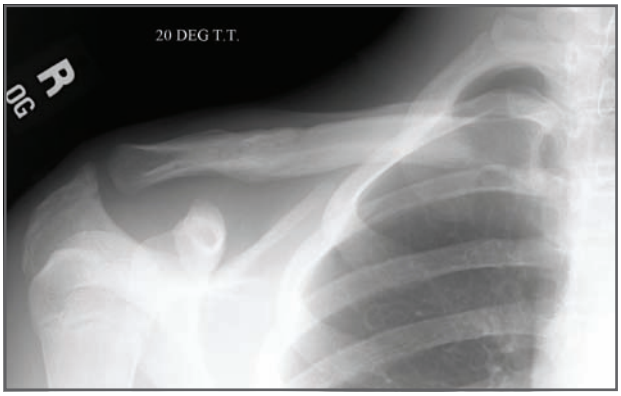
Over >

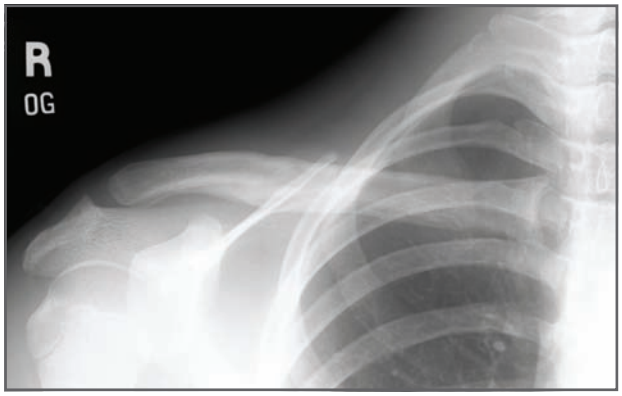
3 months





Post-device removal





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CLAVICLE FRACTURE CASE SERIES

Mid-shaft fracture with large butterfly fragment, 150% displaced

KENNAN VANCE, D.O.
Western Orthopedics and Sports Medicine
Grand Junction, CO

Patient History

A 16y/o right hand dominant male injured his right clavicle while mountain biking. Xrays at the hospital revealed a mid-shaft fracture of the clavicle with a large butterfly fragment. It was 150% displaced and the patient elected to have surgery to fix the fracture.

Treatment Method

The nail was thought to be a good choice for this patient to facilitate later removal after healing without prominent hardware. The patient was involved in scouting and does a lot of backpacking and did not want prominent hardware to interfere with these activities.

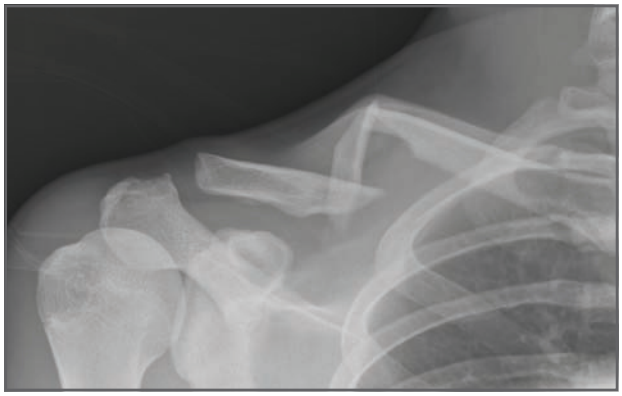
The Sonoma clavicle nail was implanted with standard technique and suture was used to cerclage the butterfly fragment.

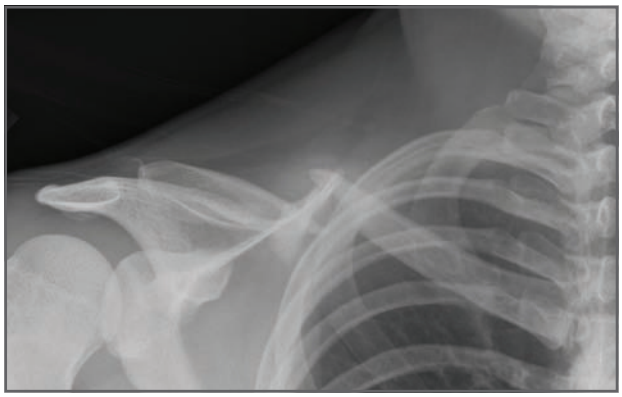
Post-Operative Results

Postoperatively, he wore a sling for the first few days then he started working on ROM. By 3 weeks he had obtained pain free full ROM to the right shoulder.

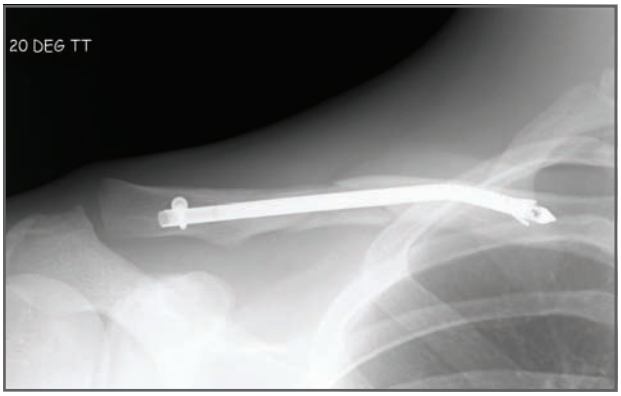
He went on to heal without problem and wanted to resume full activity within 3 months. We decided to have the nail removed due to the patient's young age and activity level. It was removed 4 months after implantation. Since then he has resumed full activities including biking, volleyball and other sports.

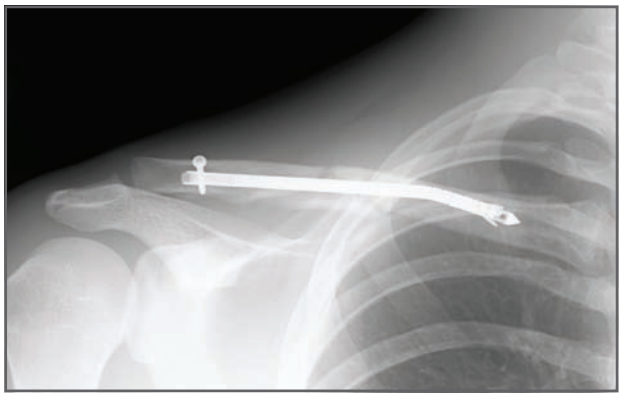
Pre-op





Post-op





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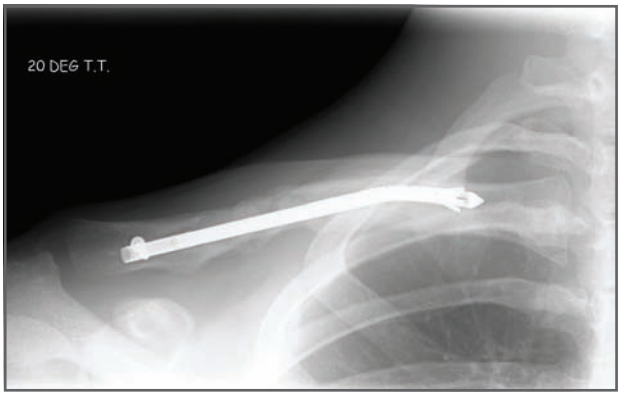

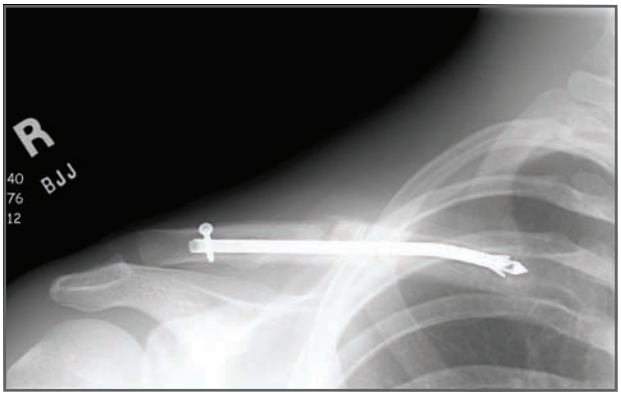

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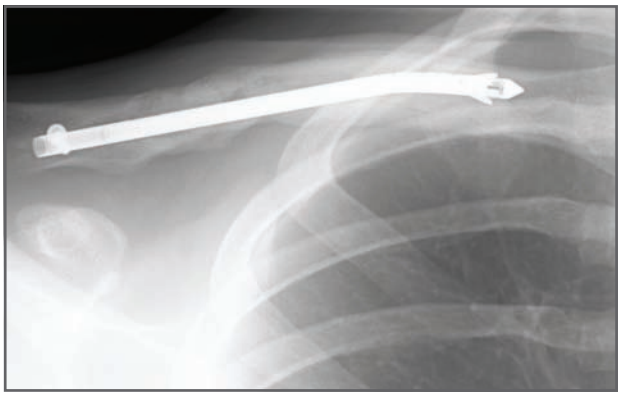
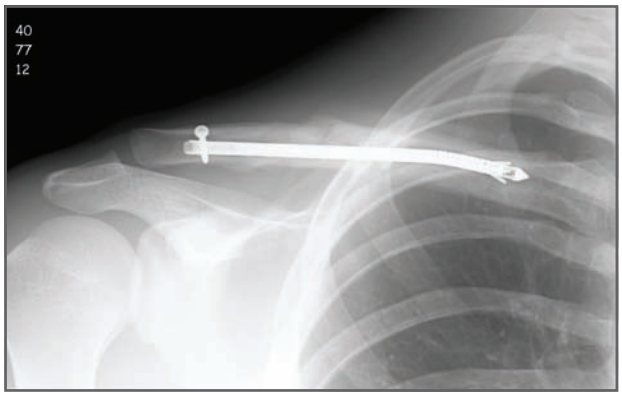
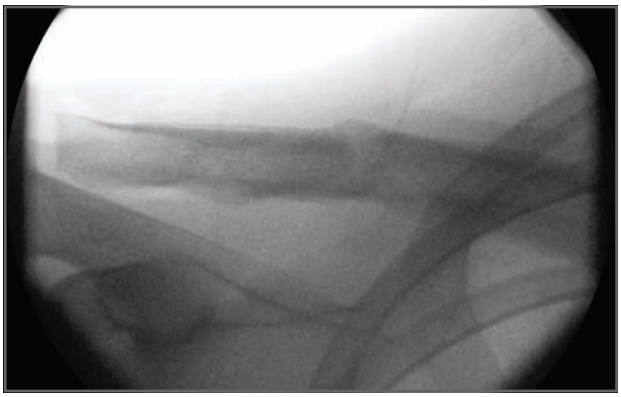




Post-device removal



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CLAVICLE FRACTURE CASE SERIES

KENNAN VANCE, D.O.
Western Orthopedics and Sports Medicine
Grand Junction, CO

Comminuted mid-shaft fracture with shortening and >100% displacement

Patient History

A 20y/o right hand dominant male injured his right shoulder while riding his mountain bike down the road in the middle of the night and collided with another biker. He sustained a mid-shaft right clavicle fracture that was comminuted, with shortening, and >100% displacement.

Treatment Method

The fracture was slightly lateral to mid-shaft and I was concerned about being too close to the conoid tubercle for the nail. The patient decided to have it fixed and I wanted to see if I could nail this fracture pattern being so lateral and comminuted.

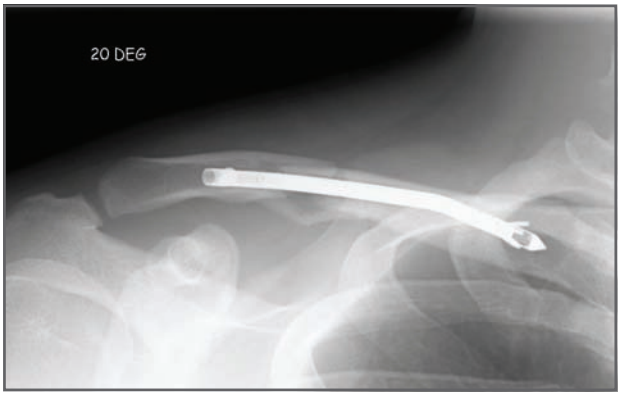
The patient was taken to surgery and a successful nail was placed without much difficulty. Suture was used to cerclage the comminuted fragments.

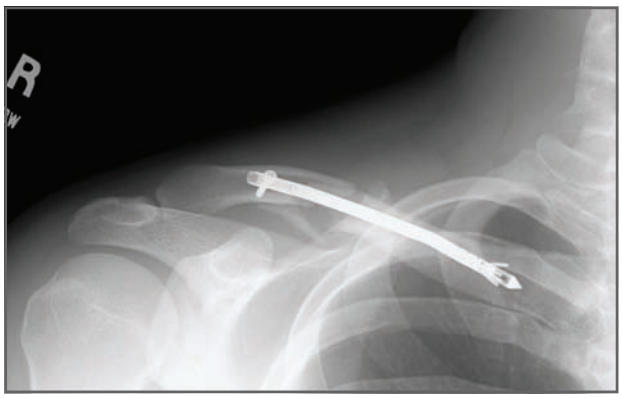
Post-Operative Results

Postoperatively, I wanted the patient to stay in a sling more than normal due to the amount of comminution, but he was non-compliant and took the sling off on post-op day 2 and started using his arm for normal daily activities. At his 10 day post-op visit he basically had full ROM and no complaints of pain. At his six week post-op, he had returned to heavy lifting and his previous work which involved heavy labor despite my recommendations not to do so. He didn't have any pain and he was doing great. He wanted no further follow up appointments.

Pre-op

Post-op





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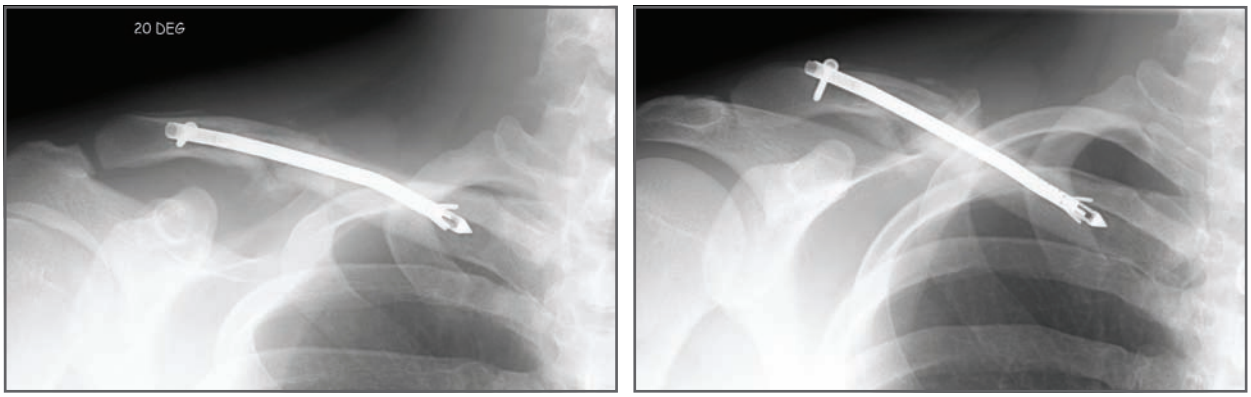

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CLAVICLE FRACTURE CASE SERIES

KENNAN VANCE, D.O.
Western Orthopedics and Sports Medicine
Grand Junction, CO

Comminuted mid-shaft fracture with a large butterfly fragment and other small comminuted pieces

Patient History

38y/o right hand dominant Orthopedic Surgeon sustained a comminuted left clavicle fracture while riding his mountain bike. The fracture was mid-shaft with a large butterfly fragment and other small comminuted pieces.

Treatment Method

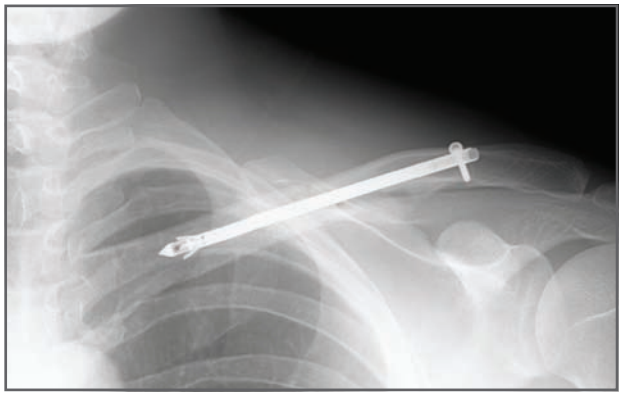
The fracture was not significantly displaced but based upon the activity level of the patient and his need to return to work, we opted for the Sonoma clavicle nail. This was chosen and preferred over a plate and screw option for the patient to have it removed at a later date with less surgical dissection and a decreased chance of re-fracture through the stress riser of the screw holes, as well as the abundant callus formation with a relatively stable construct.

Post-Operative Results

He returned to work seeing patient in the clinic four days after the surgery without wearing a sling and able to perform most all functions. He returned to performing surgery within 10 days and was performing all surgery at about 2 weeks after surgery. Full ROM was achieved without discomfort at about 3 weeks after surgery. It was healed on radiographs within 3 months. He elected to have the nail removed for lifestyle purposes, and it was removed 6 months after implantation. He returned to mountain biking within 4 weeks after the initial surgery.

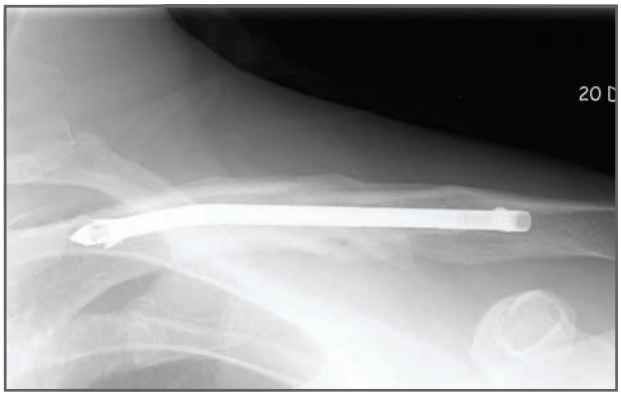
Pre-op

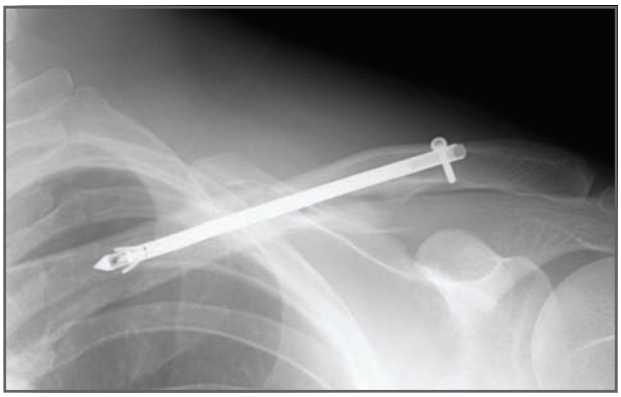
Post-op



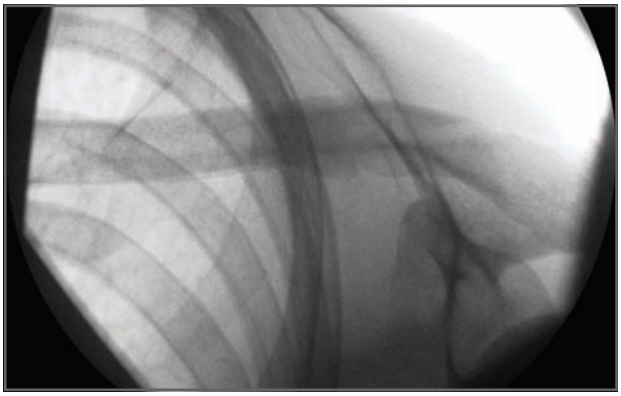
Over >

Healed





Post-device removal



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Nonunion and Malunion Fractures

These are clavicle fractures that have not united, or malunited after either conservative or operative treatment.

CLAVICLE FRACTURE CASE SERIES

Hypertrophic non-union of fully displaced and shortened midshaft clavicle fracture

CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

Patient History

A 43 year old female presented a one year old clavicle non-union. The patient had originally undergone conservative treatment, and without union had developed dramatic shoulder sequelae including pain and loss of function. Radiographs of the clavicle showed a hypertrophic non-union of a fully displaced and shortened midshaft clavicle fracture. The patient was recommended to undergo intramedullary fixation of her clavicle to restore anatomical alignment and length and allow for requisite healing.

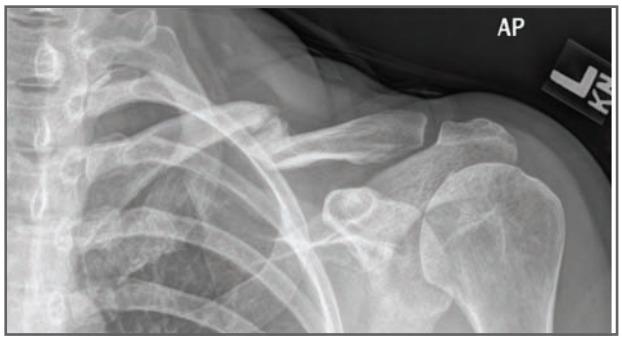
Treatment Method

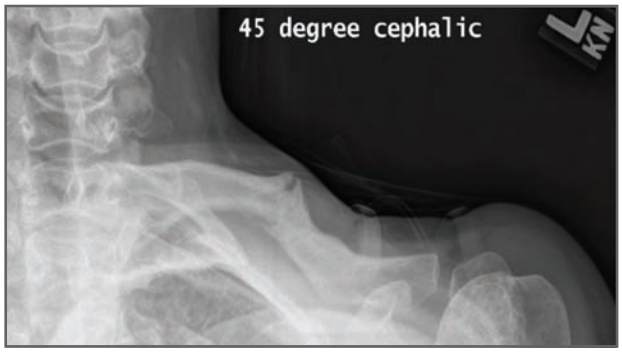
Clavicle non-unions are known to do well when alignment is restored and compression of the fracture is achieved. This patient's hypertrophic callus was removed and the bone ends were freshened up prior to preparation of the canal for implantation. The Sonoma CRx™-CWG implant was selected because of its minimally invasive intramedullary approach, and its ability to provide rigid fixation and compress the fracture site.

Post-Operative Results

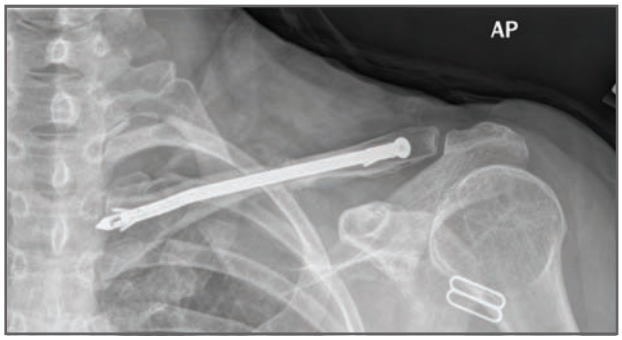
The outpatient procedure allowed the patient to return home the same day. The patient was allowed to return to non weight bearing activities immediately. At four weeks post-operative, the patient was showing signs of bridging callus. At 12 weeks, the patient was allowed to return to full activity

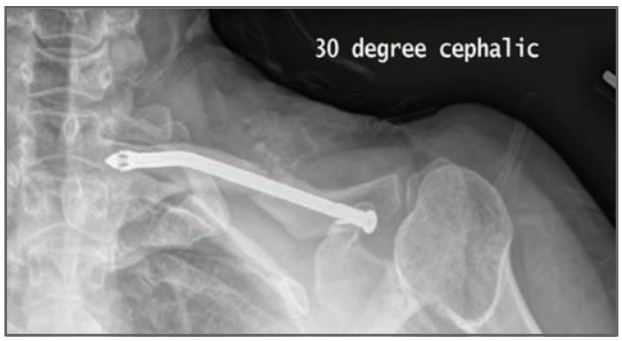
Pre-Operative





Post-Operative





CLAVICLE FRACTURE CASE SERIES

CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

10 year old clavicle mal-union with severe shortening and misalignment

Patient History

A 42 year old male presented a 10 year old clavicle mal-union. The original fracture had been sustained after a horse jumping accident, in which the horse landed on the patient. The patient originally received conservative treatment, and had chronic weakness and discomfort in his shoulder, as well as an obvious cosmetic deformity. Radiographs of the clavicle showed severe shortening and misalignment. The patient was recommended to undergo osteotemy and intramedullary fixation of his clavicle to restore anatomical alignment and length.

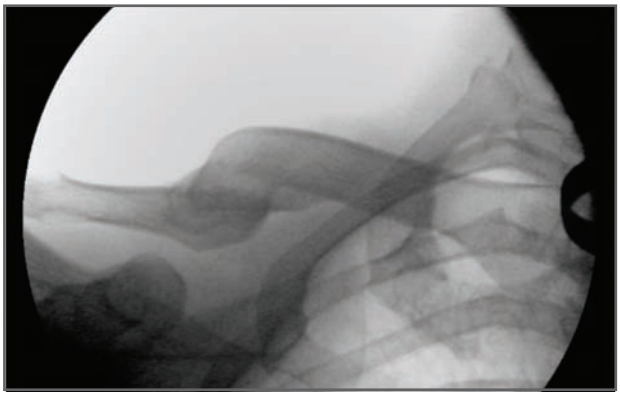
Treatment Method

Clavicle mal-unions are known to lead to strength deficits and shoulder sequelae. Restoring the length and anatomical alignment of the clavicle can resolve these issues. To realign the clavicle, a short oblique transverse osteotemy was created at the original fracture, and the majority of the callus was removed. It is desirable to be able to compress the resulting fracture to increase the stability of the fixation and achieve as much bony contact as possible. The Sonoma CRx™-CWG implant was selected because it provides rigid intramedullary fixation with up to 10mm of fracture site compression.

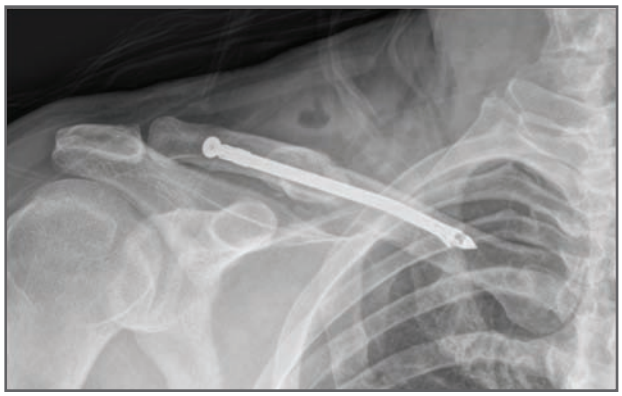
Post-Operative Results

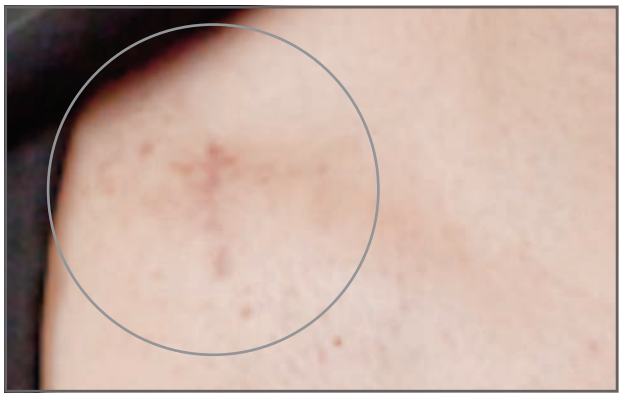
The patient was able to return home to non weight bearing activities immediately after surgery. At four weeks, the patient had returned to bike riding, and by 12 weeks had returned to full activity. At 24 weeks, the patient elected to remove the implant due to his highly active lifestyle.

Pre-Operative



Post-Operative





CLAVICLE FRACTURE CASE SERIES

Iatrogenic malunion with thoracic outlet syndrome symptoms following repair using a pre-contoured clavicle plate

CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

Patient History

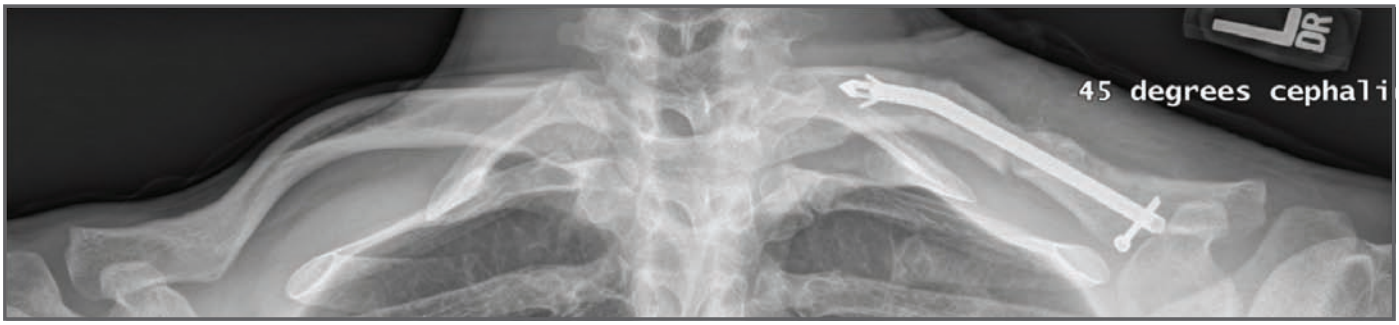
A 21 year old male presented with thoracic outlet syndrome symptoms in his left shoulder which had sustained a clavicle fracture. The initial fracture was sustained after a fall onto his shoulder, and had been operatively repaired using a pre-contoured clavicle plate.

Pre-Operative

Radiographs confirmed a well healed fracture without obvious deformity of the clavicle. However, when compared to the intact clavicle using radiographs and CT scans, it was apparent that the curvature of his operative clavicle was drastically different than his non-operative clavicle.

This appeared to cause the clavicle to compress the neurovascular structures beneath the clavicle, resulting in the TOS symptoms. The patient was recommended to undergo corrective osteotomy and intramedullary fixation to restore the natural anatomy of this clavicle.

Post-Operative



Treatment Method

A corrective osteotomy was made at the original fracture site after the plate was removed. The Sonoma CRx™ clavicle pin was selected as the optimal treatment option because of its ability to restore length and provide intramedullary fixation. With the intramedullary canals prepped and aligned, the CRx was implanted to maintain correct anatomical alignment.

Post-Operative Results

The patient was allowed to return home after surgery and instructed to perform passive ROM as tolerable. He commenced active physiotherapy to restore strength and function in his operative shoulder two weeks post-operative. By 12 weeks post-operative, he was asymptomatic and his fracture showed bridging callus on all sides.

CLAVICLE FRACTURE CASE SERIES

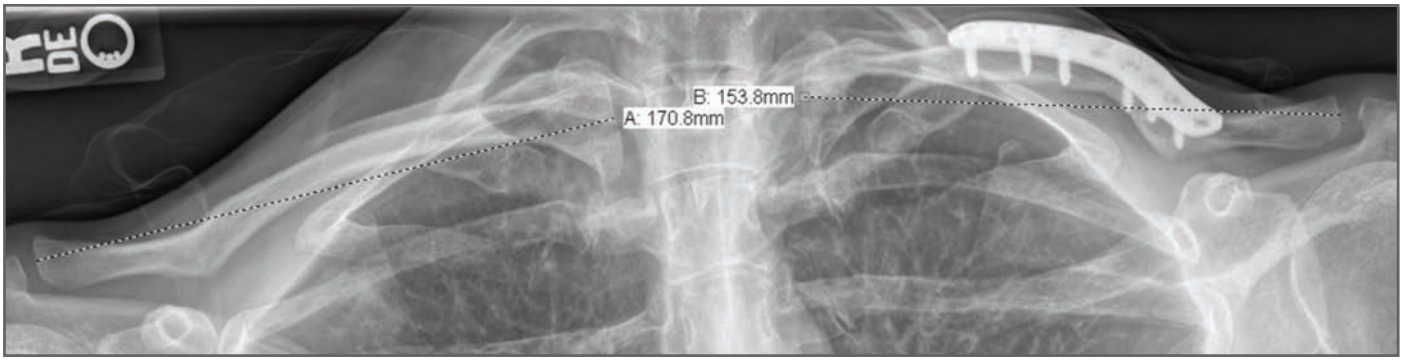
Symptomatic malunion following repair using a pre-contoured clavicle plate

CARL BASAMANIA, M.D.
Swedish Orthopedic Institute
Polyclinic
Seattle, WA

Patient History

A 48 year old female presented with a symptomatic malunion in her left shoulder. Her left clavicle had been previously fractured after a fall, and had been repaired using a pre-contoured clavicle plate.

Pre-Operative



Radiographs confirmed that her clavicle had fully healed. However, bilateral radiographs revealed that her operative clavicle was approximately 2cm shorter and more curved than her non-operative. This forced the patient's shoulder medial and superior, causing great discomfort, limited function, and displeasing cosmesis. As well, the patient, a thin female, was extremely displeased with the appearance of her clavicle due to the prominence of the plate. The patient was recommended to undergo corrective osteotomy and intramedullary fixation to restore the natural anatomy of this clavicle.

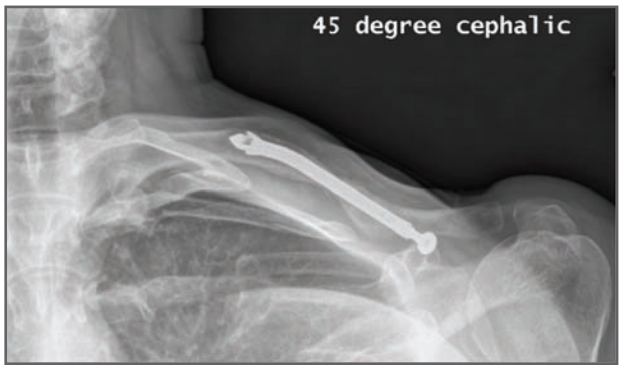
Treatment Method

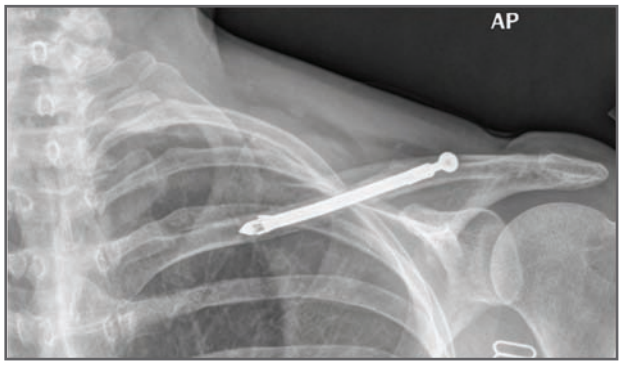
A corrective osteotomy was made at the original fracture site after the plate was removed. The Sonoma CRx™-CWG clavicle pin was selected as the optimal treatment option because of its ability to apply compression to the fracture site. This can be important for older patients to promote healing. With the intramedullary canals prepped and aligned, the device was implanted to maintain correct anatomical alignment.

Post-Operative Results

The patient was allowed to return home after surgery. She commenced active physiotherapy to restore strength and function in her shoulder. By 16 weeks post-operative, she had returned to full activity and had regained full ROM.

Post-Operative





Reference List

(1) Bostman O, Manninen M, Pihlajamaki H. Complications of plate fixation in fresh displaced midclavicular fractures. J Trauma 1997 Nov;43(5):778-83.

Abstract: BACKGROUND: The role of plate fixation in the management of fresh displaced midclavicular fractures is unsettled. The objective of this study was to evaluate the drawbacks and pitfalls of this treatment method. METHODS: We analyzed the complications encountered in 103 consecutive adult patients with severely displaced fresh fractures of the middle third of the clavicle who were treated by open reduction and internal fixation using AO/ASIF plates. These 103 patients accounted for 9.5% of the 1,081 patients with fresh midclavicular fractures seen between 1989 and 1995. The mean age of the 103 patients was 33.4 years (range, 19-62 years). RESULTS: Seventy-nine patients had an uneventful recovery, whereas 24 (23%) suffered one or several complications. The major complications included deep infection, plate breakage, nonunion, and refracture after plate removal. The most common of the minor complications was plate loosening resulting in malunion. The infection rate was 7.8%. A total of 14 reoperations were performed because of the complications. Permanent nonunion ensued in two patients. A severely comminuted fracture (relative risk of failure, 5.15) as well as a state of alcohol intoxication on admission (relative risk of failure, 3.12) were identified as markers of increased complication risk. CONCLUSIONS: Patient noncompliance with the postoperative regimen could be suspected to have been a major cause of the failures. The high complication rate supports a reserved attitude toward plate fixation of fresh midclavicular fractures. The method should be reserved for patients who have trustworthy personal motives for quick pain relief and functional recovery

(2) Chalidis B, Sachinis N, Samoladas E, Dimitriou C, Christodoulou A, Pournaras J. Acute management of clavicle fractures. A long term functional outcome study. Acta Orthop Belg 2008 Jun;74(3):303-7.

Abstract: The purpose of this study was to evaluate the long-term results after acute treatment of clavicle fractures. We reviewed 139 patients with an average age of 39.3 years (range: 18 to 74) who sustained a clavicle fracture either isolated or as part of a polytrauma. Besides demographic data, both clinical result and residual symptoms were also recorded. The average follow-up was 7.2 years (range: 4 to 13). The fracture showed a higher prevalence in young men and older women. The most frequent mechanism of injury was a fall (39.6%) and coexisting injuries were found in 12.9% of patients. Conservatively treated fractures united in 96.9% of cases and the time to union was no different with a sling or figure-of-eight bandage. Fracture location did not influence the functional outcome. One third of patients were still complaining of mild pain and discomfort during overhead activities and polytrauma patients had a lower Constant score

(3) De GS, Notarnicola A, Tafuri S, Solarino G, Moretti L, Moretti B. Conservative treatment of fractures of the clavicle. BMC Res Notes 2011;4:333.

Abstract: ABSTRACT: BACKGROUND: In the treatment of clavicle fractures, the choice of procedure depends on the possibility of restoring the anatomical functional integrity of the shoulder. METHODS: We examined 71 patients (51 males and 20 females, mean age 38.9 years) who were affected by clavicle fracture sequelae. Demographic and clinical data and the site of the lesion were recorded for each partecipant. The dissatisfaction of the patient was determined by the presence of 1 or more affirmative answers on the Simple Shoulder Test. The Constant Shoulder Score was also included in the functional and clinical exams. We measured the length of the healthy clavicle and the previously fractured clavicle, and we expressed the difference in length in mm and in percentage shortening. We then examined the correlations between the shortening of the bone and the clinical and functional outcomes of the patients. RESULTS: Sixty patients had a lesion of the diaphysis, 8 patients had a lesion of the lateral third of the clavicle, and 3 patients had a lesion of the medial third of the clavicle. The mean Constant Shoulder Score was 77.9, and 51 of the 71 patients were satisfied with their treatment. Radiography showed a mean clavicle shortening of 10 mm (mean percentage 6.5%). In the 20 dissatisfied patients, the mean clavicle shortening was 15.2 mm (9.7%). In these patients, we found a highly significant association between dissatisfaction with treatment and the amount of bone shortening, ($p < 0.0001$), as well as with a diaphyseal location ($p < 0.05$) and with the female sex ($p = 0.004$). No other variable related to the patient, the type of treatment or the fracture characteristics correlated with the treatment outcome. CONCLUSIONS: In the literature, measurements of the shortening of the bone segment following a fracture range between 15 and 23 mm, and marked shortening is correlated with the failure of conservative treatment. However, these data need to be reinterpreted in light of the physiological variability of the clavicle length, which ranges from 140 to 158 mm in the healthy population. Shortening of the bone by more than 9.7% should be the cut-off for predicting failure of conservative treatment

(4) Ferran NA, Hodgson P, Vannet N, Williams R, Evans RO. Locked intramedullary fixation vs plating for displaced and shortened mid-shaft clavicle fractures: a randomized clinical trial. J Shoulder Elbow Surg 2010 Sep;19(6):783-9.

Abstract: BACKGROUND: Recent literature supports surgical intervention for shortened, displaced, mid-shaft clavicle fractures. We present the results of a randomized clinical trial comparing locked intramedullary fixation and plate fixation for short, displaced, mid-shaft clavicle fractures. MATERIALS AND METHODS: Local ethical approval was obtained and power analysis and sample size calculations were performed prior to commencement. Patients randomized to 2 groups to be treated with either locked intramedullary fixation or plating. Patients regularly followed up to clinical and radiographic union. The primary outcome measure was the Constant score, secondary outcome measures included the Oxford shoulder score, union rate, and complication rates. RESULTS: Seventeen patients were randomized to locked intramedullary fixation and 15 randomized to plating. Mean age was 29.3 years. Mean follow-up was 12.4 months. There was no significant difference in either Constant scores ($P = .365$) or Oxford scores ($P = .773$). There was 100% union in both groups. In the intramedullary group, 1 case of soft tissue irritation settled after the pin removal; 1 pin backed out and was revised. Three superficial wound infections resulted in plate removal and 8 plates (53%) were removed. DISCUSSION: Intramedullary fixation has the theoretical advantage of preserving the periosteal blood supply, but carries the morbidity of pin removal. Clavicle plates are not

routinely removed but require greater exposure and may compromise periosteal blood supply. CONCLUSION: Both locked intramedullary fixation and plating produce good functional results; however, metalwork may need to be removed as a second procedure

(5) Harnroongroj T, Jeerathanyasakun Y. Intramedullary pin fixation in clavicular fractures: A study comparing the use of small and large pins. J Orthop Surg (Hong Kong) 2000 Dec;8(2):7-11.

Abstract: The S-shaped clavicle poses a problem for intramedullary pin fixation. Stability of fracture fixation is closely related to the length of intramedullary pin engagement. This study was carried out to determine the engagement length of intramedullary pins into clavicular fractures using a small and a large pin. Seven pairs of fresh cadaveric clavicles were prepared and arranged into Group 1 and Group 2 for paired study. A mid-third clavicular fracture was created at the junction of the two curves of the clavicle. In Group 1, a 3.2 mm diameter threaded Steinman pin was introduced into the medullary canal of the clavicle by retrograde technique and the medial fragment of the fracture was drilled until the pin perforated the bone cortex. In Group 2, a 4 mm diameter threaded Steinman pin was used in the same manner. The results showed that Group 1 had an average engagement of pin into the clavicle of 9.11 cm with a ratio to total length of the clavicle of 0.59. In Group 2, the average engagement length into the clavicle was 7.17 cm with a ratio of 0.47. The difference was significant, with the smaller pin providing better fixation. The pins in both groups perforated the lateral fragment at the posterosuperior aspect and the medial fragment at the anterior aspect of the clavicle. The angle that the pin made with the long axis of the clavicle in Group 1 was 22.43 degrees and in Group 2, 26.57 degrees. Although the 3.2 mm diameter pin was more aligned to the long axis of the clavicle than the 4 mm diameter pin, the difference was not significant

(6) Houwert RM, Wijdicks FJ, Steins BC, Verleisdonk EJ, Kruyt M. Plate fixation versus intramedullary fixation for displaced mid-shaft clavicle fractures: a systematic review. Int Orthop 2011 Dec 7.

Abstract: PURPOSE: The optimal surgical approach for displaced midshaft clavicle fracture remains controversial. The objective of this systematic review is to compare functional outcome and complications after plate fixation and intramedullary fixation for displaced midshaft clavicle fractures. METHODS: A computer aided search of PUBMED and Embase was carried out on January 11th 2011. Every study that was published in the English, German, French or Dutch language was considered for inclusion. A total of four studies could be included of which two compared intramedullary fixation versus plate fixation, and two compared intramedullary fixation and plate fixation versus conservative treatment for displaced midshaft clavicle fractures. Studies that compared plate fixation with intramedullary fixation in patients with fresh unilateral displaced midshaft clavicle fractures were included. Dislocation or displacement had to be mentioned in the inclusion criteria of the study for inclusion in this review. The modified version of the Cochrane Bone, Joint and Muscle Trauma Group's former quality assessment tool was used. Furthermore, the studies included were scored according to the GRADE approach to assess the quality. The chosen studies were summarised in a data-extraction form. Because of the different study designs and characteristics data were summarised separately for each study. CONCLUSIONS: High quality evidence from one study and low quality evidence from three studies showed no difference in functional outcome or complications after plate fixation or intramedullary fixation for displaced midshaft clavicle fractures

(7) Huang JI, Toogood P, Chen MR, Wilber JH, Cooperman DR. Clavicular anatomy and the applicability of precontoured plates. J Bone Joint Surg Am 2007 Oct;89(10):2260-5.

Abstract: BACKGROUND: Plate fixation of clavicular fractures is technically difficult because of the complex anatomy of the bone, with an S-shaped curvature and a cephalad-to-caudad bow. The purpose of the present study was to characterize variations in clavicular anatomy and to determine the clinical applicability of an anatomic precontoured clavicular plate designed for fracture fixation. METHODS: One hundred pairs of clavicles were analyzed. The location and magnitude of the superior clavicular bow were determined with use of a digitizer and modeling software. Axial radiographs were made of each clavicle and the precontoured Acumed Locking Clavicle Plate, which is designed to be applied superiorly. With use of Adobe Photoshop technology, the plates were freely translated and rotated along each clavicle to determine the quality of fit and the location of the "best fit." RESULTS: The location of the maximum superior bow was lateral, with a mean distance of 37.2 +/- 18.4 mm from the acromial articulation and with a mean magnitude of 5.1 +/- 5.9 mm. There was no significant difference in the location or magnitude of the apex of the bow between specimens from male and female donors. The anatomic precontoured clavicular plate had the best fit in specimens from black male donors and the worst fit in specimens from white female donors, with a poor fit being seen in 38% (nineteen) of the fifty specimensfrom white female donors. The best location for superior plate application was along the medial aspect of the clavicle. CONCLUSIONS: The apex of the superior bow of the clavicle is typically located along the lateral aspect of the bone, whereas the medial aspect of the superior surface of the clavicle remains relatively flat, making it an ideal plating surface. The precontoured anatomic clavicular plate appears to fit the S-shaped curvature on the superior surface of the majority of clavicles in male patients but may not be as conforming in white female patients. While this plate fits in the medial three-fifths of the clavicle, it does not fit as well laterally

(8) Dr PR King MBChB(Stell) Registrar, Dr A Ikram MBBS, FCS(Orth)SA. Intramedullary locked fixation of clavicle shaft fractures – review of early results. SA ORTHOPAEDIC JOURNAL Summer 2011 | Vol 10 • No 4 / Page 67

Abstract: Background: To assess the effectiveness of a novel locked intramedullary device in the treatment of acute clavicle shaft fractures. Description of methods: Patients admitted with midshaft clavicle fractures were assessed to determine whether operative fixation of the fracture was required. Indications for surgery were: midshaft clavicle fractures with 100% displacement; more than 1.5 cm of shortening; presence of a displaced butterfly segment; bilateral clavicle fractures; ipsilateral displaced glenoid neck fractures; skin and neurovascular compromise. Patients who matched the criteria for surgery were treated operatively with an intramedullary locked device by the author.

Post-operatively, patients were kept in a shoulder immobiliser for a period of 6 weeks. Patients were invited to attend a scheduled follow-up visit where the data was collected that comprised the review. All patients were assessed on the same day by the surgeon, a radiologist, a physiotherapist and an occupational therapist. Scar size and quality, Dash score, Constant Shoulder score, complications and the radiological picture were assessed.Summary of results: Twenty-nine patients (31 clavicle fractures – two patients sustained bilateral fractures), 18 males and 11 females with a mean age of 28 years attended the schedule data collection visit and were included in the study. Twenty-nine clavicles achieved complete union with the remaining two fractures progressing normally to union at 10 and 13 weeks post surgery. Three patients developed post-operative complications – two nail failures and one hardware sepsis. All three fractures achieved union despite the respective complications and achieved union in an acceptable position. Two of the patients were non-compliant with the post-operative regimen and one sustained secondary trauma to the affected shoulder. These factors are believed to have caused the nail breakages in the two cases but implant failure could not be excluded.

(9) Lee YS, Lin CC, Huang CR, Chen CN, Liao WY. Operative treatment of midclavicular fractures in 62 elderly patients: knowles pin versus plate. Orthopedics 2007 Nov;30(11):959-64.

Abstract: This prospective, randomized trial compared treatment with Knowles pins and plates in 62 elderly patients (>50 years) with midclavicular fractures. The clinical outcomes were evaluated at 30 months postoperatively. The mean shoulder score of the Knowles pinning was 85 points and the plating was 84 points (P=.7). Knowles pinning requires significantly shorter operative time (P<.001), smaller wound size (P<.001), shorter hospital stay P=.03), less meperidine use (P=.02), lower complication rate (P=0.04), and less symptomatic hardware (P=.015). If surgery of mid-third clavicular fractures is indicated, fixation with a Knowles pin has more advantages than plate fixation in elderly patients

(10) McKee MD, Pedersen EM, Jones C, Stephen DJ, Kreder HJ, Schemitsch EH, et al. Deficits following nonoperative treatment of displaced midshaft clavicular fractures. J Bone Joint Surg Am 2006 Jan;88(1):35-40.

Abstract: BACKGROUND: Displaced fractures of the midpart of the clavicular shaft are generally treated nonoperatively, and few functional deficits have been reported. Whereas prior investigators have presented radiographic and surgeon-based outcomes, we used a patient-based outcome questionnaire and objective muscle-strength testing to evaluate a series of patients who had received nonoperative care for a displaced midshaft fracture of the clavicle. METHODS: We identified thirty patients (twenty-two men and eight women with a mean age of thirty-seven years) who had sustained a displaced midshaft fracture of the clavicle. All patients were treated nonoperatively. At a mean of fifty-five months, and a minimum of twelve months, outcomes were measured with the Constant shoulder score and the DASH (Disabilities of the Arm, Shoulder and Hand) patient questionnaire. In addition, objective shoulder muscle-strength testing was performed with the Baltimore Therapeutic Equipment Work Simulator, with the uninjured arm serving as a control. RESULTS: The range of motion was well maintained, with flexion averaging 170 degrees +/- 20 degrees and abduction averaging 165 degrees +/- 25 degrees . Compared with the strength of the uninjured shoulder, the strength of the injured shoulder was reduced to 81% for maximum flexion, 75% for endurance of flexion, 82% for maximum abduction, 67% for endurance of abduction, 81% for maximum external rotation, 82% for endurance of external rotation, 85% for maximum internal rotation, and 78% for endurance of internal rotation ($p < 0.05$ for all values). The mean Constant score was 71 points, and the mean DASH score was 24.6 points, indicating substantial residual disability. CONCLUSIONS: Traditionally, good results with minimal functional deficits have been reported following nonoperative treatment of clavicular fractures. However, surgeon-based methods of evaluation may be insensitive to loss of muscle strength. We detected residual deficits in shoulder strength and endurance in this patient population, which may be related to the significant level of dysfunction detected by the patient-based outcome measures

(11) Mueller M, Burger C, Florczyk A, Striepens N, Rangger C. Elastic stable intramedullary nailing of midclavicular fractures in adults: 32 patients followed for 1-5 years. Acta Orthop 2007 Jun;78(3):421-3.

Abstract: BACKGROUND: Osteosynthesis of clavicular fractures is sometimes indicated. Since plate fixation may lead to complications, we have used elastic stable intramedullary nailing and report our experience of midclavicular fractures in 32 adults. PATIENTS AND METHODS: From 2000 to 2005, we treated 32 adults (26 men), median age 40 (19-66) years, by intramedullary nailing with a titanium elastic nail (TEN). All patients were re-examined after median 27 (12-59) months. RESULTS: Nonunion was not observed. 20 clavicles healed without shortening. 12 clavicles healed with shortening of more than 5 mm. Migration of the TEN in 8 patients required secondary shortening of the nail in 5 of them. Nail breakage after fracture healing was observed twice. The nails were removed in 29 patients after a median of 6 (1.3-15) months postoperatively. No patient sustained a re-fracture after TEN removal. The mean Constant score was 95 (SD 1.9) points and the mean DASH score was 5 (SD 2.3) points. INTERPRETATION: Intramedullary stabilization of midclavicular fractures with a titanium elastic nail is a minimally invasive technique with good cosmetic and functional results. Intramedullary fixation can be seen as an alternative to plate fixation and nonoperative treatment

(12) Nowak J, Mallmin H, Larsson S. The aetiology and epidemiology of clavicular fractures. A prospective study during a two-year period in Uppsala, Sweden. Injury 2000 Jun;31(5):353-8.

Abstract: In a prospective study, the age- and gender-specific incidence and features of clavicular fractures were studied during 1989 and 1990. The population at risk consisted of about 200,000 individuals aged 15 or above in the county of Uppsala, Sweden. There were 187 clavicular fractures in 185 patients corresponding to an annual incidence of 50/100,000 (males 71/100,000, women 30/100,000). Males were significantly younger and sustained comminuted fractures more often than women. The fracture incidence decreased with age in both genders, although the reduction was significant only in men. Bicycle accidents most frequently caused clavicular fractures in both

genders, whereas sports activities were significantly more common in men. Right and left clavicles were almost as frequently fractured, and a direct fall on the shoulder was the most frequent mechanism of injury for both genders. There was no difference between genders in the anatomical location with about three of four fractures occurring through the middle part and one of four through the acromial part of the clavicle. Ninety-five percent healed uneventfully, while non-union developed in 5% - evenly distributed between the middle part of the clavicle and the acromial part.

(13) Nowak J, Holgersson M, Larsson S. Can we predict long-term sequelae after fractures of the clavicle based on initial findings? A prospective study with nine to ten years of follow-up. J Shoulder Elbow Surg 2004 Sep;13(5):479-86.

Abstract: The aim of this long-term, prospective study was to identify risk factors associated with the outcome of clavicular fractures. During 1989 through 1991, 245 patients aged 15 years or older with a radiographically verified fracture of the clavicle were included. Clinical and radiographic examinations were standardized. Of the 208 patients seen at the 9- to 10-year follow-up, 112 (54%) had recovered completely whereas 96 (46%) still had sequelae. Nonunion occurred in 15 patients (7%). No bony contact was the strongest radiographic predictor for sequelae. Comminuted fractures with transverse fragments had a significantly increased risk for remaining symptoms, as did older patients, whereas there was no significant difference between sexes. Fracture location and shortening did not predict outcome except for cosmetic defects. Angulation of the fracture had no effect on cosmetic defects. Patients with predictive risk factors, such as fractures with no bony contact or displacement, especially if comminuted, and also elderly patients with fractures should be considered for more active treatment options

(14) Nowak J, Holgersson M, Larsson S. Sequelae from clavicular fractures are common: a prospective study of 222 patients. Acta Orthop 2005 Aug;76(4):496-502.

Abstract: BACKGROUND: Nonoperative treatment is preferred for clavicular fractures irrespective of fracture and patient characteristics. However, recent studies indicate that long term results are not as favourable as previously considered. METHODS: We have identified predictive risk factors associated with demographic and baseline data on clavicular fractures. In particular, the following symptoms were investigated: pain at rest, pain during activity, cosmetic defects, reduction in strength, paresthesia and nonunion until 6 months after injury. We followed 222 patients with a radiographically verified fracture of the clavicle, and who were at least 15 years of age, for 6 months. RESULTS: Nonunion occurred in 15 patients (7%). 93 patients (42%) still had sequelae at 6 months. Displacement of more than one bone width was the strongest radiographic risk factor for symptoms and sequelae. Both radiographic projections used in this study (0 degree and 45 degrees tilted view) provided important information. A comminute fracture and higher age were associated with an increased risk of symptoms remaining at 6 months. Shortening was not predictive of functional outcome; nor was the site of the fracture in the clavicle. INTERPRETATION: The risk for persistent symptoms following nonoperative treatment of clavicular fractures was far higher than expected. Based on these findings it seems reasonable to explore the possibly use of alternative treatment options including surgery for certain clavicular fracture types

(15) Pearson AM, Tosteson AN, Koval KJ, McKee MD, Cantu RV, Bell JE, et al. Is surgery for displaced, midshaft clavicle fractures in adults cost-effective? Results based on a multicenter randomized, controlled trial. J Orthop Trauma 2010 Jul;24(7):426-33.

Abstract: OBJECTIVES: To determine the cost-effectiveness of open reduction internal fixation (ORIF) of displaced, midshaft clavicle fractures in adults. DESIGN: Formal cost-effectiveness analysis based on a prospective, randomized, controlled trial. SETTING: Eight hospitals in Canada (seven university-affiliated and one community hospital). PATIENTS/PARTICIPANTS: One hundred thirty-two adults with acute, completely displaced, midshaft clavicle fractures. INTERVENTION: Clavicle ORIF versus nonoperative treatment. MAIN OUTCOME MEASUREMENTS: Utilities derived from SF-6D. RESULTS: The base case cost per quality-adjusted life-year (QALY) gained for ORIF was $65,000. Cost-effectiveness improved to $28,150/QALY gained when the functional benefit from ORIF was assumed to be permanent with cost per QALY gained falling below $50,000 when the functional advantage persisted for 9.3 years or more. In other sensitivity analyses, the cost per QALY gained for ORIF fell below $50,000 when ORIF cost less than $10,465 (base case cost $13,668) or the long-term utility difference between nonoperative treatment and ORIF was greater than 0.034 (base case difference 0.014). Short-term disutility associated with fracture healing also affected cost-effectiveness with the cost per QALY gained for ORIF falling below $50,000 when the utility of a fracture treated nonoperatively before union was less than 0.617 (base case utility 0.706) or when nonoperative treatment increased the time to union by 20 weeks (base case difference 12 weeks). CONCLUSIONS: The cost-effectiveness of ORIF after acute clavicle fracture depended on the durability of functional advantage for ORIF compared with nonoperative treatment. When functional benefits persisted for more than 9 years, ORIF had a favorable value compared with many accepted health interventions

(16) Potter JM, Jones C, Wild LM, Schemitsch EH, McKee MD. Does delay matter? The restoration of objectively measured shoulder strength and patient-oriented outcome after immediate fixation versus delayed reconstruction of displaced midshaft fractures of the clavicle. J Shoulder Elbow Surg 2007 Sep;16(5):514-8.

Abstract: Outcome after surgical treatment for nonunion and malunion of midshaft displaced clavicle fractures has generally been described as favorable and equal to results of acute repair. This assumption has been based on subjective criteria, however, and no direct comparison is available in the literature. This study used objective measurements of limb function to compare outcome in patients who underwent delayed operative intervention for nonunion and malunion with the outcome of patients who underwent immediate open reduction and internal fixation after displaced clavicle fracture. All patients had sustained completely displaced, closed, isolated midshaft clavicle fractures, of whom 15 had undergone acute open reduction and internal fixation with a compression plate at a mean of 0.6

months after injury (acute group). Another 15 patients had undergone delayed reconstruction with open reduction, bone grafting, and compression plate fixation for nonunion or malunion a mean of 63 months after injury (delayed group). The 2 groups were similar in age, gender, original fracture characteristics, and mechanism of injury. Complete assessment included standard history and physical examination, the Disabilities of the Arm, Shoulder and Hand (DASH) score and Constant Shoulder Score, subjective rating of outcome satisfaction, and objective muscle strength testing using a previously validated and published protocol on the Baltimore Therapeutic Equipment (BTE) work simulator. There were no significant differences between acute fixation and delayed reconstruction groups with regard to strength of shoulder flexion (acute, 94%; delayed, 93%; P = .82), shoulder abduction (acute, 97%; delayed, 97%; P = .92), external rotation (acute, 97%; delayed, 90%; P = .11), or internal rotation (acute, 98%; delayed, 96%; P = .55). Constant scores in the acute group were superior (acute, 95; delayed, 89; P = .02), but differences in DASH scores were not significant (acute, 3.0; delayed, 7.2; P = .15). Shoulder flexion muscle endurance was significantly decreased in the delayed group (acute, 109%; delayed, 80%; P = .05). Differences in muscle endurance in other planes were not significantly different (abduction endurance: acute, 107%; delayed, 81%; P = .24). Both groups rated their satisfaction with the procedure as excellent. Late reconstruction of nonunion and malunion after displaced midshaft fractures of the clavicle is a reliable and reproducible procedure that results in restoration of objective muscle strength similar to that seen with immediate fixation; however, there are subtle decreases in endurance strength and outcome compared with acute fracture repair. This information should not be used to justify primary operative repair in isolation but is useful in decision-making when counseling patients with displaced midshaft fractures of the clavicle

(17) Thyagarajan S, Day M, Dent C, Williams R, Evans R. Treatment of mid-shaft clavicle fractures: A comparative study. Int J Shoulder Surg 2009 Apr;3(2):23-7.

Abstract: We retrospectively evaluated 51 patients (17 in each of three groups) with mid shaft clavicle fractures. Group 1 underwent intramedullary stabilization using clavicle pins. Group 2 underwent open reduction and internal fixation using plates and group 3 underwent non operative treatment with a sling. Group1 patients progressed to union within 8 to 12 weeks. In Group 2, six patients had scar related pain and two had prominent metal work and discomfort and in group 3, three patients developed non union and one had symptomatic malunion. Our results suggest that the displaced and shortened midshaft clavicle fractures require operative fixation and the techniques of clavicle pinning resulted in less complications, short hospital stay and good functional outcome

(18) Zlowodzki M, Zelle BA, Cole PA, Jeray K, McKee MD. Treatment of acute midshaft clavicle fractures: systematic review of 2144 fractures: on behalf of the Evidence-Based Orthopaedic Trauma Working Group. J Orthop Trauma 2005 Aug;19(7):504-7.

Abstract: BACKGROUND: Fractures of the clavicle were reported to represent 2.6% of all fractures with an overall incidence of 64 per 100,000 per year (1987, Malmo, Sweden). Midshaft fractures account for approximately 69% to 81% of all clavicle fractures. Treatment options for acute midshaft clavicle fractures include nonoperative treatment (mostly sling or figure-of-eight bandage), open reduction and internal fixation with plates, and closed or open reduction and internal fixation with intramedullary pins, wires, or a nail. Most surgeons prefer nonoperative treatment of nondisplaced midshaft clavicle fractures. However, the optimal treatment option for isolated acute displaced midshaft clavicle fractures remains controversial. OBJECTIVES: This study was designed to systematically summarize and compare results of different treatment options (nonoperative, operative extramedullary fixation, and operative intramedullary fixation) in the management of midshaft clavicle fractures, specifically for displaced fractures