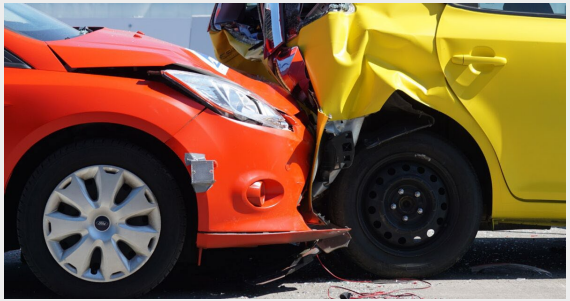
L1 Rib

August 26, 2024

What kind of cases are these?



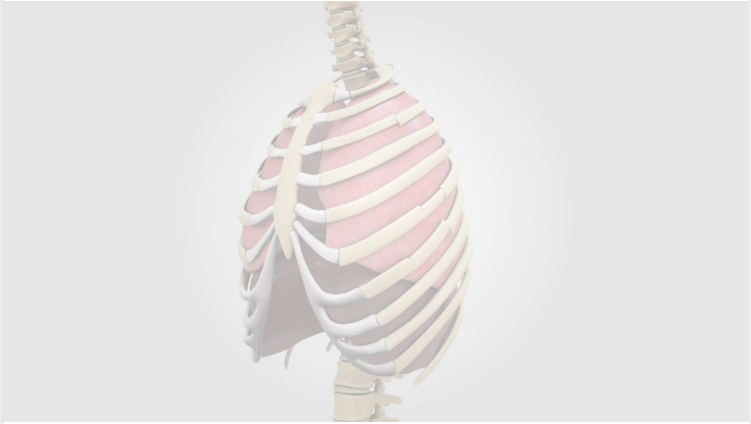
What kind of cases are these?

Fracture types

- Single or multiple fractures (typically only plate the displaced fractures)
- Flail Chest – 2 or more fracture on 3 consective ribs
  - Paradoxical breathing

The ultimate goal in rib plating is to restore chest wall stability.

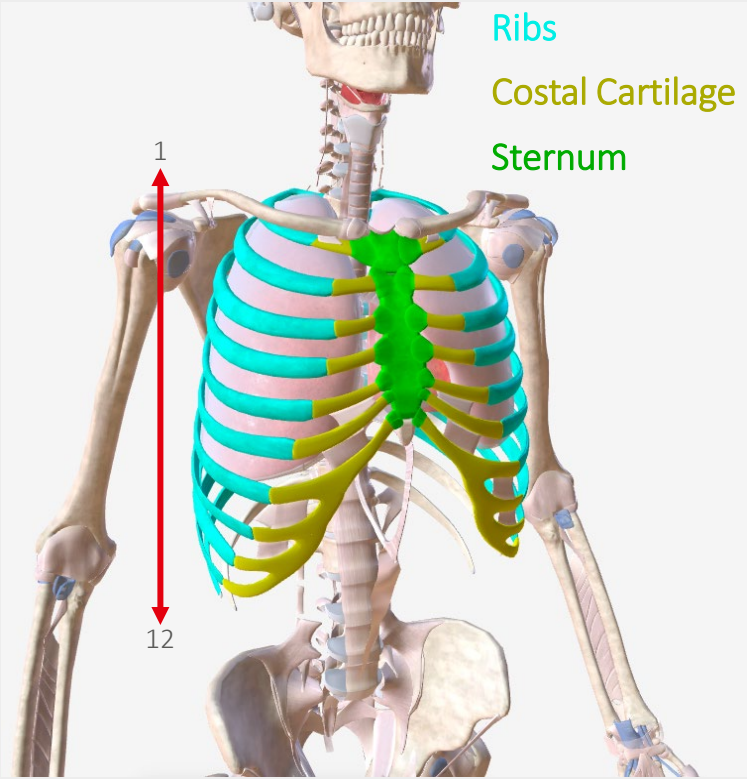
- Pulmonary function (i.e. get the patient off the ventilator)
- Reduce pain
- Return to function



Anatomy & Pathology

Anatomy

- Each rib has a bony part (posterior) and a cartilage part (anterior)
  - With the cartilage part the ribs are attached to the sternum
- 12 Rib pairs total
- Ribs 1-7 are “true ribs”, attached to the sternum with cartilage
- Ribs 8-12 are “false ribs”, not attached to the sternum
- Ribs 8-10 share cartilage to sternum
- Ribs 11 and 12 are floating ribs



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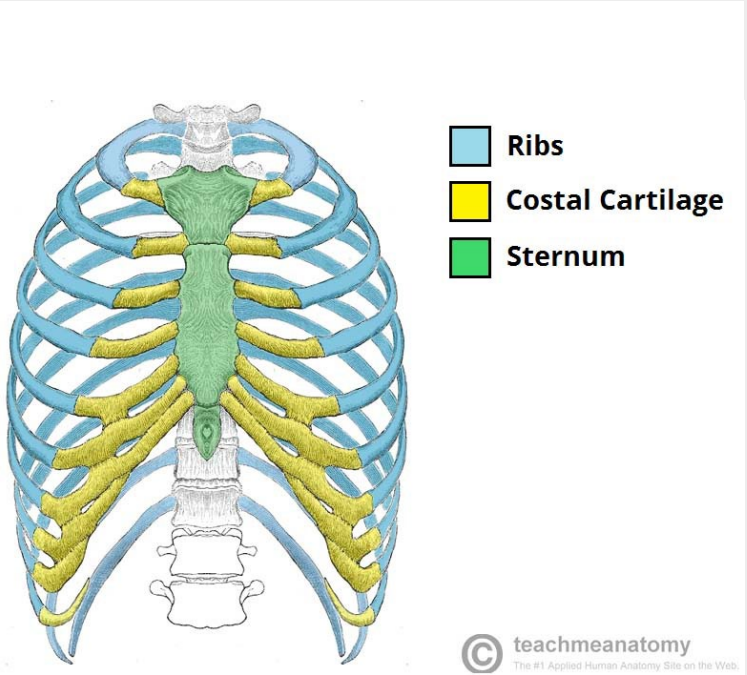
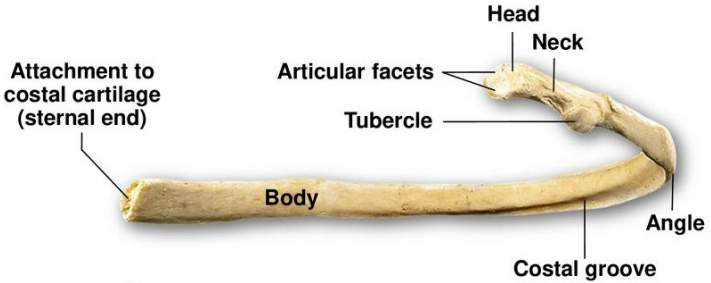


https://teachmeanatomy.info/thorax/bones/ribcage/

Anatomy

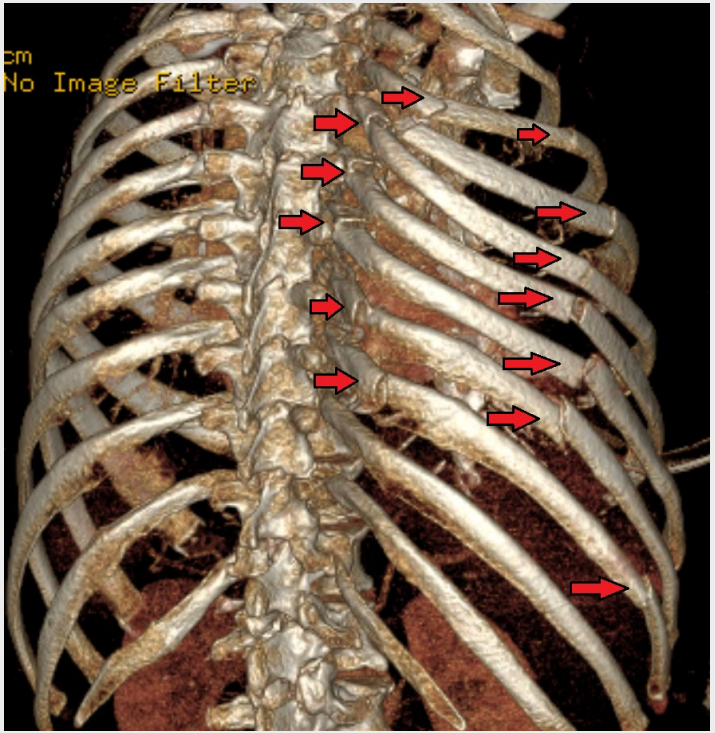
- Each rib has a bony part (posterior) and a cartilage part (anterior)
  - With the cartilage part the ribs are attached to the sternum
- Each rib consists of a head, neck and shaft
- All ribs attach to thoracic vertebrae



https://slideplayer.com/slide/14160375/

Pathology

- Rib fractures are one of the most common injuries following blunt trauma, occurring in about 10% of all trauma patients
- Flail chest
  - is a life-threatening medical condition that occurs when multiple adjacent ribs are broken in multiple places, separating a segment, so a part of the chest wall moves independently.
    - ➢ Traumatic fracture of 2-3 ribs in at least 2 places
  - Symptoms: Chest pain, shortness of breath
  - Leads to: Paradoxical breathing, pulmonary contusion, 30% mortality

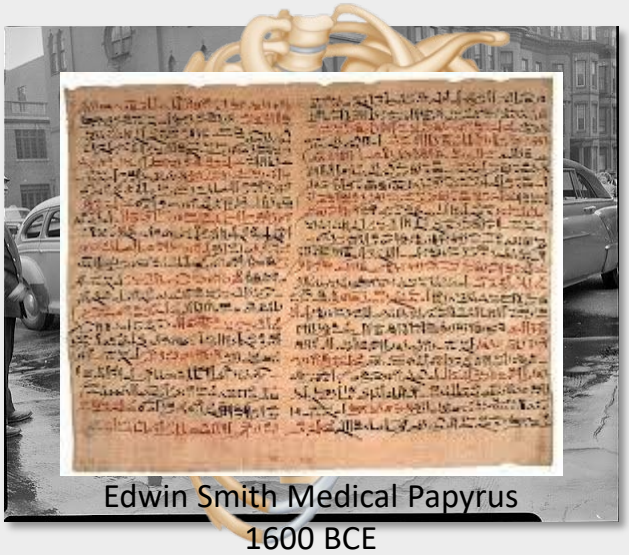


https://upload.wikimedia.org/wikipedia/commons/6/61/Flailchest3to9.png

History of rib fractures

History of Rib Fracture Management

- Interest by medical professionals first noted in 1600 BCE
- Systematic fracture patterns ID as early as 1940s
  - “Stove in chest”
  - “Steering wheel injury”
- Early reports show mortality ~80%


Edwin Smith Medical Papyrus
1600 BCE

History of Rib Fracture Management

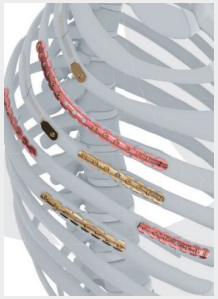
Drinker respirator
"Iron lung"

1940s

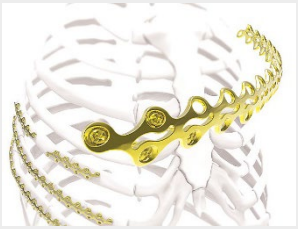
Sink plunger

K Wire

1960s



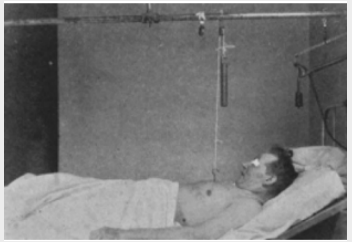
2008



2016

1926

Traction via clothes
hanger and string

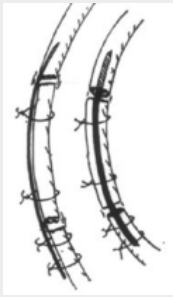


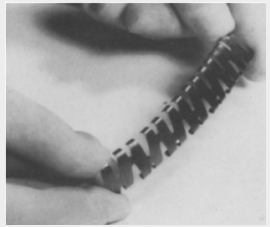
1950s

Internal ventilation

70s-Today

ORIF





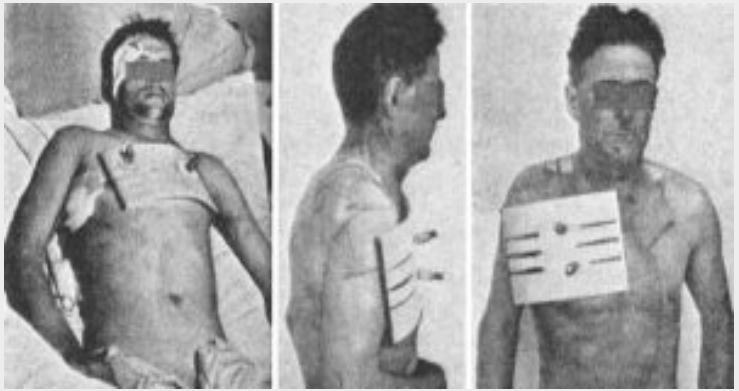
1980

History of Rib Fixation

- Surgical intervention was relatively unheard of in 1940's and 1950's due to success of mechanical ventilation
- As automobiles became more common, so did flail chest (steering wheel FX's)
- Very little change in treatment modalities from the early 1950's until plating systems were introduced in 1980's

Alternative Therapies

- Traditionally rib fractures are treated conservatively
  - This includes supportive measures such as incentive spirometers, oxygen and ventilator support, and pain management via medications
- In patients who receive non-operative care, the contribution of rib fractures to long-term pain and disability is greater than traditionally expected



Alternative Therapies

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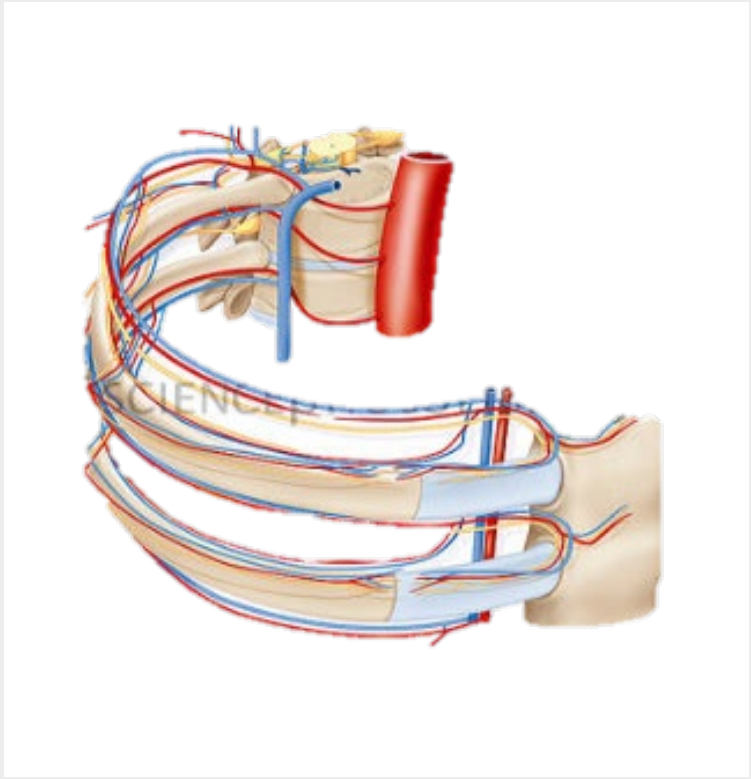
  - This includes supportive measures such as incentive spirometers, oxygen and ventilator support, and pain management via medications
- In patients who receive non-operative care, the contribution of rib fractures to long-term pain and disability is greater than traditionally expected
- Therefore surgical stabilization of rib fractures with titanium plates and screws gets more and more popular. It assists in immobilizing the fracture, allowing for proper healing while maintaining normal respiratory function

Why are ribs difficult to repair?

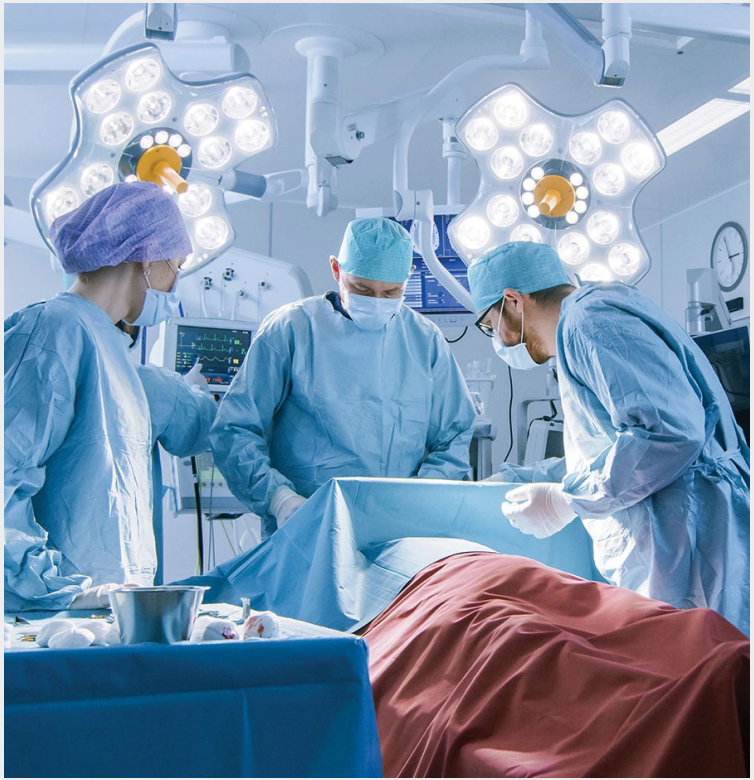
- Large incisions are needed to accommodate fixation, which leads to a more morbid procedure
- Ribs are narrow with a thin cortex that surrounds soft marrow, making reliable fixation problematic
- Fixation must endure upwards of 25,000 breathing cycles per day, including coughing
- Risk of damage to the neurovascular bundle



What patient population gets ORIF treatment?

- Historically conservative treatment
  - flail chest
  - severely displaced fractures
  - Avoided operative treatment for elderly

- Recent clinical publications have shifted protocols
  - Non flail
  - Patient age is still in debate

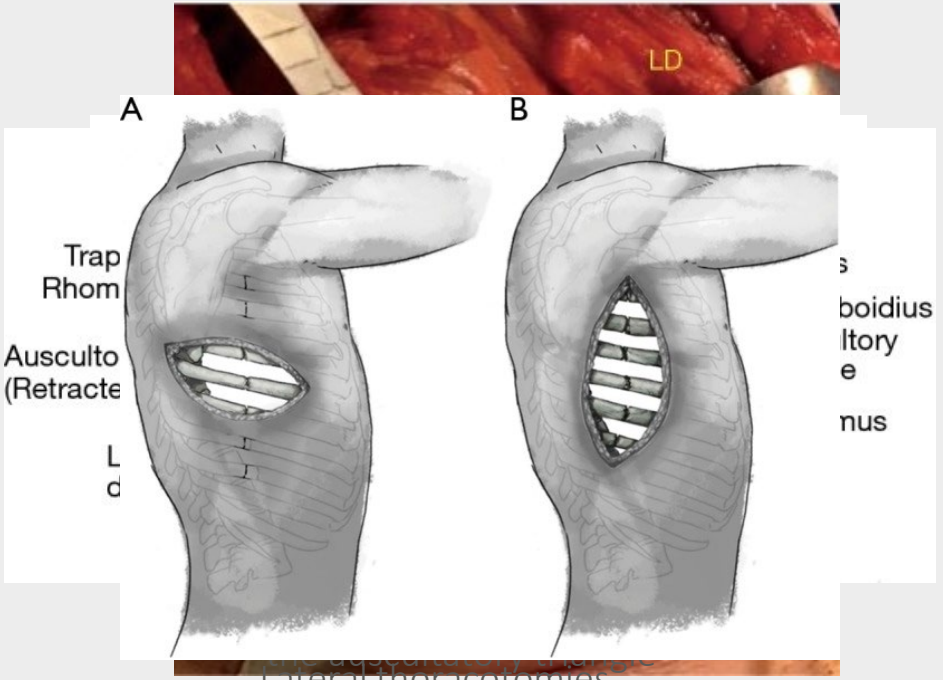


When are patients treated?

- Historic clinical indication within 7-10 days
  - Goal to get patients off vent
- Recent recommendation is within 72 hours
  - To ID patients before having to go on the ventilator

How is surgical treatment approached?

- Approach largely dependent on location and # of fracture(s)
- Common approaches:
  - A/P lateral- lateral longitudinal thoracotomy
  - Anterolateral – Muscle-sparing approach
  - Posterior – Auscultatory triangle



Lateral thoracotomies

Muscle-sparing approach for anterolateral fractures

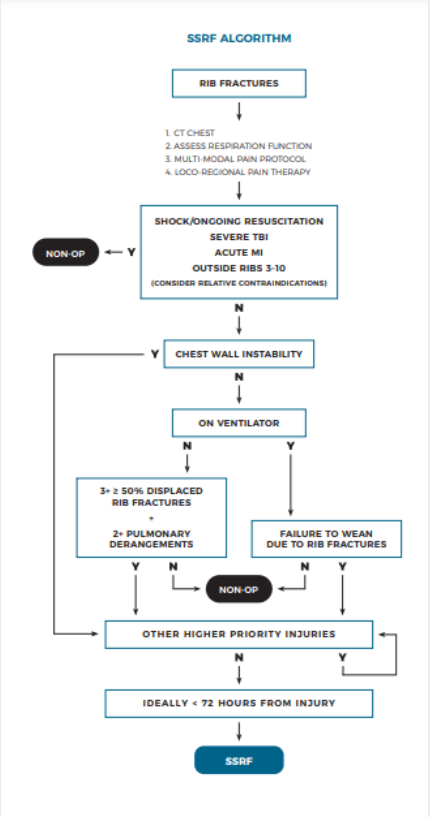
Clinical Data

- SSRF vs. conservative treatment for **flail chest (FC)**– 4 RCTs
- SSRF vs. conservative treatment for **multiple fractures and concurrent FC** – 1 RCTs
- SSRF vs. conservative treatment for **multiple fractures, non-FC** – 2 RCTs

  - 2019 Marasco non-operative QOL study – 71% did not return to work
  - 2020 Non-flail RCT
    - less pain
    - less narcotic usage
    - less complications

Chest Wall Injury Society (CWIS) Guidelines

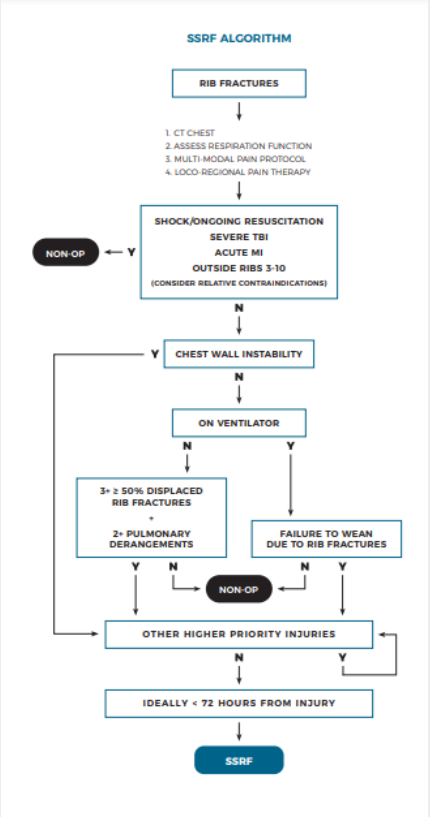
- CWIS established in 2017
- CWIS guideline for surgical stabilization of rib fractures (SSRF)
  - Published in 2021
  - Most comprehensive guidelines available
- Pro rib plating
- Guidelines are still controversial



Chest Wall Injury Society (CWIS) Guidelines

- In summary, calls for operative treatment if:

- Chest wall instability or,
- 3+ fractures with ≥ 50% cortical displacement or,
- Failure to wean from vent due to rib fractures

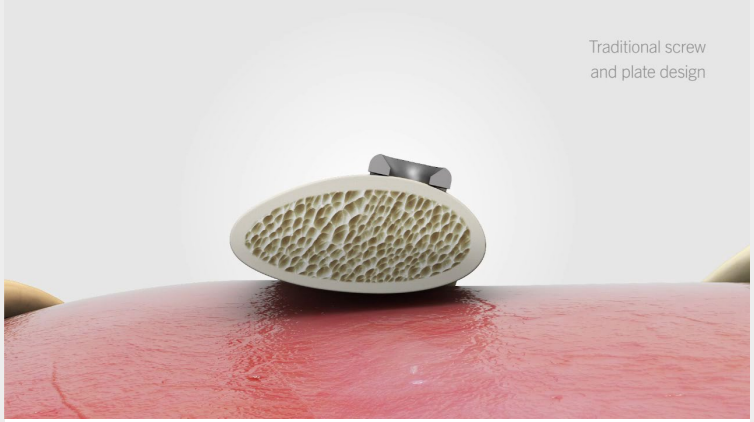


CB 3 Technology

What is CB3 technology?
Convergent Biaxial 3-D fixation

The screws converge on each other ensuring stable fixation of the plate to the bone.

- Bi-cortical fixation strength without the risk of lung perforation



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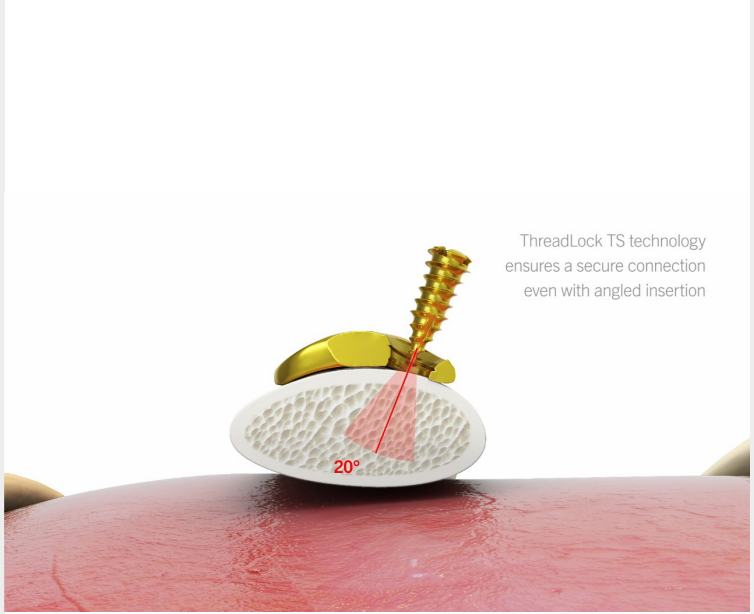
- 20 degree angulation



What is CB3 technology?
Convergent Biaxial 3-D fixation

The screws converge on each other ensuring stable fixation of the plate to the bone.

- Bi-cortical fixation strength without the risk of lung perforation
- 20 degree angulation
- Convergent screws allow for a strong pull-out force
- Design allows for more screw fixation options

L1 Rib Plates & Screws

L1® Rib offers distinct advantages over other products on the market

- Plates are designed for a universal anatomic fit
  - No need for specific sided plates.
  - Limited plate lengths – by design.
- CP titanium plates offer better intra-operative handling and better adaptation to normal rib function.
  - Simple, intuitive plate contouring
  - Allows for better physiologic function of the rib
- Pre-package sterile, UDI compliant

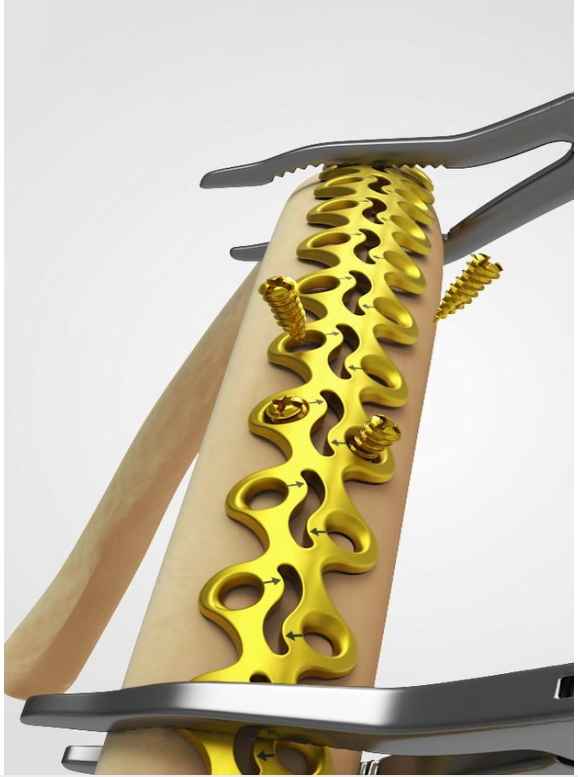
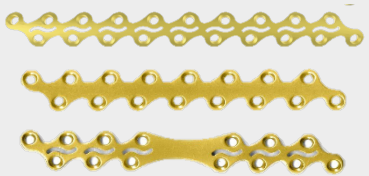


Plate Material:
Commercially Pure Titanium (ASTM-F67)

Grade II

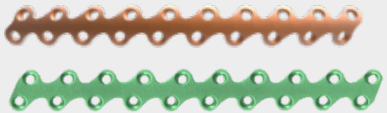
- **General properties** - Allows for moderate strength but higher ductility.
- **Ultimate Tensile Strength** – 345 MPa
- **Percent Elongation** – 20%
- **Grade II plates:**



- **Grade II benefit:** easier to shape to patient's anatomy

Grade IV

- **General properties** - Allows for high strength but lower ductility.
- **Ultimate Tensile Strength** – 550 MPa
- **Percent Elongation** – 15%
- **Grade IV plates:**



- **Grade IV benefit:** Able to withstand greater loading forces in the chest wall

Screw

- Made from titanium alloy (Ti6Al4V)
- Diameter 2.3 mm
- Length 7 mm (only one length necessary due to CB3)
- Locking (+- 20°)
- Drill-free
- Color coding: Gold
- Different packaging sizes (1 pc / 4 pc / 10 pc)
  - 4 pc and 10 pc sterile packed in „contact lense“ box
  - 1 pc sterile packed in single-clip

L1 Rib Instruments

Instruments

- Screwdrivers
  - Standard Handle with 2.0 /2.3 mm maxDrive blade
  - Angulus2 Angled Screwdriver with 2.0 /2.3 mm maxDrive blade
  - BOS HT with 2.0 /2.3 mm maxDrive blade

Screwdrivers and Blades

maxDrive®

Blades suitable for		25-407-03-07	50-990-00-07	50-800-04-07
25-486-97-07	2.0 / 2.3 mm	80 mm		
50-817-20-07	2.0 / 2.3 mm	40 mm		40 mm
50-991-20-07	2.0 / 2.3 mm		10 mm	
50-991-20-71	2.0 / 2.3 mm		10 mm	
24-015-58-07	2.0 / 2.3 mm	130 mm		

Instruments

- Screwdrivers
- Depth gauges (function more as a go/no-go)
  - Tri Color
  - Fixed
- CB3 screw guide
  - Used for precise screw angulation
  - Not required but is recommended if bone thickness is in the “yellow” zone

Instruments

- Screwdrivers
- Depth gauges
- CB3 screw guide
- Cushing forceps
- Bone lever (to manipulate displaced fractures)
- Temporary fixation instrument

Instruments

- Screwdrivers
- Depth gauges
- CB3 screw guide
- Cushing forceps
- Bone lever
- Temporary fixation instrument
- Plate cutter
- CB3 Bending pliers
  - Fit the contour of the CB3 plate
  - Currently being updated to better accommodate the plates

Instruments

- Screwdrivers
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- CB3 screw guide
- Cushing forceps
- Bone lever
- Temporary fixation instrument
- Plate cutter
- CB3 Bending pliers
- Diverse Bone / Plate holding forceps

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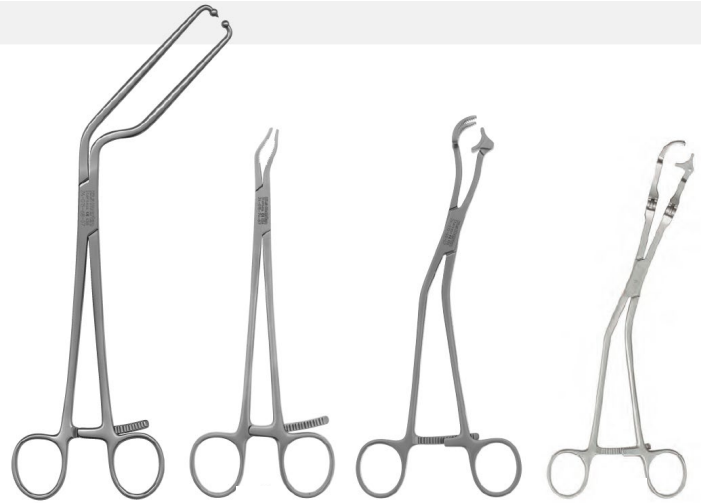

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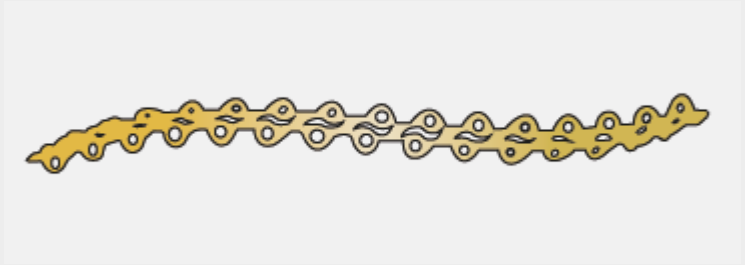
- Diverse Bone / Plate holding forceps

Temporary Fixation Screws

- Function similar to the clamps
- Non-locking to lag the plate to the bone

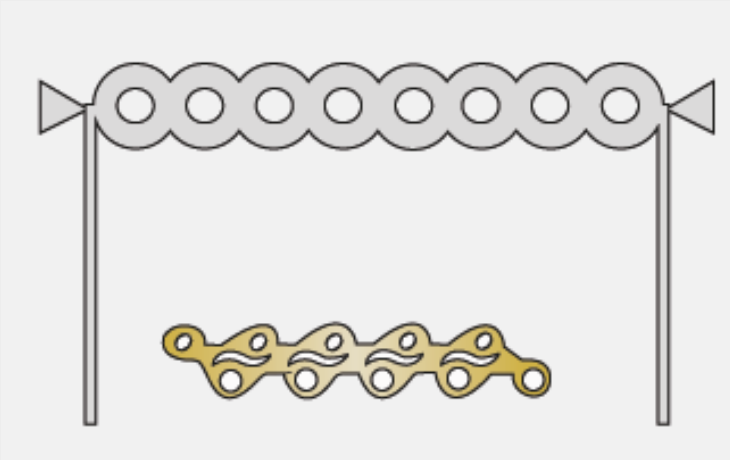
Feature, Function, Benefit

- Smart shape design based on average patient data
  - ➢ Enable the same plates to be applied to any rib shape
  - ➢ Decreasing inventory
  - ➢ Improving overall system ease of use



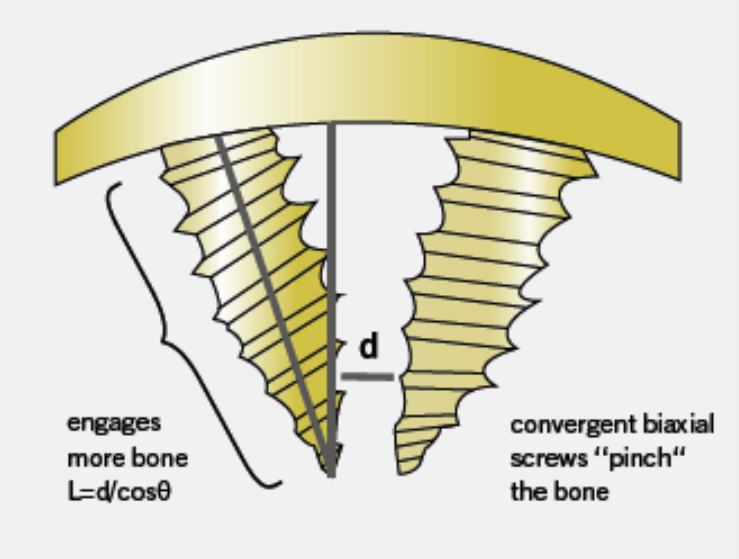
Feature, Function, Benefit

- Special x- shape design with minimal footprint
  - ➢ Allows for more screws per area of rib than conventional reconstruction plates
  - ➢ Enables physical placement in a smaller segment of bone, smaller dissection or retraction area and easier precision in placement
  - ➢ Frees up the rib for natural movement



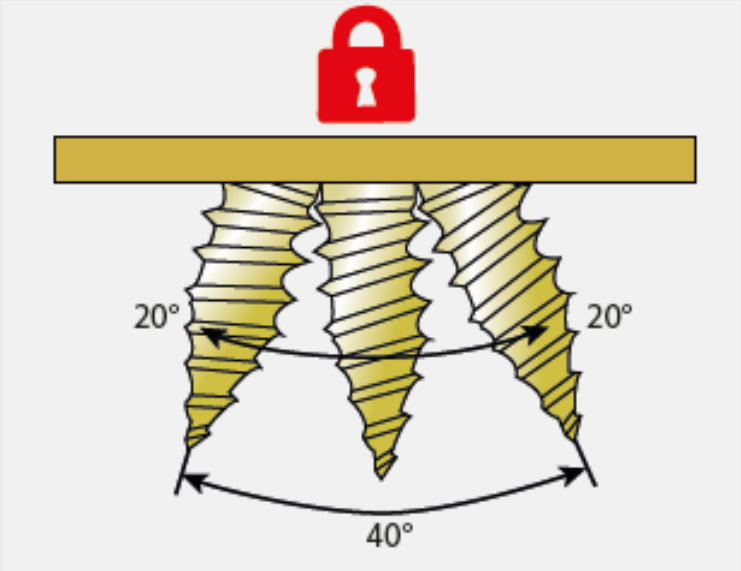
Feature, Function, Benefit

- Convergent Biaxial fixation “CB3” technology engages more bone
  - ➢ Secure osteosynthesis is possible using monocortical screws
  - ➢ No need for careful drilling, depth measurement and screw placement, which is required for traditional bicortical fixation
  - ➢ Helps to mitigate risk, increase operative efficiency and provide excellent fixation for rib fractures
  - ➢ Only one screw length required which simplifies the application and ease of use



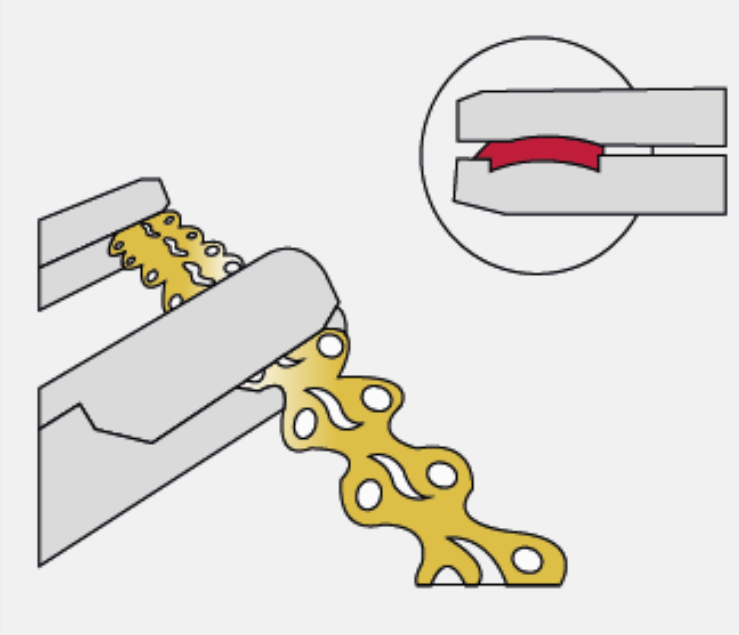
Feature, Function, Benefit

- ThreadLock TS multidirectional locking screw
  - ➢ Single pitch locking mechanism that allows for up to 20° of angulation in any direction
- Drill-free screw
  - ➢ No need for pre-drilling



Feature, Function, Benefit

- Innovative instrumentation
  - ➢ Enables the surgeon to contour, secure and fix the plate in position with control and precision



Surgical Technique & Indications

Indications

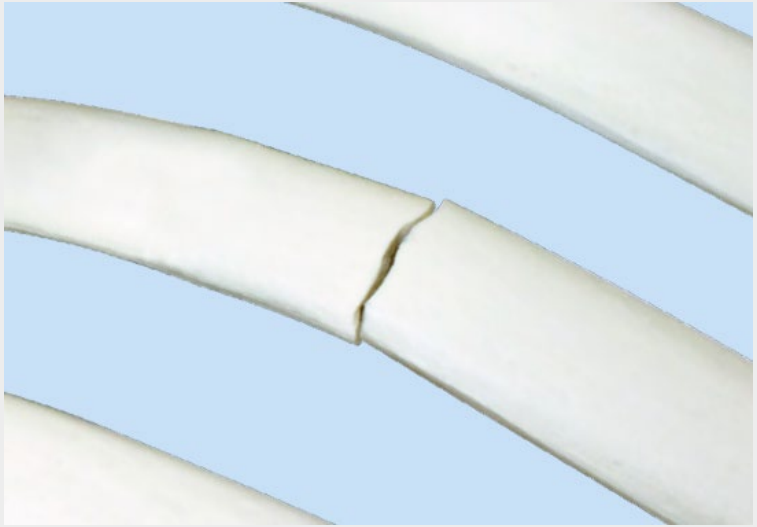
The L1 Rib Plating System is indicated for surgeries requiring osteosynthesis of the chest wall, including

- stabilization and fixation of fractures
- osteotomies
- reconstructive procedures

Surgical Technique

Step 1 - Expose the fractured rib

- Expose to allow a minimum of three screws on each side of the fracture. Remove any nonviable bone.

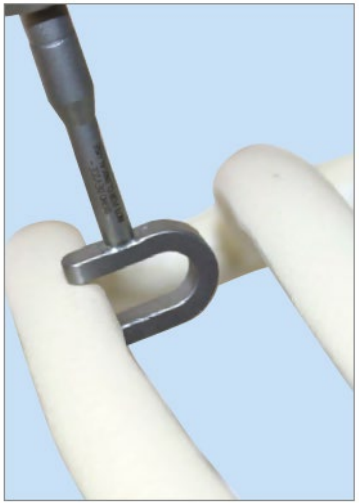


Surgical Technique

Step 2 - Ensure the rib has adequate thickness

- If there is no existing incision in the location where screws are desired, then make a small incision in the intercostal space at the superior border of the rib to allow insertion of a caliper.
- Insert the Tri Color Depth Gauge tip (left) or Fixed Depth Gauge tip (right) through the incision and measure the rib thickness.

Tri Color Depth Gauge



Fixed Depth Gauge

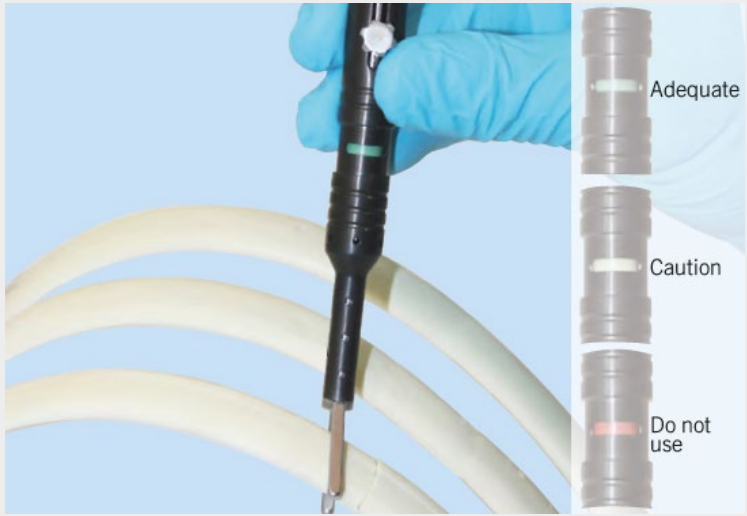
Surgical Technique

Step 2a - Tri Color Depth Gauge

- Push the sliding button to extend the working ends around the rib. The tip is spring loaded and will close down on the rib automatically when released. After releasing the button read the display window.

  Rib has adequate thickness.
  Caution: use only with the Screw Guide.
  Do not use.

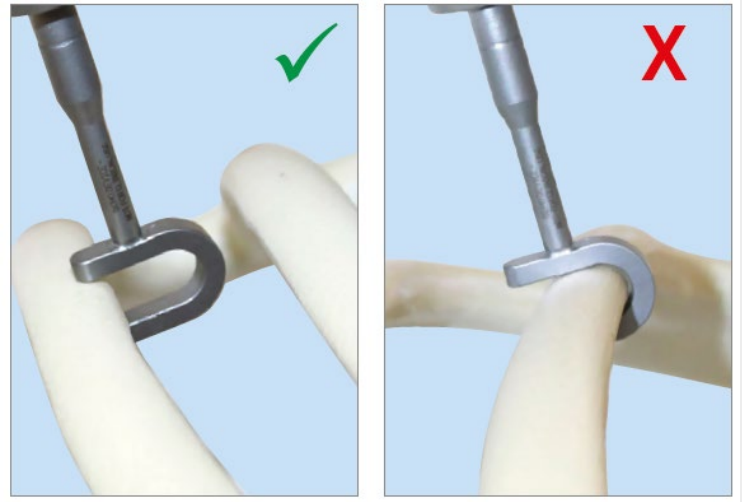
- The placement of screws into bone less than 7 mm is not recommended.



Surgical Technique

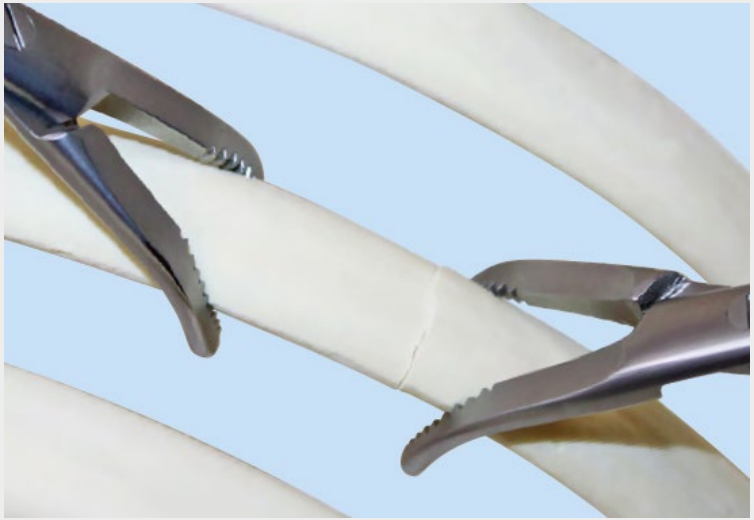
Step 2b - Fixed Depth Gauge:

- The Fixed Depth Gauge provides a simple method of measuring rib minimum thickness.
- If the Fixed Depth Gauge fits over the rib, use the Adjustable Gauge to determine if screw placement is possible.
- If the Fixed Depth Gauge does not fit over the rib, then the rib thickness is greater than 7 mm. This thickness is adequate for placement of screws with or without the Screw Guide controlling the angle of insertion.



Surgical Technique

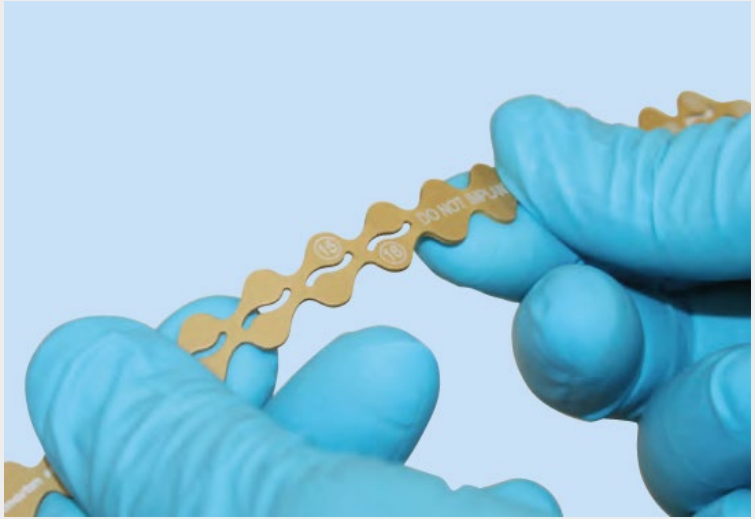
Step 3 - Approximate the broken rib segments with the Rib Bone Holding Forceps.



Surgical Technique

Step 4 - Cut and contour the plate template (optional)

- Place the template over the area where plate coverage is desired, ensuring a minimum of three screws in each segment. If desired, cut the template to the correct size.
- The template may also be used to aid in contouring the plate to match the bone surface. The template is malleable and may be digitally shaped to the bone contour.



Surgical Technique

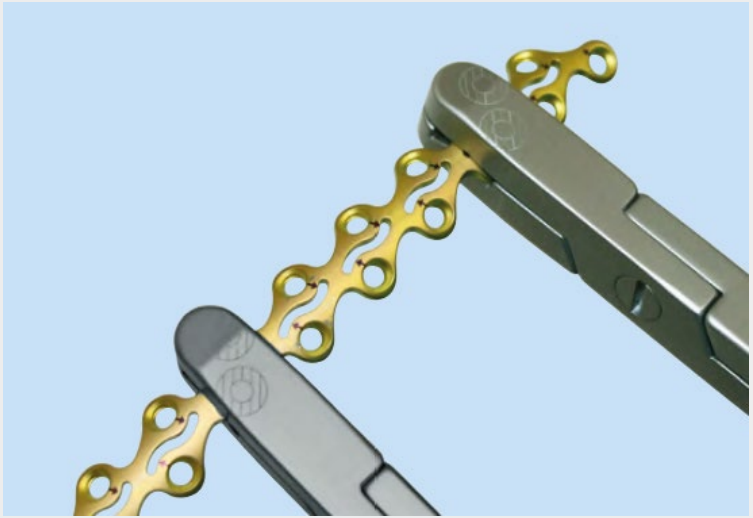
Step 5 - Select and cut plate

- The surgeon must select the appropriate plate for fracture fixation. If necessary, cut the plate based on your template measurements using the Double Action Plate Cutter.
- A deburring attachment may be used to smooth any rough edges along the cut section.
- Caution: The surgeon should ensure the fractured segment has bone to bone contact and no continuity defect. Any bridging of a continuity defect must be combined with a bone graft.

Surgical Technique

Step 6 - Contour the plate

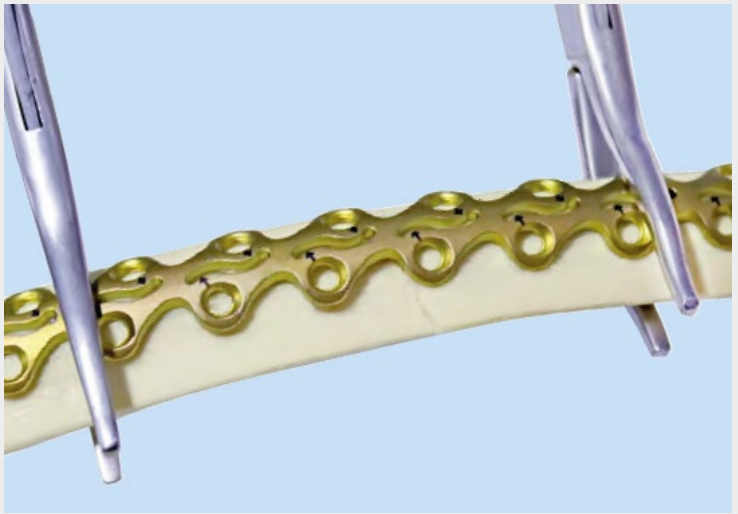
- Using the bending pliers with the screw hole etching facing up, contour the plate to match the template. The CB3 Bending Pliers have been specially designed to retain the surface curvature and protect hole integrity while bending.
- Caution: If contouring is necessary, avoid sharp bends, reverse bends, or bending the implant at a screw hole. Avoid notching or scratching the implant. These factors may produce internal stresses which may become the focal point for eventual breakage of the implant.



Surgical Technique

Step 7 - Position the plate

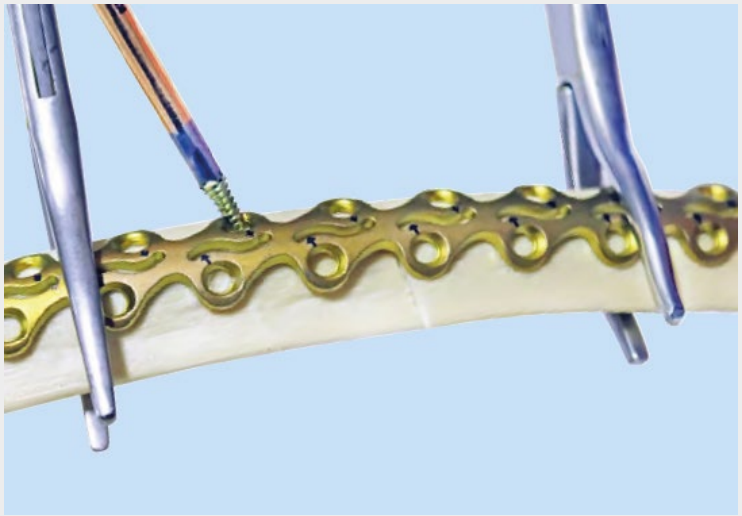
- Position the plate on the rib over the fracture, allowing a minimum of three screws on each side of the fracture. Verify that the contour of the plate matches the rib. The Plate Holding Forceps are specially designed to hold the plate on the rib.
- Caution: It is recommended to insert the forceps from the superior border of the rib to avoid damaging the nerve and vessel bundle located at the inferior border of the rib.



Surgical Technique

Step 8 - Select and insert the screw

- The ThreadLock TaperScrew technology in the screw and plate allows up to 20° of angulation; however, ideal placement angulation can easily be done with the CB3 Screw Guide. It is recommended to use this option if the Adjustable Depth Guide indicated a yellow caution thickness.
- The surgeon should ensure the screws enter the plate at a correct angle if the Screw Guide is not used. Directional markings are etched onto the plate surface to aid in correct angulation.



Surgical Technique

Step 8 - Select and insert the screw

- Alternatively the screw can be inserted with a battery-powered screwdriver (e.g. our BOS HT Driver). If a a battery-powered screwdriver is used, make sure the screws are tight and further secure them with a manual screwdriver.

Surgical Technique

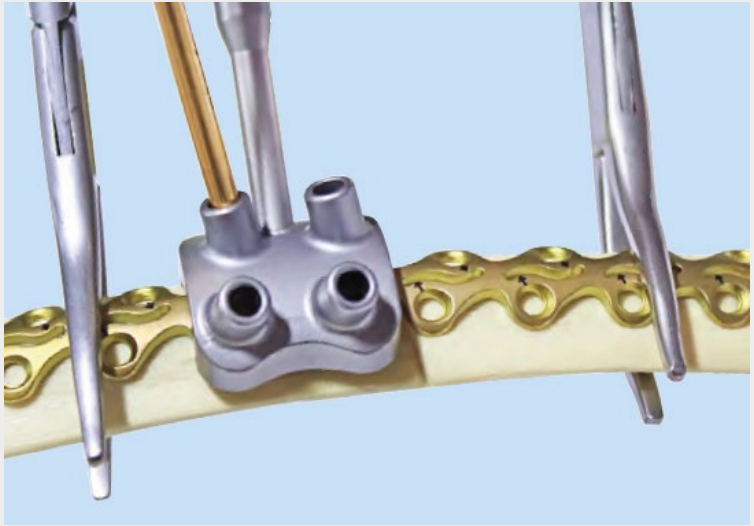
Step 8 - Select and insert the screw

- Alternatively the screw can be inserted with a battery-powered screwdriver (e.g. our BOS HT Driver). If a a battery-powered screwdriver is used, make sure the screws are tight and further secure them with a manual screwdriver.
- For placement of screws in the sub-scapular approach or in areas where a straight screwdriver may not be utilized, the Angulus 2 angled screwdriver is ideal.

Surgical Technique

Step 8 a - Screw Insertion with Thumb Twist Screwdriver handle and blade with CB3 Screw Guide

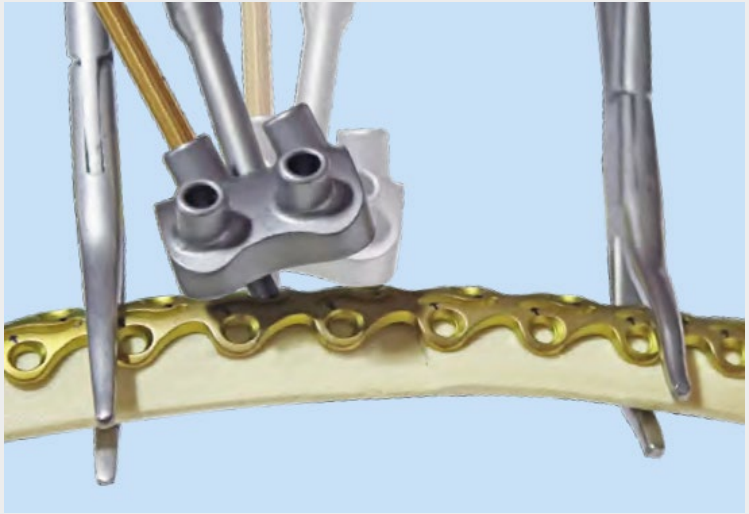
- To load the screwdriver blade into the driver, retract the collar and fully insert the hexagonal blade. Release the collar and ensure the blade is securely seated.
- Place the Screw Guide over the plate to ensure the screws enter the plate at the correct angle and orientation. Using the Thumb Twist Screwdriver, place the 7 mm screws through CB3 Screw Guide and into the plate. Tighten until secure. Ensure that each screw is completely locked into the plate.



Surgical Technique

Step 8a - Removal of screwdriver blade

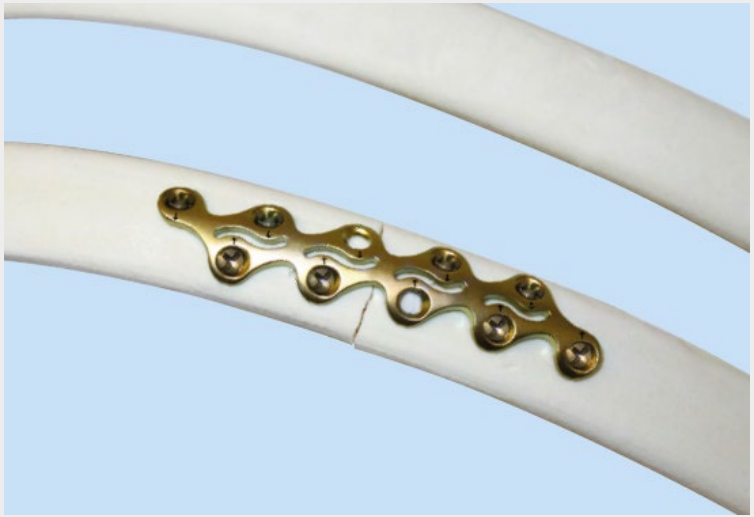
- Remove the screwdriver blade from the screw by lifting the CB3 Screw Guide and rocking the screwdriver blade back and forth.



Surgical Technique

Step 9 - Insert screws.

- Ensure that the screws are completely locked into the plate. Surgeon should ensure proper fracture reduction and plate placement.



Surgical Technique

Spar Plate:

- Position the plate on the rib over the fracture, allowing a minimum of three screws on each side of the fracture.
- The spar of the plate should be aligned over the fracture, leaving the screws holes on each side of the fracture.
- If possible, screws should be placed in the holes adjacent to the spar.

Surgical Technique

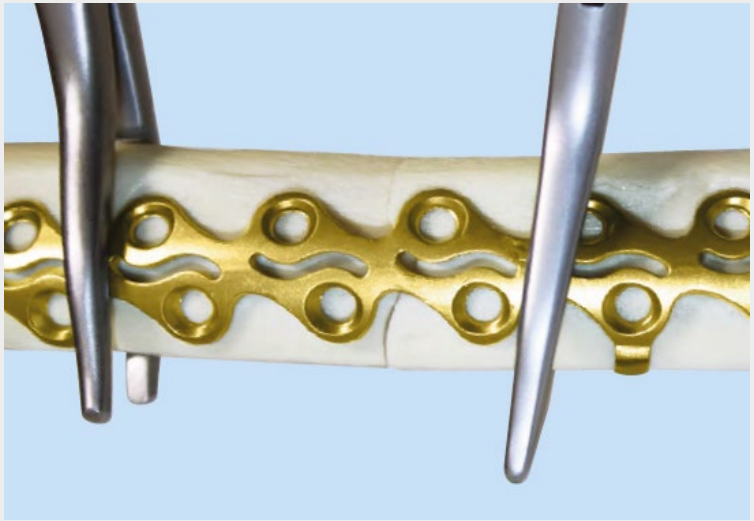
Spar Plate:

- Caution: It is recommended to insert the forceps from the superior border of the rib to avoid damaging the nerve and vessel bundle located at the inferior border of the rib.
- Caution: When using the Spar plate, the surgeon must ensure the spar is aligned over the fracture site and that a minimum of three screws are place on each side of the fracture. Failure to align the plate properly may result in inadequate fixation of the fracture.

Surgical Technique

Tabbed Plate:

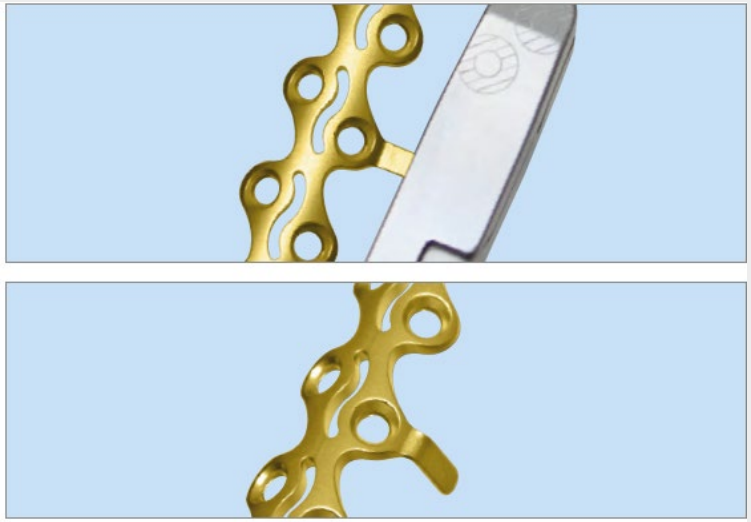
- Using the Bending Pliers, bend the tabs on the plate to a 90° angle with the superior edge of the plate. These tabs will assist in plate alignment.
- Position the plate on the rib over the fracture, allowing a minimum of three screws on each side of the fracture.
- The tabs will rest of the superior aspect of the rib to ensure the plate is aligned properly.



Surgical Technique

Tabbed Plate:

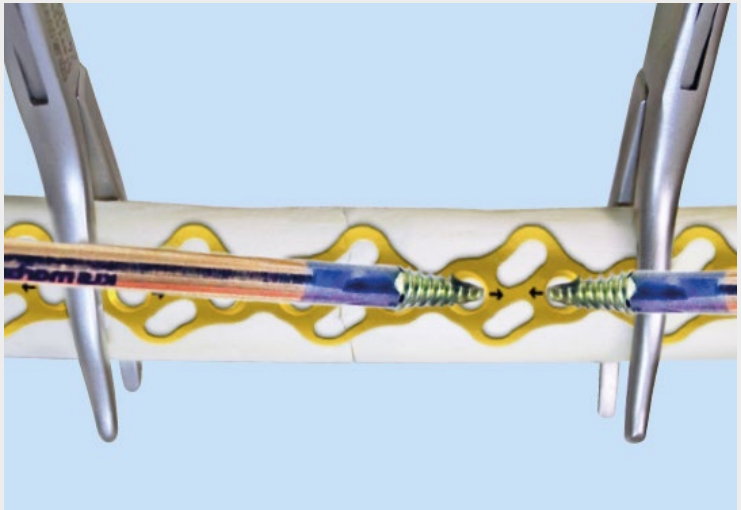
- Caution: When using the Tabbed plate, the surgeon must not bend the tabs in a back and forth motion as this may weaken the tabs, causing them to fracture.
- The tabs are for alignment purposes only and do not provide any additional fixation. The tabs should be aligned on the superior border of the rib and screws should be placed in the same manner as other rib plates.
- The surgeon must ensure the tabs are not interfering with any important anatomical structures and are not protruding into the pleural space.



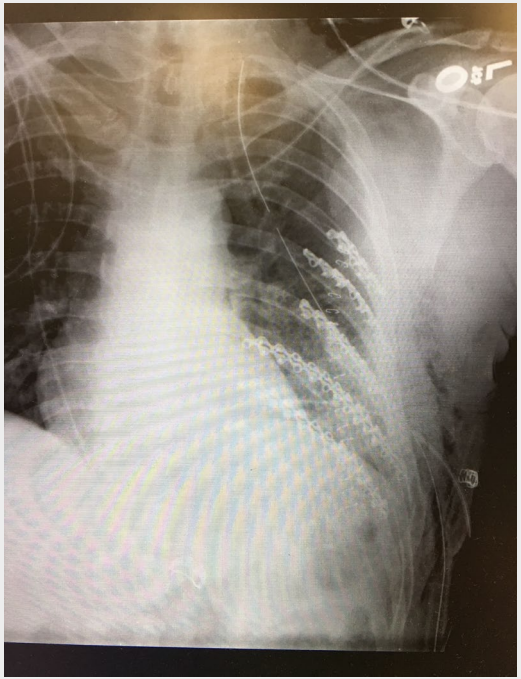
Surgical Technique

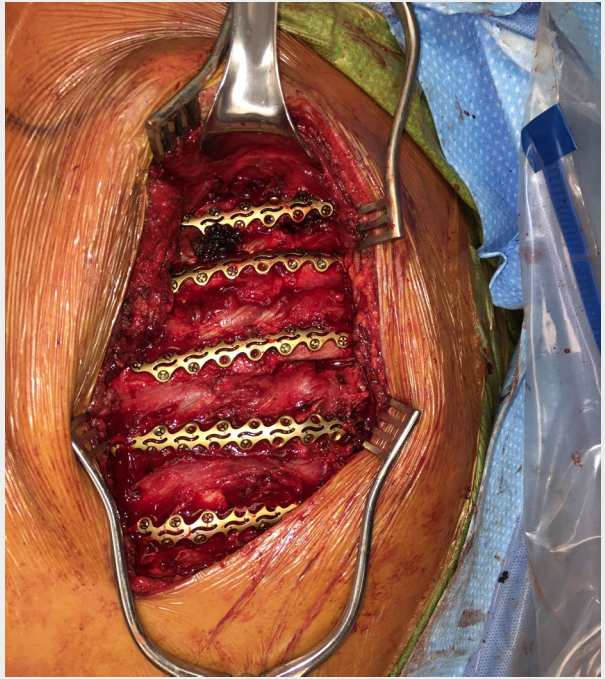
Specialty plate screw insertion:

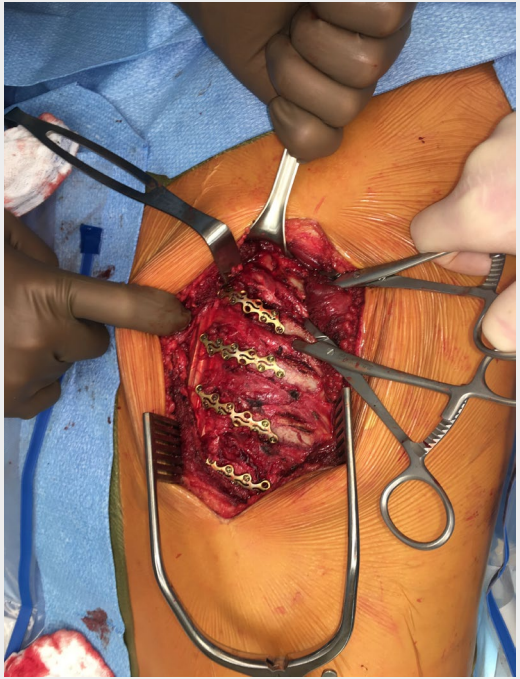
- Select and insert the screw.
- The ThreadLock TaperScrew technology in the screw and plate allows up to 20° of angulation. It is recommended to use this plate only when the adjustable depth guide indicates a green thickness.
- The surgeon should ensure the screws enter the plate at a correct angle. Directional markings are etched onto the plate surface to aid in correct angulation.

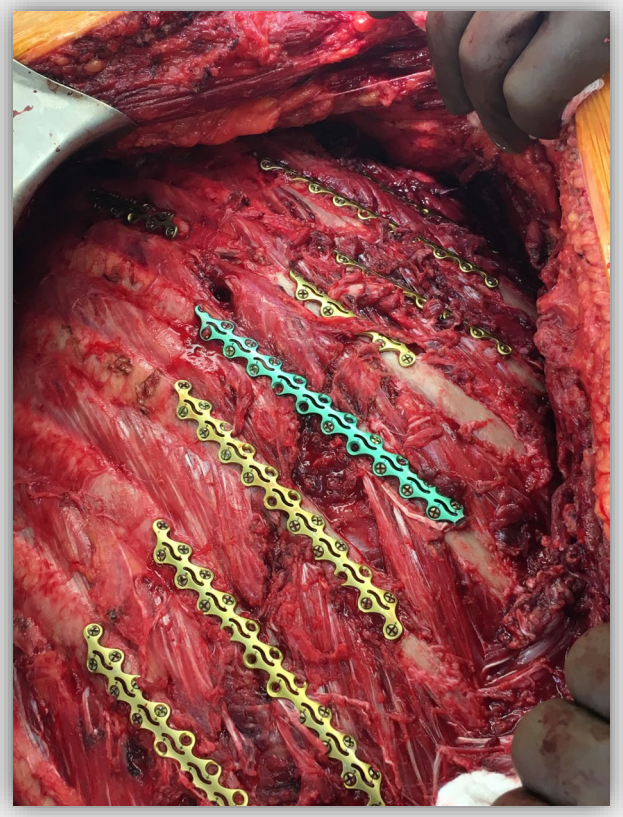


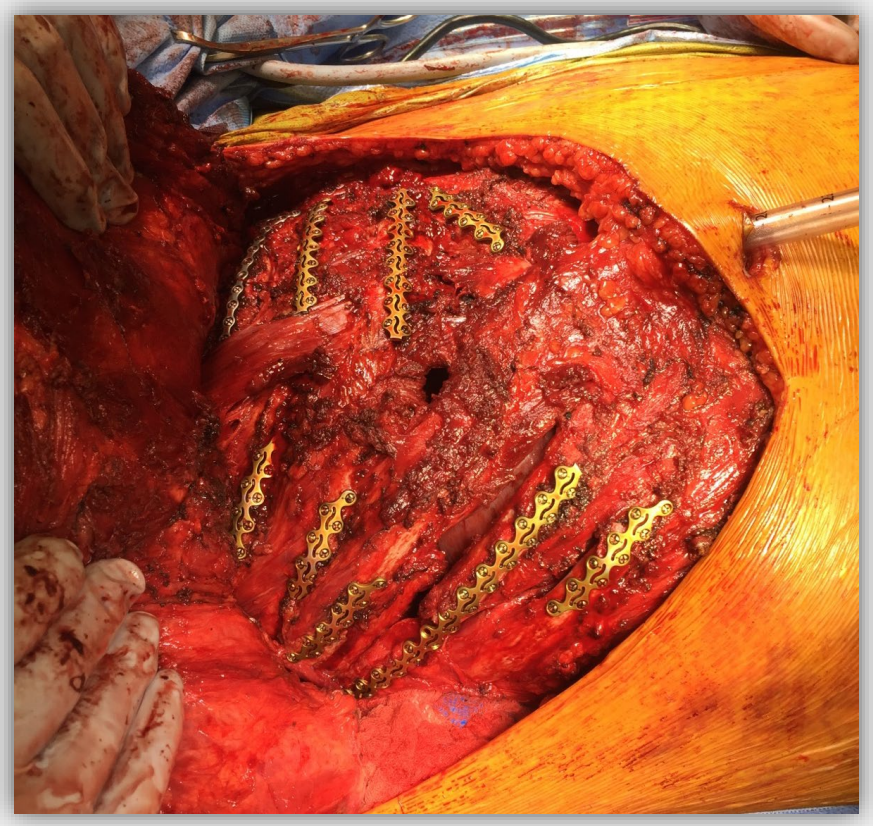
Case examples

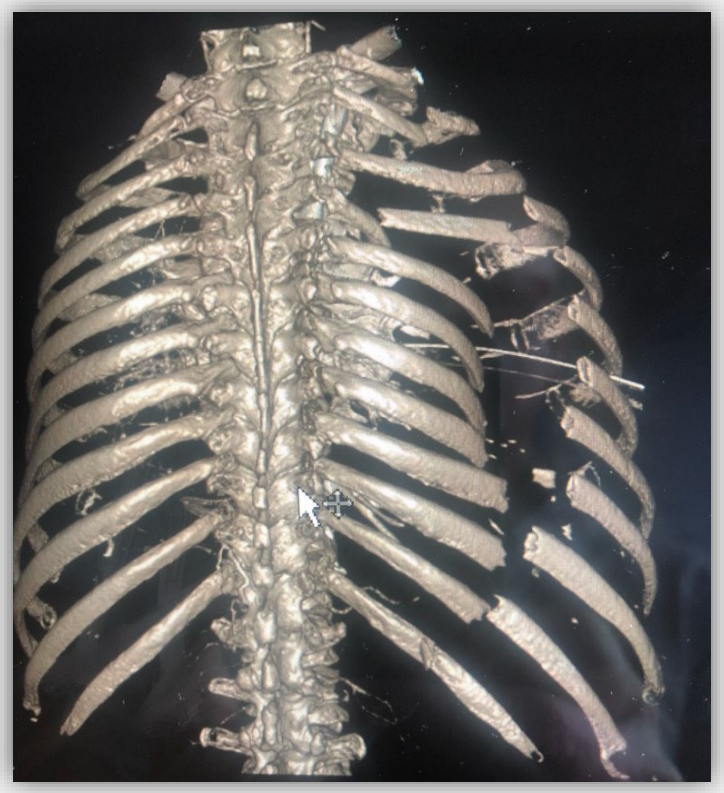


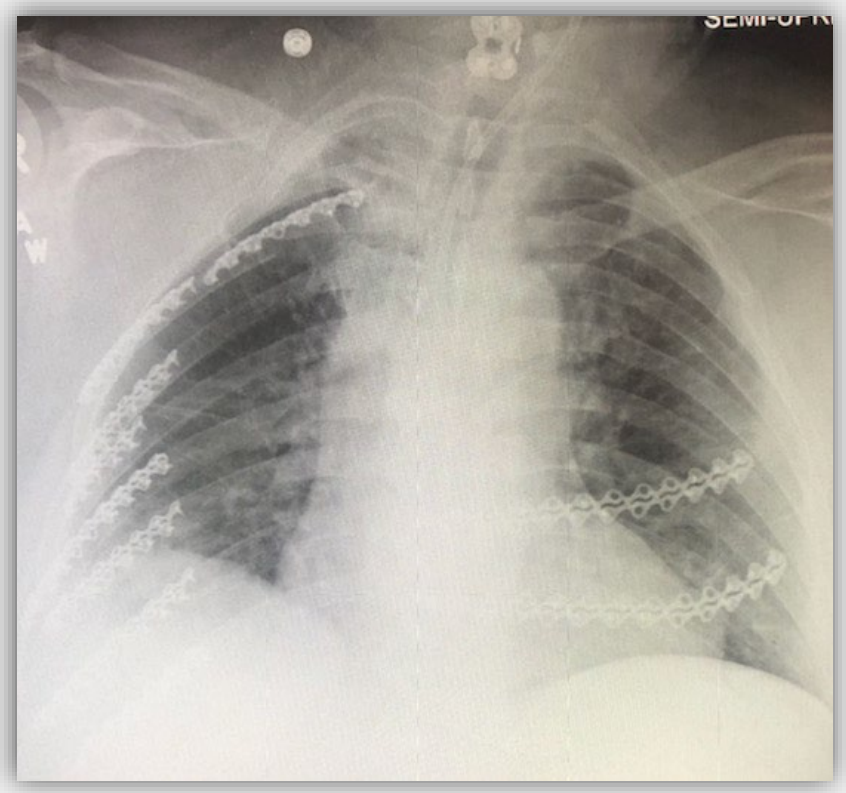


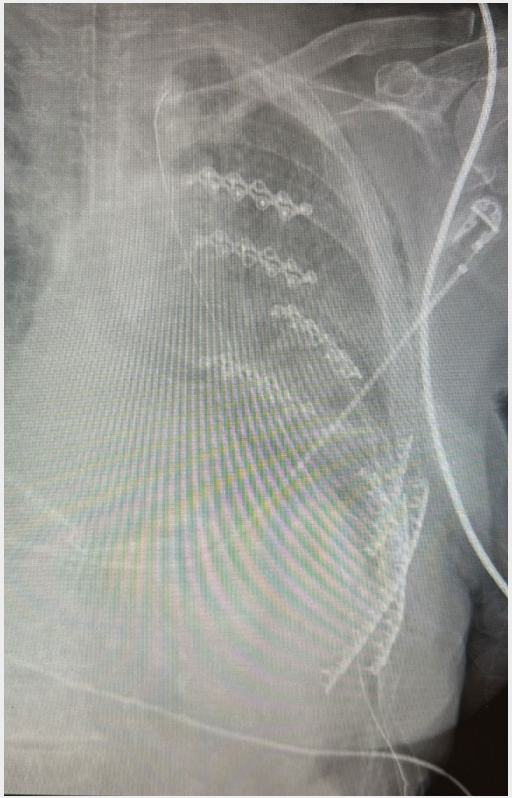












FAQ's

Q: Do I need to drill pilot holes?
A: No, our screws are drill free and self-tapping.

Q: Do I have to elevate the periosteum?
A: No. We are more focused on making sure the plate is contoured to the bone and has a passive lie. We would like to leave as much vascularity in place as possible.

Q: Does your set have pre-contoured plates and left/right plates?
A: Our plates do have a curviture to them which should make bending as you go posterior easier. We included long and short plates to give options and when only a short plate is needed decrease waste to the hospital. Our system is based on a more simplistic, universal concept. In the research we did, we found more frustration with the difficulty of the Synthes system and the wide majority wanted an easier system to use.

Q: Do I have to go bi-cortical?
A: No. The cortex is not well defined like a mandible or femur. The risk you run having a screw tip poke through the posterior cortex is not worth the benefit. Our screw/plate interface is locking negating the need to have bicortical fixation.

Q: I am right over the fracture but I really want to use this hole. What can I do?
A: Remember the plate is chamfered to place the screws on a 10 degree angle toward the middle of the rib, but a nice feature of our plating system is that you can angle the screw 20 degrees in any direction so feel free to use the hole and just angle the screw away from the fracture or even across it.

FAQ's

Q: Do most people plate ribs now? We really haven't in the past.
A: The paradigm has certainly shifted. In the mid 1940's on to the 80's plating was fairly common but very crude with mixed results. In the last 4-5 years it has become the standard when dealing with flail segments and multi-level fractures. With 1 or 2 fractures most of our surgeons assess pain level and give the patient an option. Feel better in 2 weeks with surgery or 6-8 weeks without.

Q: How does your set compare with the others on the market?
A: Highlight the benefits of our set first and as you do highlight the shortcomings (carefully) of the other systems with the understanding this surgeon may have been the champion of the other set getting into the hopsital.

Q: How does your case cost compare with the other systems on the market?
A: Even with the latest technology advancements in the industry we typically save the hospital money. We also save the hospital money by having a drill free screw system which requires no twist drills. This can save $400-$600 per case alone. Ribloc and Synthes are both significantly more expensive than we are at list. Synthes discounts very little, even at their largest accounts.

Further resources concerning surgical access:

Axillary approach:

https://www.youtube.com/watch?v=y8QXYBnnEeY

Subscapular approach:

https://www.youtube.com/watch?v=lS2cnxrVCTc

Paraspinal approach:

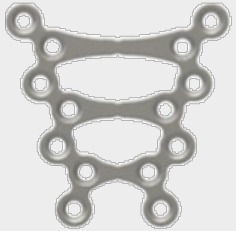
https://www.youtube.com/watch?v=mTr-cSF3378

New Product development – L1 Sternum coming soon

24-025-43-09
10-Hole body plate
= 1.8 mm

24-025-49-09
6-Hole straight plate
= 1.8 mm

24-025-44-09
8-Hole X plate
= 1.8 mm



24-025-61-09
14-Hole ladder
= 1.8 mm

24-025-52-09
9-Hole Y plate
= 1.8 mm

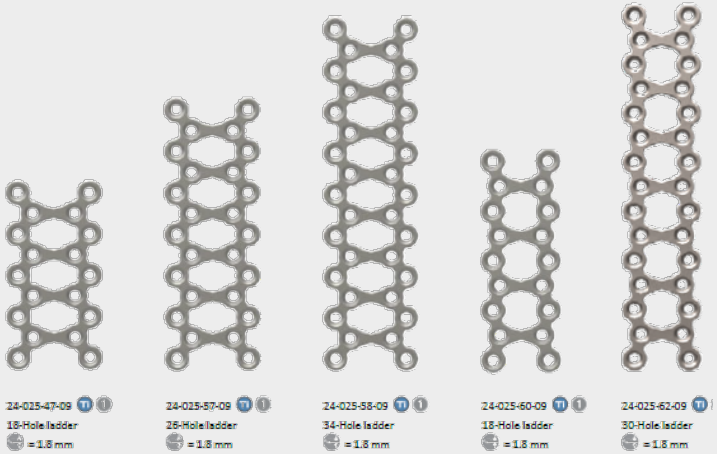
24-025-54-09
14-Hole Y plate
= 1.8 mm

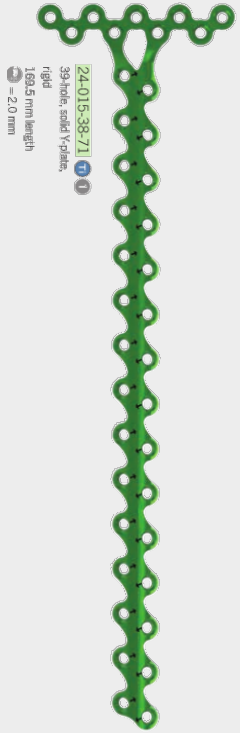
24-025-07-09
20-Hole straight plate
= 2.0 mm

24-025-50-09
8-Hole straight plate
= 1.8 mm

24-025-51-09
10-Hole straight plate
= 1.8 mm

New Product development – L1 Sternum coming soon





New Product development – L1 Sternum coming soon

24-025-42-09 TI 1
6-Hole football
= 1.8 mm

24-025-63-09 TI 1
2x 2-Hole ladder
= 1.8 mm

24-025-55-09 TI 1
8-Hole ladder
= 1.8 mm

24-025-46-09 TI 1
7-Hole JLT plate
= 1.8 mm

24-025-56-09 TI 1
11-Hole JLT plate
= 1.8 mm

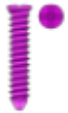
24-025-59-09 TI 1
4-Hole curved plate
= 1.8 mm

24-025-48-09 TI 1
4-Hole straight plate
= 1.8 mm

New Product development – L1 Sternum coming soon

Drill-Free maxDrive Ti

Sternal Screws		self-retaining	
		5	1
	2.3 x 7 mm	24-023-07-09	24-023-07-91
	2.3 x 9 mm	24-023-09-09	24-023-09-91
	2.3 x 11 mm	24-023-11-09	24-023-11-91
	2.3 x 13 mm	24-023-13-09	24-023-13-91
	2.3 x 15 mm	24-023-15-09	24-023-15-91
	2.3 x 17 mm	24-023-17-09	24-023-17-91

Emergency Screws		self-retaining	
		5	1
	2.5 x 9 mm	24-024-09-09	24-024-09-91
	2.5 x 13 mm	24-024-13-09	24-024-13-91
	2.5 x 17 mm	24-024-17-09	24-024-17-91

Thank you very much for your attention