



A.L.P.S. Hand Fracture System

Advanced Plating Guide

Surgical Protocols by

Lloyd Champagne, M.D

BIOMET

One Surgeon. One Patient.

Over 1 million times per year, Biomet helps one surgeon provide personalized care to one patient.

The science and art of medical care is to provide the right solution for each individual patient. This requires clinical mastery, a human connection between the surgeon and the patient, and the right tools for each situation.

At Biomet, we strive to view our work through the eyes of one surgeon and one patient. We treat every solution we provide as if it's meant for a family member.

Our approach to innovation creates real solutions that assist each surgeon in the delivery of durable personalized care to each patient, whether that solution requires a minimally invasive surgical technique, advanced biomaterials or a patient-matched implant.

When one surgeon connects with one patient to provide personalized care, the promise of medicine is fulfilled.

A.L.P.S. Hand Fracture System

Advanced Plating Guide

Table of Contents

Intro	4
Plates	5-9
Screws	10
Benders.....	11
K-wires	11
Sizing Plates	12
Plate Bending, Contouring and Plating Strategies.....	13
Subunit-by-Subunit Bending Strategy.....	14
End-to-End Plating Strategy.....	15
Symmetrical Plating Strategy with Central-to-Peripheral Plating	16
Asymmetrical Plating Strategy with Central-to-Peripheral Plating.....	17
Fragment Drift, Un-intentional or Intentional.....	18
Importance of F.A.S.T. Guide Inserts in Relation to Bending Strategy	18
Skin incisions and Tendon Management	19
Technique Principles with Pertinent Examples.....	20-22
Compression.....	23
Lag Technique.....	24
Lagging Through a Plate	24
Using the Straight Plate	25
Using the Y Plate	26
Using the T Plate	27
Using the T/Y Plate	28
Using the Web Plate.....	29
When Bending is More Than Contouring	30
Articular Maneuvers.....	30-33
Plating Fracture Dislocations	34
Fusions.....	35
Bridge Plating.....	35
Unusual Plating Scenarios.....	36
Errors and Pitfalls	37,38
Conclusion.....	39
Ordering Information	40-42
Indications.....	43

A.L.P.S. Hand Fracture System

Advanced Plating Guide

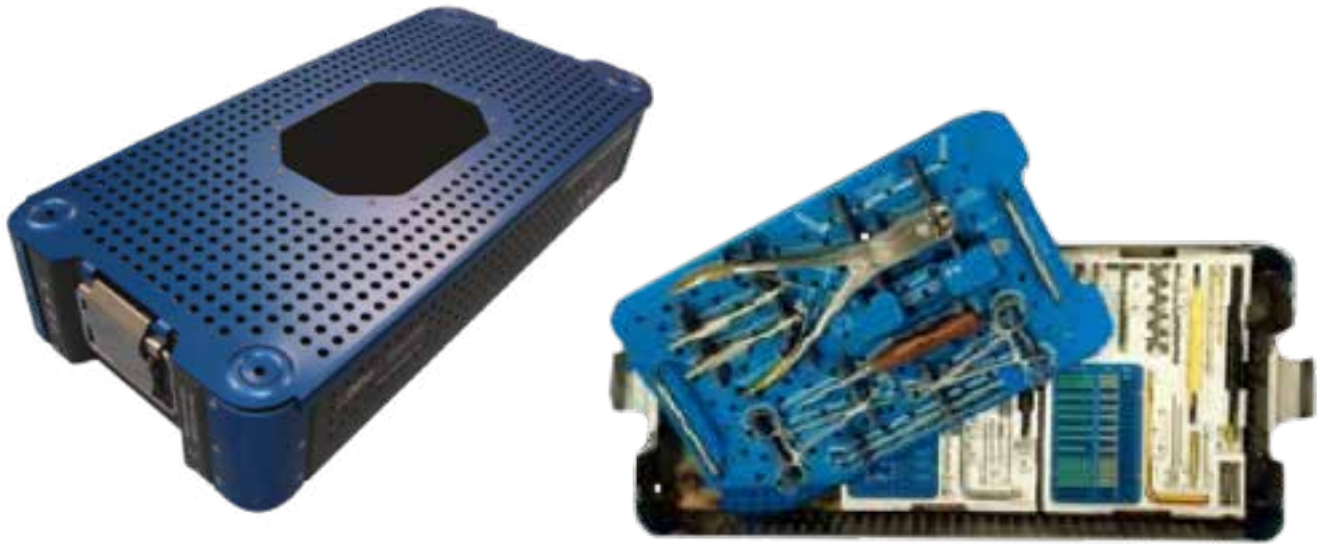


Figure 1

Introduction to A.L.P.S. Hand Fracture System Plating

The A.L.P.S. Hand Fracture System (Figure 1) is designed to provide surgeons a plating system that delivers locking, non-locking and multi-directional locking fixation in a low profile plate that can be contoured directly on the bone. The design of this plating system is based on the F3 Fragment Plating System that is available in the DVR Anatomic tray. The high-flex F3 plates introduced the concept of in-situ contourable plates working with 2.5 mm locking and non-Locking Screws. The 2.5 mm cobalt chrome multi-directional Locking Screws (MDTP) are being utilized in the DVR Anatomic Plating System.

The A.L.P.S. Advanced Plating Guide is a technical guide to small bone plating relative to the A.L.P.S. Hand Fracture System and the paradigm shift that has occurred due to new plating concepts generated by A.L.P.S. plating.

The A.L.P.S. Hand Fracture System was designed and developed in conjunction with **Lloyd P. Champagne, M.D., Mathew M. Tomaino, M.D., M.B.A. and Brian J. Hartigan, M.D.**

These techniques were prepared in conjunction with licensed health care professionals. Biomet does not practice medicine and does not recommend any particular orthopedic implant or surgical technique for use on a specific patient. The surgeon is responsible for determining the appropriate device(s) and technique(s) for each individual patient.

The engineering team reviewed all commercially available systems for potential improvements and for ways the system could do more with fewer plates. Their research resulted in the A.L.P.S. Hand Fracture System with five primary plate shapes in both 2.5 mm and 1.5 mm. An additional Small T plate was added to address the size constraints of the mid phalanx.

The following information was gathered by Dr. Lloyd Champagne from his own cases to demonstrate how he uses the system to address both simple and complex fractures.

Please see the A.L.P.S. Hand Fracture System Surgical Technique (BMET0010.1) for additional information including a closer look at the instruments included in the tray.

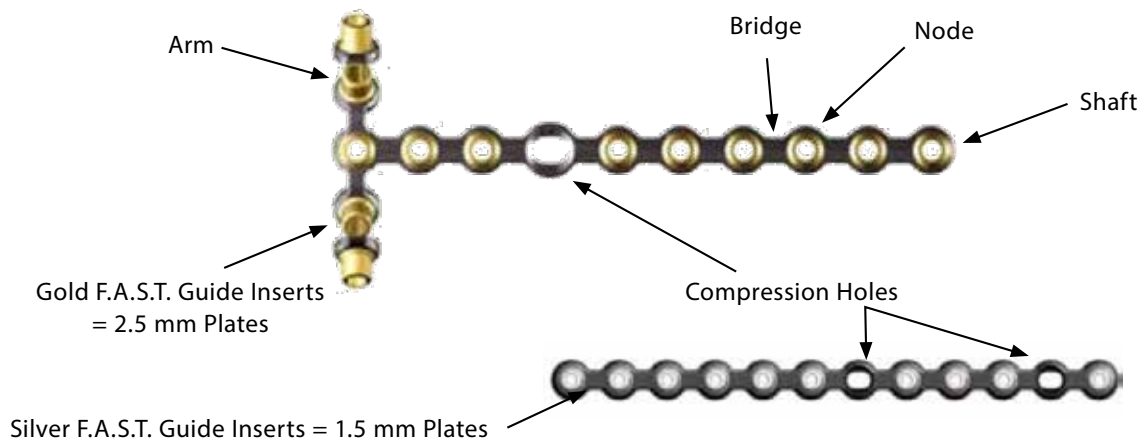


Figure 2

A.L.P.S. Hand Plate Terminology

Plates

There are 11 plates in the A.L.P.S. Hand Fracture System: 5 in the 2.5 mm module, 6 in the 1.5 mm module. The plates are made from a type 2 anodized titanium alloy (Ti6Al4V). The plates were created by connecting nodes (a node contains a screw hole) with bridges (Figure 2). The plates are designed so they will only bend through the bridge while being contoured. Since bending does not occur in the nodes, the integrity of the thread in the plate is not damaged, maintaining the ability of the Locking Screws to thread into the plate. This node and bridge concept is utilized to create the following plate options (Figure 3):

1. Straight Plates
2. T Plates
3. Y Plates
4. T/Y Plates
5. Web Plates

Each of these styles is provided in a single length. This length was determined by calculating the length of plate needed for a typical installation.

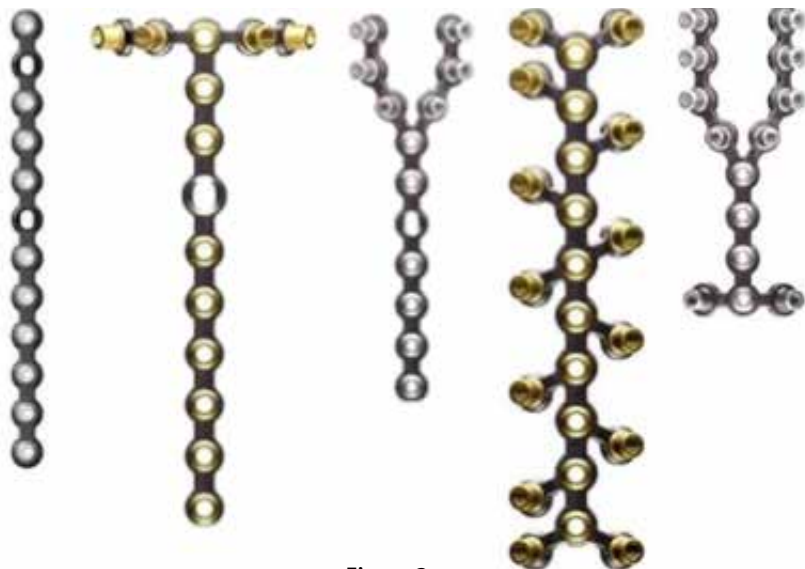


Figure 3

Five primary plate shapes

A.L.P.S. Hand Fracture System

Advanced Plating Guide

		Bending Mode		
		Coronal	Axial	Sagittal
Region	1.5 mm Shaft	45 deg.	15 deg.	15 deg.
	1.5 mm Arm	45 deg.	45 deg.	45 deg.
	2.5 mm Shaft	45 deg.	15 deg.	15 deg.
	2.5 mm Arm	45 deg.	45 deg.	45 deg.

Table 1

Recommended plate bending limits (Biomet Product Development Data, DVA-0716-DVR)

To facilitate drilling, bending and plate identification, the plates are delivered with pre-installed F.A.S.T. Guides. Originally designed for the DVR Anatomic Plating System, the F.A.S.T. Guides provide pre-installed drill guides that allow the surgeon to drill in the optimal direction for the Locking Screw without the need for additional blocks or repositioning of independent drill guides. The color coding of the F.A.S.T. Guides gives the surgeon confirmation that the OR staff has provided the correct size of plate and corresponding instruments. All the instruments in the 2.5 mm plate module are gold. The instruments in the 1.5 mm plate module are either silver, to indicate that they are designed to work with the 1.5 mm plates with silver F.A.S.T. Guides, or bronze, to indicate they also work with the 1.3 mm inter-fragmentary screws that are denoted in the screw caddy with the bronze highlighted flag.

For all the plates, the bridges between nodes along the shaft of the plate are designed to be stronger and stiffer than the bridges on the arms of the plate that branch from the shaft. The plates were designed this way because:

- 1.) The shaft of the plate is more likely to remain straight along the metaphysis of the bone.
- 2.) Bending of the plate shaft while attempting to contour an arm typically is undesired. While the shafts of the plates can be curved, bent and twisted, their range is less than that of the arms (see Table 1).

The Straight, T and Y configuration plates have non-locking holes that are designed to allow axial compression of bone fragments. The compression holes in the 1.5 mm plates can provide up to 0.75 mm of compression in each hole. The compression holes in the 2.5 mm plate can provide up to 1.5 mm of compression in each hole. To achieve compression the surgeon must drill toward the end of the slotted hole opposite of the desired direction of compression.



Figure 4

1.5 mm Straight plate options

The Straight plates are the simplest of the plates in the system (Figure 4). Like all the A.L.P.S. Hand Fracture System plates, the Straight plates can be shortened by using the benders or the plate shears at any of the bridges. This allows for plate configurations with 1 or 2 compression holes or plate configurations that have all Locking Screws.



Figure 5

2.5mm T plate options

The T plates were designed to address fractures where there is a base fragment that is too small to receive 3 Locking Screws from a straight plate (Figure 5). T plates can be modified by removing nodes to create short T's, narrow T's, unequal T's and left or right L's configurations.

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Figure 6
1.5 mm Y plate options

The Y plates were designed to give options for placing fixation close to a joint without having metal on the dorsal aspect of the bone adjacent to the joint. The Y plate allows fractures to be addressed obliquely from either one or both sides of the bone.

Short Y armed plates and unequal length armed Y configurations can be created through cutting or bending. The Y arms can be shortened to one node each to create a cluster (Figure 7).

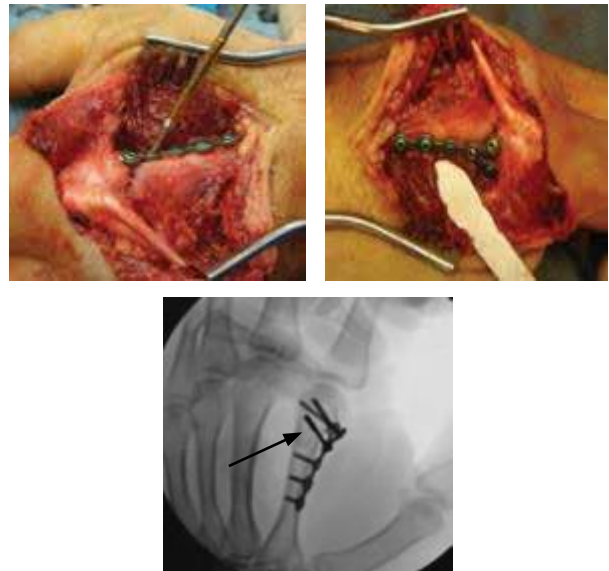


Figure 7
2.5 mm A.L.P.S. Y plate shortened to create a plate with distal cluster of three screws purchasing the metacarpal head. A multi-directional screw (black arrow) is used to enable a confluence of arms to gain purchase in the fracture fragment. This diverging screw is aimed to help create a three dimensional configuration of screws inside of the metacarpal head.

One use of the Y configuration is bilateral fixation of a comminuted fracture. By wrapping the Y arms laterally around the bi-condylar fragments, a construct is formed that lacks a metal profile on the dorsum of the distal shaft to limit periarticular tendon friction. By widening the confluence of arms, the Y shape can approach a T shape. By narrowing the confluence of arms, the Y shape can be closed, bringing the distal arms together, creating two adjacent rows of plating opportunity.



Figure 8

1.5 mm T/Y Plate options

The T/Y plate has four arms branching from the central axis (Figure 8). This plate is used frequently for complex and comminuted fractures. The four arms enable management of fracture fragments throughout the metacarpal or phalanx base, shaft, neck and head regions.

The Y end of the plate can be managed with the Y plate options presented previously. The T end of the plate can be managed with the T plate options presented previously. The Y end on the T/Y plate has one more screw node than the Y-alone plate. If Y plate configurations with longer Y arms are needed, the T/Y plate can be converted to a long-armed Y by removing the T end.



Figure 9

2.5 mm Web Plate options

The Web plate is typically used for stabilization and fixation of complex and comminuted fractures. This plate offers the option of multi-planar screw fixation over the full plate length. The plate's short arms can be contoured independently to buttress and hold a fragment or to orient a screw to a particular trajectory or target (Figure 9).

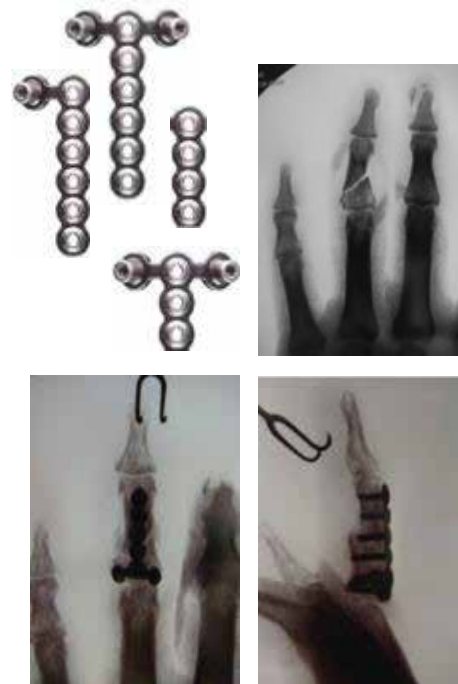


Figure 10

The Small T plate is a condensed version of the 1.5 mm T plate.

The 1.5 mm set also contains the Small T plate. This plate was created for situations where the bones are not long enough for a standard T plate to provide the desired cortices of fixation. This plate was designed primarily for fracture fixation of the middle phalanx in patients with small hands and fingers (Figure 10). The arms of the Small T plates can be contoured in all planes, but the shaft can only be contoured axially by skipping 1 node between the bending irons.

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Figure 11

1.5 mm CoCr Locking Screw and 1.5 mm Ti Non-Locking Screws



Figure 12

1.3 mm CoCr Inter-fragmentary Non-Locking Screw



Figure 13

2.5 mm Non-locking, Locking and Multi-directional Locked screws

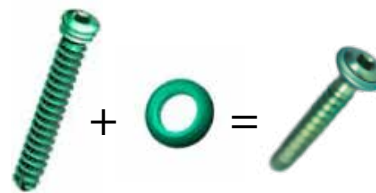


Figure 14

A washer can be used to create a non-locking 2.5 mm screw for axial compression

Screws

Screw options vary slightly between the 1.5 and 2.5 mm plate sets. The systems were engineered to contain locking, non-locking and multi-directional screw options for both the 1.5 and 2.5 mm plating sets.

There are two screw options for the 1.5 mm plates (Figure 11). A cobalt-chromium (silver) screw has a threaded head which mates with the 1.5 mm plate, creating a Locking Screw. The cobalt-chromium (CoCr) material used to create these screws has a greater hardness than the titanium alloy plate (Ti6Al4V). This differential hardness allows the screw to form a new thread in the plate as it is driven into place. The angular variation of the screw should be confined to a 20 degree cone to ensure solid screw and plate engagement. A Type II anodized (dark grey) non-Locking Screw made of titanium has a bulbous head that can be used in both locking and axial compression holes. The 1.5 mm screws use a square screwdriver.

The third screw in the 1.5 mm set is a 1.3 mm CoCr non-Locking Screw. This screw was included for inter-fragmentary fixation of small fracture fragments outside the plate (Figure 12). These often are used to manage periarticular fractures about the PIP and DIP joints when the 1.5 mm and 2.5 mm screws are too large. The 1.3 mm screws use a cruciate driver.

The 2.5 mm plate set contains locking, non-locking and multi-directional screws (Figure 13). These screws can also be found in the DVR Anatomic Volar Plating System. There are gold non-Locking Screws, green Locking Screws and silver Co-Cr multi-directional Locking Screws. All of these screws are intended for use in the locking holes of the 2.5 mm plates.

A green washer, unique to the 2.5 mm set, is provided to convert the green Locking Screw into a non-Locking Screw. The reason for creating this second non-Locking Screw is to be able to create axial compression in the plate's non-locking holes. These holes are larger and the washer prevents the screw from sliding through the plate. The green Locking Screw is advanced through the washer and turned to engage the threads in the washer (Figure 14).



Figure 15
1.5 mm benders

Benders

The instrument tray consists of tools useful to both the 1.5 and 2.5 mm plating sets. The tray holds 3 different types of fracture reduction clamps, screwdriver handles, two mini Hohmann retractors, a periosteal elevator, a plate cutter and a K-wire caddy. Plate benders are specific to each plate set and are color-matched to that set and housed in each plate set respectively. The benders in each set differ slightly in configuration and use but conceptually do the same thing: bend plates in any of three planes, sagittal, coronal or axial.

Both sets of benders are designed to sit 30 degrees off the alignment of the F.A.S.T. Guide inserts to allow plate bends in any direction. The benders can be rotated around and positioned on F.A.S.T. Guide inserts to provide maximum mechanical efficiency during bends.

The 1.5 mm benders are colored silver and attach to the F.A.S.T. Guide inserts by slipping over the outside of the F.A.S.T. Guide inserts (Figure 15). The short ends of the benders are used for sagittal bends and the longer ends are used for axial and coronal bends.



Figure 16
2.5 mm benders

The 2.5 mm benders are colored gold and attach to the F.A.S.T. Guide by slipping inside the F.A.S.T. Guide inserts. The long end inserts into the F.A.S.T. Guide inserts to enable axial and coronal bends. The “teeth” ends engage over the F.A.S.T. Guide inserts for sagittal bends, thus working exactly like the 1.5 mm plate benders (Figure 16).



Figure 17

Figure on left shows use of K-wires through F.A.S.T. Guide inserts for provisional plate positioning/fixation. Picture on right shows temporary reduction with K-wires as well as a K-wire through a F.A.S.T. Guide insert to hold the plate in position.

K-wires

The K-wire caddy dispenses 0.028, 0.035, 0.045 and 0.062 inch K-wires. The K-wires can be used for permanent fixation, temporary fixation, for joy sticks or to provisionally tack the plates to the bone. The 0.028 inch K-wires can be placed through the F.A.S.T. Guide inserts on the 1.5 mm plate (Figure 17) and the 0.035 inch K-wires can be placed through the F.A.S.T. Guide inserts on the 2.5 mm plate. Inadvertent attempts to place K-wires that are larger than allowed with F.A.S.T. Guide inserts can result in jammed and stuck K-wires.

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Figure 18

Sizing the plates with plate cutter



Sizing the plates with bender method



Figure 19

Proper plate shortening using benders creates an end barb pointing toward the bone

Sizing Plates

Plates can be shortened by removing nodes. Nodes can be removed from plates by either using plate benders or by cutting. When removing nodes, it is recommended to place the benders on adjacent F.A.S.T. Guide inserts and bend the end of the plate towards the bottom of the plate section you wish to keep (Figure 18). Removing nodes in-situ can be accomplished by curving the bridges with the benders until the node(s) break off. Using either method, the sharp edges of the plate should face the bone (Figure 19). Trimming is performed prior to fixation, but contouring can be performed in-situ. It is highly recommended that the plates be shortened by using the plate benders to create a smooth edge and limit soft tissue and tendon irritation.

It is important to always use two benders. The benders counter each other's forces, thereby reducing the risk of a loss of fixation. For the 1.5 mm Small T plate, the cutter must be used to shorten the shaft due to space limitations between the nodes.

When cutting with the supplied instrument, care should be taken to ensure that no sharp edges result. Removing nodes with the cutter should be done ex-vivo.



Coronal Bend



Axial Bend



Sagittal Bend

Figure 20
Types of plate bends

Plate Bending, Contouring and Plating Strategies

The purpose of this section on plating strategies is to help recognize different methods used to tackle complex fractures. Simple metacarpal fractures, addressed with stiff straight plates, require the consideration of fewer factors than highly comminuted fractures addressed with contourable Web plates.

Most of the described strategies break up the fracture plan into subcomponents. Comminuted fractures often can be resolved by reducing many fragments into fewer fragments, and then finally into one fragment. This document is intended to provide one framework for looking at complicated fractures.

Types of Contouring

Plates can be contoured in three planes: axial, sagittal and coronal (Figure 20).

To bend or twist a plate in the axial or coronal plane, place the long end of the bender over (1.5 mm) or into (2.5 mm) the F.A.S.T. Guide inserts of adjacent nodes. Hold one bender as an anchor and manipulate the other.

To curve a plate sagittally, place the short “teeth” ends of the benders over the F.A.S.T. Guide inserts of adjacent nodes. Hold one bender as an anchor and curve with the other. It should be noted that the two benders are a matched pair and not two of the same. One of the benders should be marked “End Node Bender.” If curving an end node, use the End Node Bender at that position.

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Figure 21

An example of precise plate contouring. Note: that the plate is in close contact with the bone.

Subunit-by-Subunit Bending Strategy

Simple fractures often can be reduced completely via provisional stabilization using K-wires prior to plate placement. Complex multi-part fractures often cannot be completely reduced prior to plate placement. The entire bone need not necessarily be reduced prior to plate application. Subunits of fractures can be independently reduced, plate contouring performed and fixation performed. For the majority of fractures, plating with in-situ bending is obvious and intuitive. In some instances it may help to do 'rough' contouring of the plate with the plate off the bone and then finish the contouring in-situ. The goal is a flush, smooth, anatomically contoured plate application. The purpose of subunit strategy is that small units can be joined to create larger units. If it simplifies a three-part fracture to initially join two fragments, then consider the fracture as a two-part fracture before moving on to the final fragment.

Holding multiple fragments aligned while placing the plate and drilling can be difficult. By fixing the first fragment to a second fragment, one can concentrate on only these two fragments. Then the subsequent fragments can be reduced to the first two. This technique allows the plate to be contoured to the bone as each fragment is aligned. After contouring, the plate should be firmly in contact with the bone (Figure 21). Use of intermittent non-Locking Screws helps to generate contact between the plate and bone. At the end of the plate placement, key non-Locking Screws can be exchanged for Locking Screws if desired.

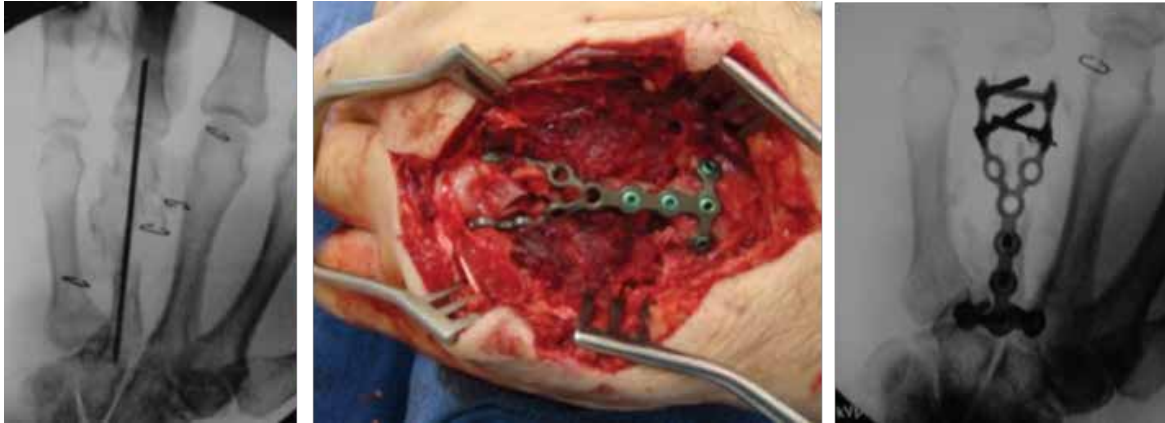


Figure 22

Example: A highly comminuted metacarpal fracture that employs proximal metacarpal base fixation, followed by out-to-length reduction of the metacarpal head, then distal articular fixation. Central fixation is done last.

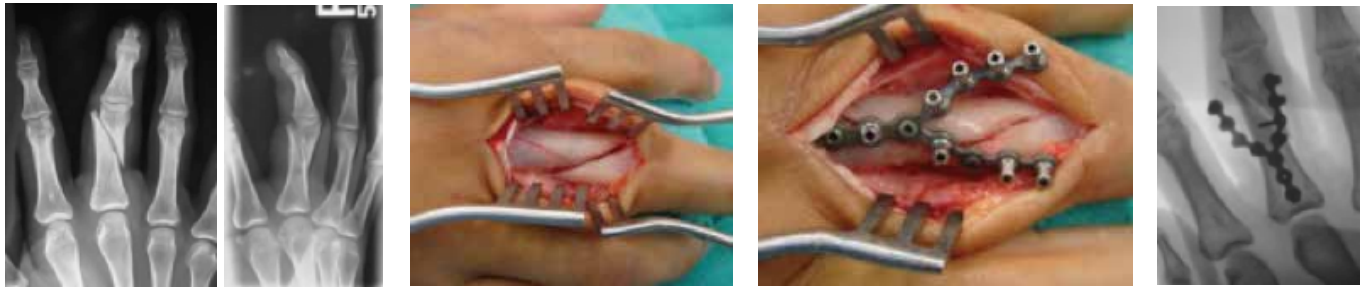
End-to-End Plating Strategy

When plating highly comminuted fractures that involve the length of the bone, one strategy is to use the Web or T/Y plate. Fix the plate to the proximal or distal end, restore the bone's length, and then fix the plate to the opposite end. Once the articular surfaces have been reduced, fixation of the central bone section can follow (Figure 22). The remaining central shaft fracture fragments are captured last.

Multi-directional screws can be aimed at fracture fragments. Nodes can be contoured to aim locking and non-Locking Screws toward fragments. This 'end-to-end' plating strategy is especially useful with the Web and T/Y plates with long segments of central shaft comminution. The goal of the fracture management is to place the ends of the bone back out to length and position; central fixation is not as critical.

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Oblique proximal phalanx fracture

Intra-op photo showing additional fracture

Placement of arms across fractures

X-ray initial plating, note fixation of central shaft and only one plate arm initially placed



Showing contoured a Y arms with non-locking and Locking Screws

Radiographs final plating;

Non-Locking Screw exchanged, tendon free near joint

Figure 23

Demonstration of near symmetrical plating with placement of off axis main Y arm to capture proximal oblique fragment. The screws and fixation are placed centrally and fixation is walked out to the ends of the Y arms. Last frame shows that many non-Locking Screws are exchanged for Locking Screws at end of fixation.

Symmetrical Plating Strategy with Central-to-Peripheral Plating

The A.L.P.S. Hand Fracture Plates were designed to be symmetrical to give the surgeon the same fixation options on both sides of the plate. Fixing the plate along the central axis of the bone first and reducing condylar fragments with symmetrical arms is relatively simple. Insert the first screw near the central part or main shaft of the plate then move outward to the arms of the plate, keeping forces of rotation neutralized while proceeding with fixation (Figure 23).

After contouring, the plate should be firmly in contact with the bone. Use of intermittent non-Locking Screws helps to generate contact between the plate and bone. At the end of the plate placement, key non-Locking Screws can be exchanged for Locking Screws if desired

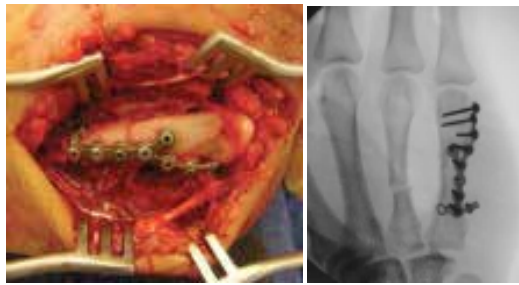


Figure 24

Asymmetrical plate application in progress



X-rays: comminuted proximal phalanx fracture

Intraoperative photo



Notice 1.3 mm lag screw used to create one unit distal segment prior to plating; final X-rays

Figure 25

Asymmetrical plate application in progress



Rotated ring finger

In-situ de-rotation with benders



De-rotated finger

Final X-rays

Figure 26

In-situ bending used to perform fine adjustment of finger rotation. First picture shows rotated ring finger, second picture shows bending adjustment and third picture shows final ring finger position.

Asymmetrical Plating Strategy with Central-to-Peripheral Plating

More complex fractures sometimes require an asymmetric plating plan. Begin by planning out each arm location and length so that screw holes end up where desired. The use of provisional K-wire fixation through a periarticular or crucial screw hole may help.

Other potentially important screw locations are the holes adjacent to a transverse fracture (for compression plating) and the holes adjacent to a short oblique fracture for lagging across the fracture. Like the symmetrical plate and central screw plan, placing the first screw hole in the central portion of the plate may make things simpler. Move from the central to peripheral holes, contouring the plate as necessary. See Figures 24 and 25 for asymmetric plating examples.

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Figure 27

Index finger MCP fusion. At end of procedure, key pinch position was not pulp to pulp. In-situ bending was used to fine-tune the fusion to create a pulp to pulp possibility.



Figure 28

Fracture reduction clamp using F.A.S.T. Guide inserts to hold the plate

Fragment Drift, Un-intentional or Intentional

The installation of plates and screws in a broken bone creates a risk of misalignment of the final reduction. You can decrease this risk by working node by node rather than skipping over large spans of plate when inserting screws or contouring.

In some cases it is desirable to have the ability to contour the plate after it has been installed. For instance: if the rotational alignment is off, a pair of adjacent F.A.S.T. Guide inserts can be reinserted into the plate and benders can be used to move or adjust the plate to align fragments that are slightly mal-aligned (Figure 26). This method can be used to correct a rotational or angular deformity in a plated, fractured, fused or osteotomized finger (Figure 27). The surgeon's judgment must be considered as to whether the correction of slight scissoring or crossing of finger at the end of the case is better corrected by in-situ contouring or by adjusting the position of the fixation.

Importance of F.A.S.T. Guide Inserts in Relation to Bending Strategy

Two F.A.S.T. Guide inserts are needed to create any bend, therefore it is important to think ahead when removing F.A.S.T. Guides inserts and installing screws. Ensure that the necessary F.A.S.T. Guide inserts for the final in-situ bends are in the correct locations of the plate. If an additional bend maneuver is needed the F.A.S.T. Guide inserts can be temporarily reinserted back into the plate.

The F.A.S.T. Guide inserts can be used with the towel clamps from the general instrumentation tray to hold the plate to the bone (Figure 28).



Figure 29

Dorsal incision image

Skin Incisions and Tendon Management

The skin incision and tendon management are independent. The standard skin incision is dorsal for metacarpals and phalanges (Figure 29). This approach is meant to provide the widest exposure to the fracture and pertinent soft tissues. Through a dorsal incision, the tendon can be managed with median and paramedian tendon splitting approaches or via tendon mobilization and other routes around the tendon.

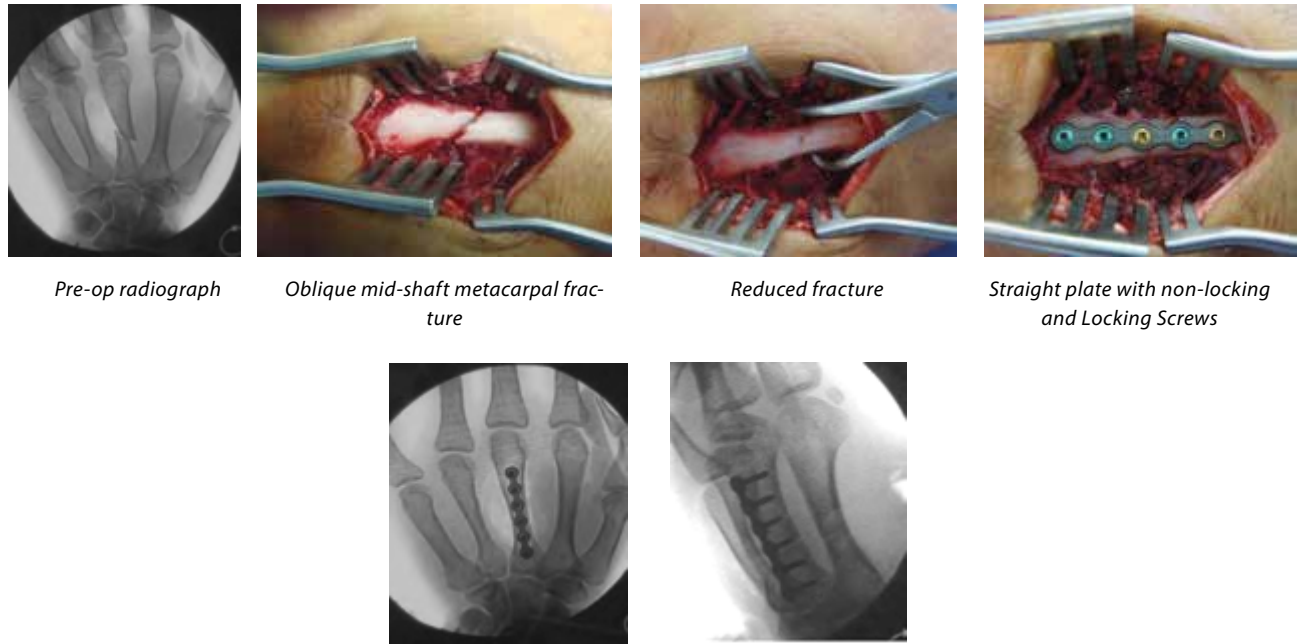
Lateral skin incisions provide a more limited exposure but may be better suited for lateral plating. In this case, the extensor tendon is usually retracted not split. The periosteum should be preserved whenever possible and pulley attachments should be protected during exposure.

The use of incisions based on the traumatic exposure usually makes sense in open fracture cases.

Plates can be placed wherever is most appropriate for the fracture and soft tissues, whether the plate placement ultimately is dorsal, lateral, dorsal-lateral or oblique.

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Pre-op radiograph

Oblique mid-shaft metacarpal fracture

Reduced fracture

Straight plate with non-locking and Locking Screws

Figure 30

A 2.5 mm straight A.L.P.S. plate for the fixation of an oblique metacarpal fracture in a middle finger. Clinical pictures show fracture reduction followed by fixation. The enlarged clinical plate picture demonstrates that one gold non-Locking Screw was applied to each side of the plate to co-opt the bone to plate and the remaining plate holes were filled with Locking Screws. Note that no compression was used due to the oblique nature of the fracture. The oblique fracture was too short for a lag technique.

Technique Principles with Pertinent Examples

Non-locking Fixation

Non-locking fixation with the A.L.P.S. Plating System differs very little from traditional plating. As long as bone stock is good and purchase is achieved in at least four solid cortices proximal and distal to the fracture, non-locking techniques are suitable. The A.L.P.S. plates still offer F.A.S.T. Guide technology and in-situ contouring.

Locking Fixation

Locking techniques are usually employed in circumstances of bony comminution and osteopenia, where at least one side of the plating construct has less than ideal conditions for screw fixation.

i. Screw Construct Techniques

There are many construct building patterns possible when using locking configurations. After reduction, initial plate fixation should be with a non-Locking Screw to compress the plate to the bone. This should be done on both sides of the fracture prior to insertion of any Locking Screws, if possible.

In the ideal circumstance, the plate is now snugly approximated to the bone and fracture and Locking Screws are then added. Contouring using the plate benders should be done prior to Locking Screw insertion.

Lag screw placement through the plate and compression screw placement should also precede any Locking Screw placement. The ability to lag or compress is increasingly limited as more Locking Screws are applied and the fixation construct becomes more rigid (Figure 30).

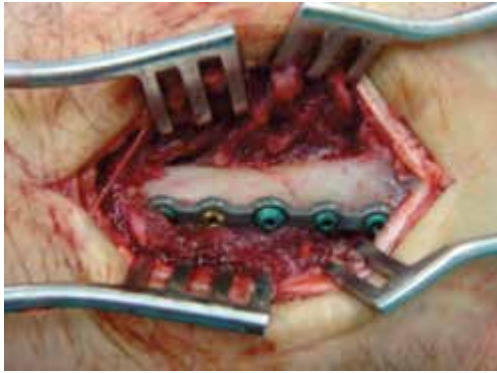


Figure 31

Locking Screws on both sides of fracture

In certain situations, ideal screw order is not possible. For instance, sometimes there is little to no purchase of bone with the initial non-Locking Screw. In this instance, manual reduction of the plate to the fracture can be done with digital pressure or reduction clamps with immediate insertion of Locking Screws. This technique of manual fracture reduction with placement of a non-lag bi-cortical screw has been shown experimentally to be equivalent to the fixation strength of a lag screw^{1,2}.

Locking bi-cortical screw constructs provide more rigidity than locking uni-cortical or unlocking bi-cortical constructs³. When there are multiple screws, placing Locking Screws in the outermost screw positions adds rigidity to the construct^{4,5} (Figure 31). When the fixation screws are limited, non-Locking Screws can be exchanged for Locking Screws at the end of the case.

ii. Strongest Constructs

Independent of bone quality and fracture situation, the strongest fixation constructs depend on length of plate, number of screws on each side of the fracture, proximity of fixation to fracture, size of the screws, rigidity of plate and number and placement of Locking Screws. Despite the abundance of newer locking technology, there is a paucity of data regarding ideal constructs. In a biomechanical study of non-locking vs. locking constructs by Fulkerson, constructs fixed by plates with bi-cortical Locking Screws withstood significantly more load prior to failure as compared to non-locking plating and uni-cortical locking plating. Increased distance of the plate from the bone surface, and use of uni-cortical Locking Screws led to early failure with cyclic loading.

There is conflicting information with respect to the importance of plate apposition in non-locking vs. locking constructs. With non-locking constructs, the strength depends on bone screw plate friction; lack of bone plate apposition decreases strength. Lack of apposition with locking constructs is possibly of lesser importance. Locking constructs function as a unit and therefore an all-or-none phenomenon occurs in the instance of plate failure, with failure being related to the number of screws at the bone interface on each side of the fracture^{4,6}. Even if precise adherence to the bone may not contribute to construct strength, this tight adherence makes the construct low profile and is therefore important. Placement of a Locking Screw in the most distant screw holes on each side of the fracture can add stability to a plating construct. However, this does create higher stress concentrations at the plate ends that could potentially lead to an increased risk of peri-prosthetic fractures⁷.

When performing fixation near joints, there is evidence that the placement of screws in the immediate subchondral position creates constructs with significantly more rigidity with higher resistance to postoperative loads and displacement forces⁸.

Dorsal vs. lateral plate placement also affects construct stability and rigidity depending on direction of the applied load. In Prevel's study of metacarpals and phalanges, dorsal apex loads were best resisted by dorsal plating and apex anterior loads were best resisted by bilateral lateral plating⁹.

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Figure 32

A Y Plate used to provide multi-planar fixation for a distal 5th metacarpal fracture

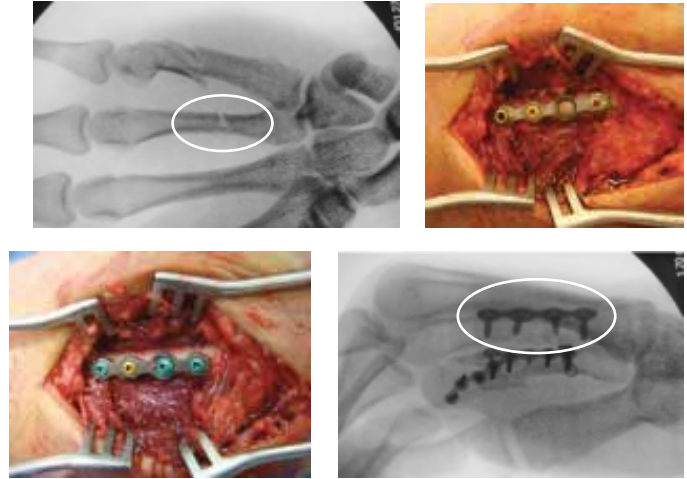


Figure 33

Images showing the proper application of axial compression utilizing a 2.5mm Straight plate and a 2.5 mm locked screw with a washer

Three dimensional (3-D) plating compares favorably to straight plate options. The advent of square, rectangular, and now multi-armed 3-D plates makes wrap-around plating with converging screws possible (Figure 32). In comparing different metacarpal plating methods, Sohn demonstrated superior strength of construct with multi-planar fixation compared to a construct with linear fixation¹⁰. How exactly a multiple arm contoured plate fixation fits into this scheme remains undetermined.

The analysis of the biomechanics of hand fracture fixation, especially when considering the physiology of bone healing, is a discipline with a paucity of hard data. The point of construct analysis is to help create stable plating constructs. During A.L.P.S. plating, the surgeon needs to consider fixation principles with the aim of creating small, stable, low profile plating configurations.

iii. Errors and Pitfalls with Locking Plating

In cases of error associated with Locking Screw fixation, it is likely that the early placement of Locking Screws, prior to lag or compression screws, created rigidity before compression could occur. Also, premature placement of Locking Screws can prevent anatomic contouring of plate to bone.

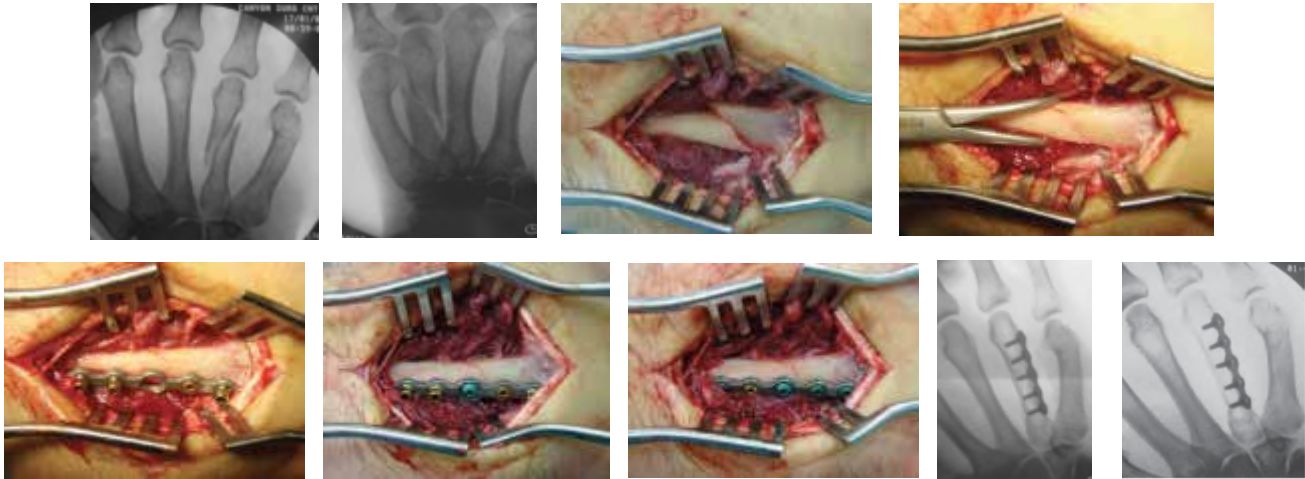


Figure 34

Series of photos showing the use of a 2.5 mm straight plate with a 2.5 mm Locking Screw and washer placed across the fracture line to simultaneously create inter-fragmentary and axial compression

Compression

Straight, T, and Y configuration plates in the 1.5 and 2.5 mm modules have oblong compression holes to aid with compression plating techniques. Compression across fractures should be considered whenever feasible and can be done with most fractures (Figure 33). Since compression techniques can involve axial forces across the fracture, those fractures which are not stable due to comminution or obliqueness are not ideal for compression.

Compression across comminution accomplishes very little and compression of oblique fractures can create non-anatomic fixation as the fracture surfaces tend to misalign as compression occurs. The tendency for oblique fractures to slide can be neutralized with transverse, lagging fixation across the oblique fracture. Excessive compression can lead to the distal side of the fracture opening up due to compression.

A.L.P.S. Hand Fracture System

Advanced Plating Guide

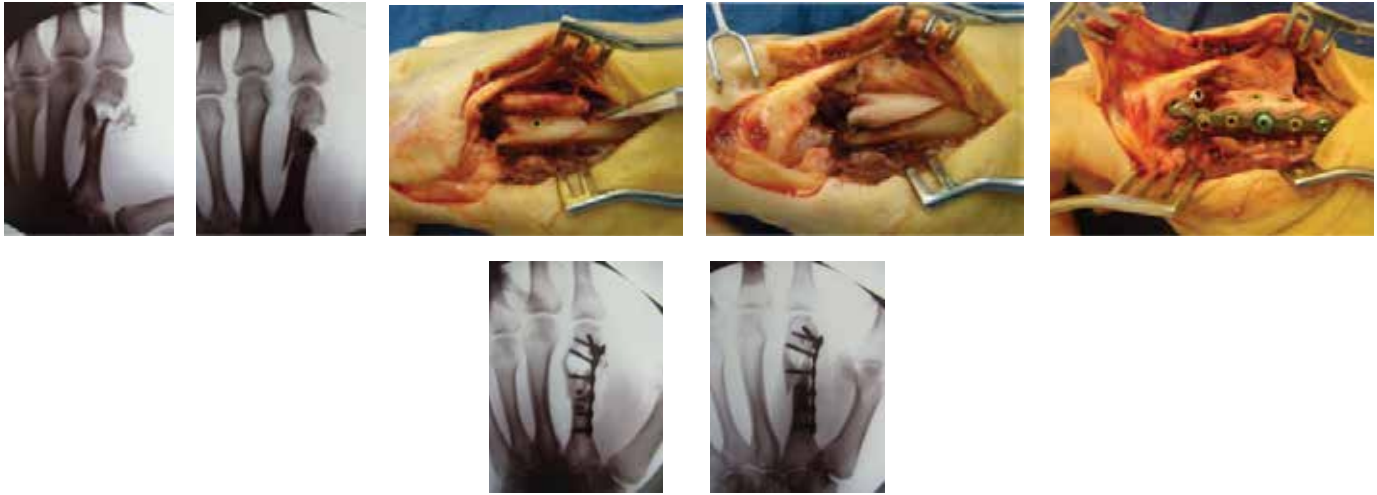


Figure 35

Series of images showing a screw outside the plate to lag fragments together

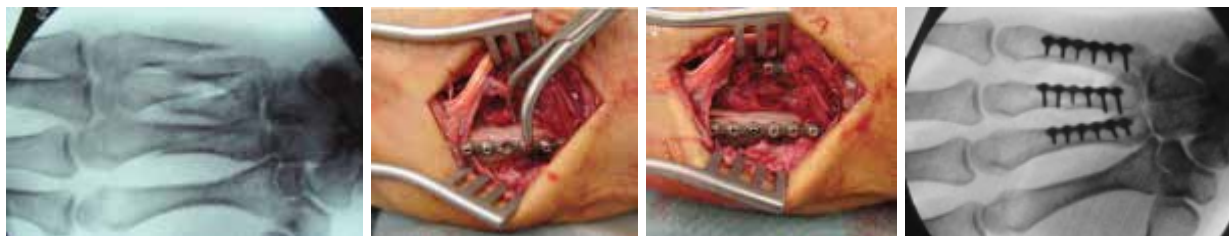


Figure 36

Series of images showing a 1.5 mm straight plate and a 1.5 mm non-Locking Screw used to lag a fragment through the plate.

Lag Technique

Lag techniques should be used when there is an oblique fracture plane that is two times the length of the transverse diameter of the bone (Figure 34). The 1.5 mm and 2.5 mm trays contain the drill guides and drills required for lag fixation with 1.3, 1.5 and 2.5 mm screws.

Lagging Through a Plate

Lag screw fixation through the plate allows for compression at the fracture site. It is used frequently in short oblique fractures when there is not enough room for screws to complete a pure lag screw technique. It may also be indicated if there is micro-comminution around an oblique fracture, rendering it unstable, when otherwise a pure lag technique would have been indicated.

Lagging through the plate can be achieved using any hole in the plate. In a locking threaded hole, use the non-Locking Screw for lagging (Figure 35). In the non-locking oblong compression holes, use a 1.5 mm non-Locking Screw in the 1.5 mm set, or a 2.5 mm Locking Screw combined with the green washer in the 2.5 mm set (Figure 35 and 36). As with any screw that is applied increasingly off angle, there will be a small screw lip arising above the plate at the end of screw seating.

The height of the screw lip will depend on the angle of insertion, with larger angles producing a larger lip. Opting to use the compression holes for lagging fixation through the plate will result in a less noticeable screw lip prominence over the plate.

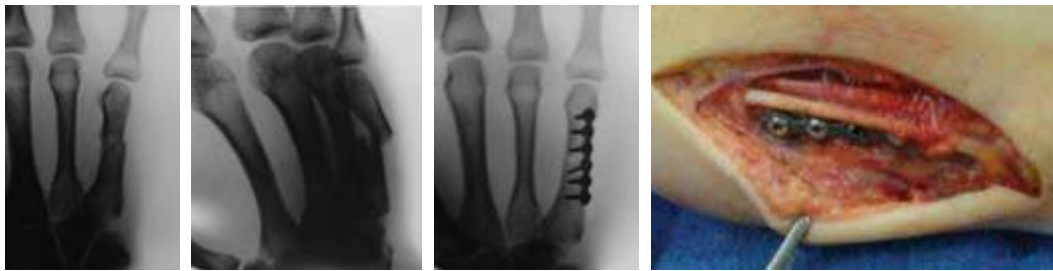


Figure 37

Preoperative radiographs shaft fracture

Dorso-lateral fixation with A.L.P.S. Hand 1.5 mm straight plate

Extensor tendon moved away from plate



Radiographs oblique phalanx fracture

Lateral plate with first buttress screw then lag screw



Sagittal bend, all screws replaced with Locking Screws

Initial lag screw radiographs

Figure 38

Little finger proximal phalanx fracture managed with straight plate lateral application. Frames 3 and 4 show the plate initially applied as a buttress, followed by lag screw fixation through the plate. Frame 5 shows the sagittal bend required to keep the plate tracking the lateral profile of the phalanx. The radiograph in frame 7 shows the plate following the lateral and volar phalanx.

Using the Straight Plate

Conventional dorsal plating with A.L.P.S. Hand Straight Plates is a common treatment for fractures. This plate's contouring features and screw options allow for various plating possibilities. In-situ contouring allows for the ability to advance the plate to the periarticular area, while limiting the plate contour from interfering with the joint and tendons. The plates can be contoured to lower the construct profile in the area adjacent to the joint.

Multi-directional screws enable additional fixation near the subarticular joint compared to screws that originate farther from the joint.

The ability to contour in-situ is especially beneficial for the lateral application of straight plates. The three dimensional contour of metacarpals, phalanges and other bones is not naturally straight. Metacarpal bases flare, shafts narrow and condyles widen. When plates are placed laterally, the gentle arc (concave volarly, Figure 37 and Figure 38) of these bones often requires a sagittal plate bend for precise fit. Tubercles, collateral ligament origins and other contours can be negotiated in-situ using the A.L.P.S. straight plate.

A.L.P.S. Hand Fracture System

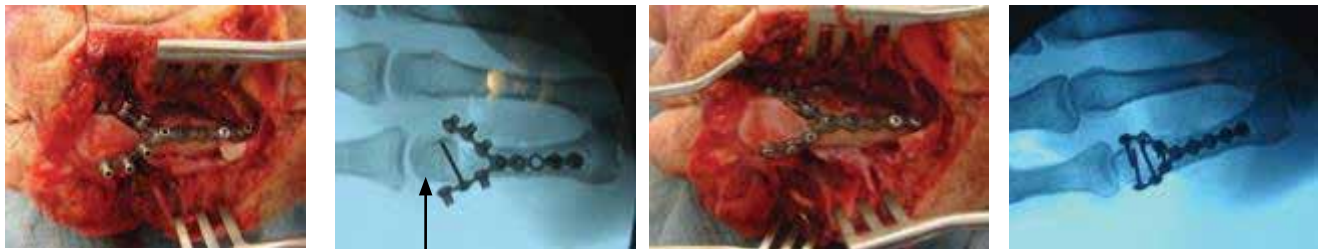
Advanced Plating Guide



Radiograph metacarpal fracture, mechanism is a fan blade, comminution present

A.L.P.S. 1.5 mm Y Plate

Y plate pre-contoured to a widened Y plate



Central shaft applied prior to inserting screws in the arms

Ulnar arm being applied, initial non-Locking Screw

Y shape wrapping around

Final radiograph

Figure 39

A.L.P.S. 1.5 mm plate used for a comminuted metacarpal neck fracture. Note the widening of the Y arm confluence, the first bend in the bending sequence, which allows the plate to wrap around the fracture area. This case depicts the strategy of symmetrical plating, anchoring the plate on the proximal end first. Subsequent bending and screw fixation proceeds distally down the Y arms hole by hole. Non-Locking Screws (grey) are used periodically where bone is of good quality to draw the bone to the plate.



Sledgehammer vs. ring MCP joint radiograph

Comminuted metacarpal head and phalangeal base articular fractures

Phalangeal fixation with 1.5 mm A.L.P.S. Hand Plates

Figure 40

Demonstration of asymmetrical plating with wrap-around style

Using the Y Plate

The Y plate has two arms each open to alteration and/or removal. By widening the confluence of the Y arms, the desired morphology can be chosen. This widening feature also allows the plate to be manipulated into double opposing arms that provide for very distal fixation options (Figure 39).

One of the uses of the Y plate design is a dorsal application with wrap-around plating of complex articular fractures (Figure 40). The wrap-around plating style captures articular fragments, limiting friction on the dorsal periarticular region.



Preoperative radiographs proximal phalanx fracture

Provisional K-wire fixation, in-situ bending with 1.5mm benders; note K-wire through plate



Drill bit (black arrow), K-wire (yellow arrow) Final radiographs, multidirectional screws (black arrow)

Figure 41

Lateral placement of A.L.P.S. 1.5 mm T plate. Clinical photo shows provisional fracture fixation and plate positioning with K-wire. The clinical photo also shows benders functioning over the F.A.S.T. Guide inserts. The 4th image shows drilling under fluoroscopy (black arrow) for the purposes of placing well-positioned multi-directional screws which appear on the 5th image.

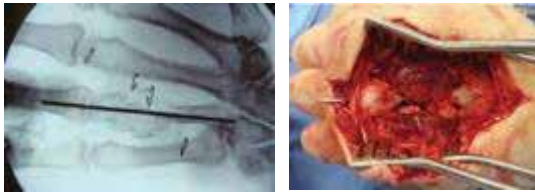
Using the T Plate

Although the most common T plate use is typically for dorsal plating with wrap-around T arms, the T plate is also able to be made into left and right L plates. The example above demonstrates the use of a T plate for subarticular

support, a fixation technique analogous to the construct created by DVR Anatomic Plates in the distal radius (Figure 41).

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Radiographs of comminuted metacarpal fracture

Intraoperative comminution



Wrap-around plating with proximal and distal fixation



2.5 mm A.L.P.S. T/Y plate, proximal end fixation

Figure 42

A.L.P.S. 2.5 mm T/Y plate used for high energy comminuted fracture that spans significant portion of the ring metacarpal.



Figure 43

A.L.P.S. 1.5 mm T/Y plate for comminuted articular fracture. Use of end-to-end plating method.

Using the T/Y Plate

The T/Y plate has four arms, giving it the most plate shape options. By altering the arms with bending, many different shapes can be created. The angle of the T or the Y can be changed symmetrically or each arm bent into an asymmetrical fashion in three different planes. Shortening or removing one arm makes a three-armed plate.

The T/Y plate was designed as an option for complex high energy fractures throughout the small bones of the hand (Figure 42). This plate may be suited for the 'end-to-end' style plating method by capturing the metacarpal or phalanx base with the T end of the plate, then pulling the head out to length and capturing it with the Y end, which is bent and contoured to match the anatomy (Figure 43).



Figure 44

1.5 mm web plate for distal ulnar wrist fracture. Frame 3 shows the articular portion of ulnar head reduced, sitting congruous in the sigmoid notch.



Figure 45

2.5 mm web plate for distal ulnar wrist fracture

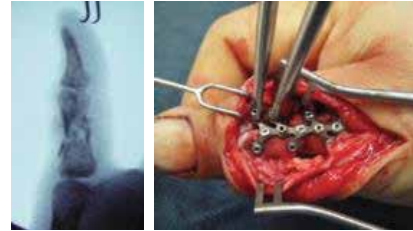


Figure 46

1.5 mm web plate for a proximal phalanx fracture. Sixth frame demonstrates ability to aim (by contouring the plate using plate benders) unrestrained screw hole nodes to point and capture specific fragments.

Using the Web Plate

The web plate offers the most and varied screw fixation potential. This plate is ideal for comminuted fractures where purchase of many independent fracture fragments is desired. Multiple screw options at the end of the plate provide the advantage of 'screw aiming' (Figure 45).

These end holes have 45 degrees of freedom of contouring/aiming with benders. Alternatively, multi-directional screws can be used to target a specific fragment. With segmental loss of metacarpal and phalanx fractures, the end-to-end fixation technique of anchoring one bone end, pulling the fracture out to length and anchoring the other end may work well with the use of this plate (refer to Figure 46).

A.L.P.S. Hand Fracture System

Advanced Plating Guide

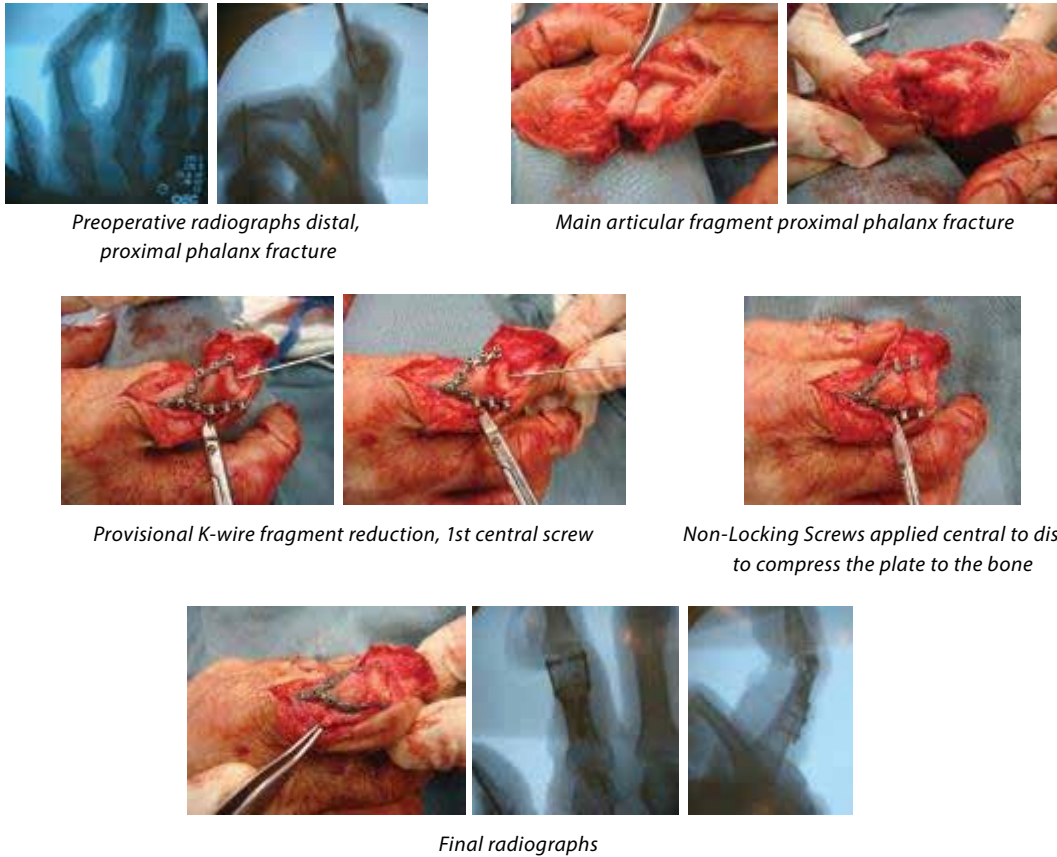


Figure 47

Articular maneuver of lateral placement of fixation plate arms. Fixation achieved with an A.L.P.S. 1.5 mm T/Y plate. A symmetrical configuration was created with the fixation beginning at the confluence of the arms. Notice the use of non-Locking Screws to create plate apposition as screw fixation proceeds towards the ends of the plate. The last plate holes are filled with Locking Screws. A rough bend was done to estimate the size and length of plate. This plate configuration potentially minimizes metal tendon irritation dorsally, especially adjacent to the joint.

When Bending is More Than Contouring

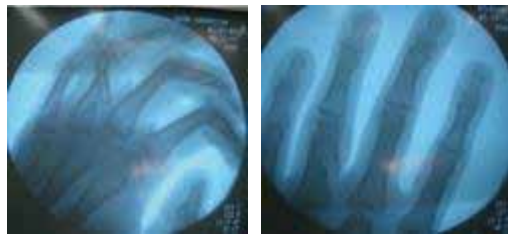
There are several reasons why plates are bent. The first and most obvious reason is to contour the plate to the fracture. With A.L.P.S. Hand Plates, bending can also be used to aim screws; to clamp, hold and buttress fractures by wrap-around plating or by bicondylar plating; and to de-rotate fractures or osteotomies.

As discussed with the web plate, a locking hole can be aimed at a specific target by bending the plate. The target can be a particular fragment or a position in a posterior cortex. Bending a plate during application prior to complete screw fixation may be a method to achieve reduction. For instance, if a plate is applied as a buttress in fixation of an oblique fracture, bending the plate toward the fracture may reposition the fracture. Similarly, during fracture management and in the course of an osteotomy, axial bending of the plate can be used to correct minor rotational deformities.

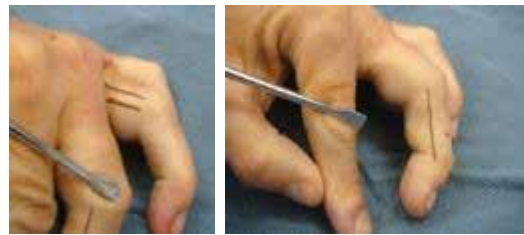
Articular Maneuvers

i. Help Avoid Tendons with Y Plate Wrap-around Lateral Plating

The Y plate can help avoid tendons in the distal half of the fractured bone near the joint. The plates are designed so that the angle and width of the Y can wrap around the fracture to provide lateral fixation distally near the joint (Figure 47). This pattern of plating is intended to keep the tendon free as it drags over the neck and head of the bone during movement. When creating the Y wrap-around, some plate modification may be necessary, depending on the size of the bone and the way that the arms lay across the fracture. The Y plate offers one configuration and the T/Y plate offers a similar but longer Y configuration (one more hole on each arm of the Y).



Radiographs proximal and middle phalangeal fractures



Lateral approach to proximal phalanx

Lateral approach middle phalanx.

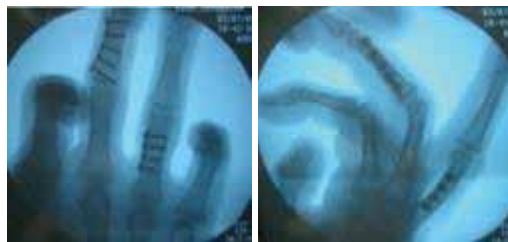


Proximal phalanx fracture

Proximal phalanx reduction



Plating with 1.5 mm plate, non-locking lag screw first
Lateral application 1.5 mm plate to help reduce tendon contact



Final radiographs



Extension and flexion at 4 weeks

Figure 48

Series depicts lateral plating of ring finger proximal phalanx and middle finger middle phalanx using the A.L.P.S. 1.5 mm Plating System. Lateral approaches are made and lateral plating is performed. The intent is to keep the hardware away from the extensors and joint to limit adhesions and allow range of motion. Picture 7 shows that during the middle finger middle phalanx plating, the initial grey colored non-Locking Screws were ultimately replaced with Locking Screws. Picture 8 shows that a lag-through-the-plate technique was used during the ring finger proximal phalanx plating and the black headed non-locking lag screw remains. The last two pictures are clinical photos showing the flexion and extension at 4 weeks post-operative state.

ii. Lateral Plating

Lateral plating may be advantageous due to the fact that the plates are placed away from the tendon to limit adhesion and interference with the extensor tendon. Keeping the incisions and plating away from the extensor tendon hopefully allows the adjacent joints unimpeded motion (Figure 48).

A.L.P.S. Hand Fracture System

Advanced Plating Guide

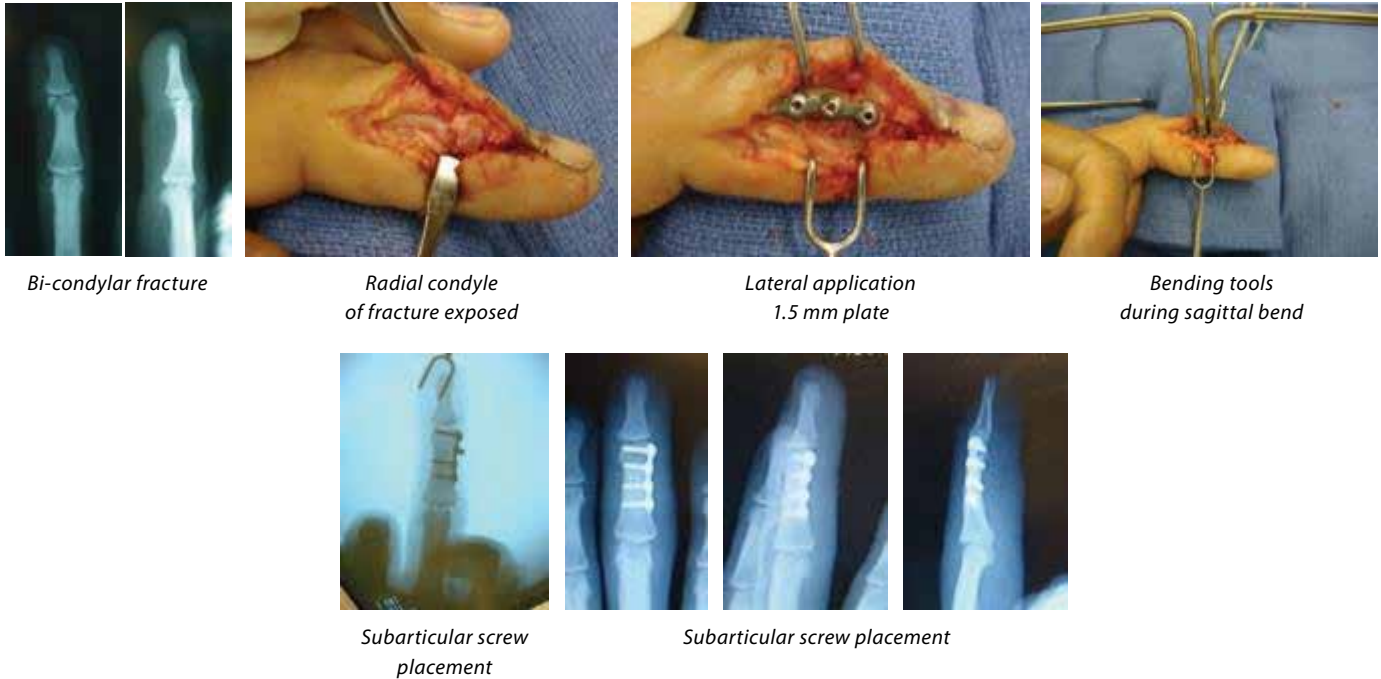


Index comminuted metacarpal fracture with 2.5 mm Y plate, multidirectional screw

Final radiographs

Figure 49

Articular fragment with few possibilities for fixation managed with A.L.P.S. 2.5 mm Y plate



Bi-condylar fracture

Radial condyle of fracture exposed

Lateral application 1.5 mm plate

Bending tools during sagittal bend

Subarticular screw placement

Subarticular screw placement

Figure 50

Complicated bi-condylar articular fracture stabilized with subarticular fixed angle screw fixation. Notice the need for sagittal plate bending (frame 4 shows sagittal bend and frame 5 shows bending process).

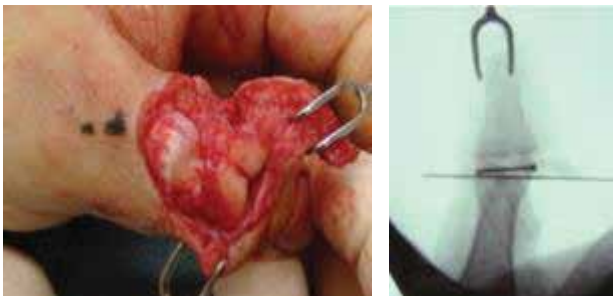
iii. Subarticular Support

For comminuted articular fractures, placement of fixed angle subarticular screws can enable immediate articular range of motion. The subarticular support can originate from dorsal or lateral approaches (Figure 49). The ability of the Locking Screw to hitch its stability to the proximal plate and bone makes screw fixation here possible (Figure 50).



Thumb proximal phalanx articular fracture

Fracture fragment



Lag screw fixation

Radiograph prior to provisional K-wire removal

Figure 51

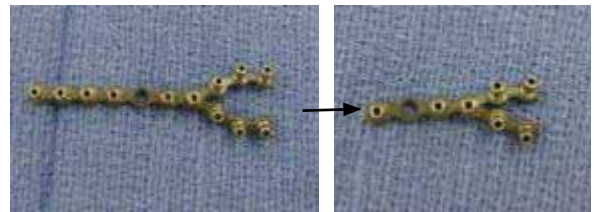
Lag screw fixation of articular proximal phalanx fracture

iv. Lag Screw Technique

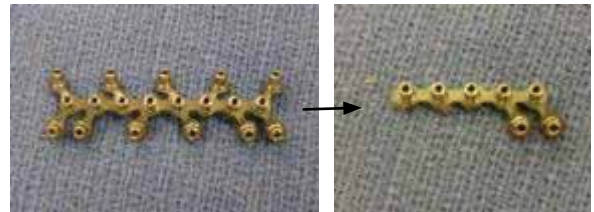
Lag screw fixation of smaller articular fractures avoids using the juxta-articular hardware that may compromise motion. The 1.5 mm tray contains 1.3 mm cruciate head screws which may be used with this technique (Figure 51).

v. Transarticular Screws

With fixation of very small articular fragments, placement of a countersunk 1.3 mm lag screw directly through the articular surface is an option of fixation, without the use of potentially interfering peri-articular hardware.



Y plate arms narrowed to create distal screw cluster



Web Plate Cluster

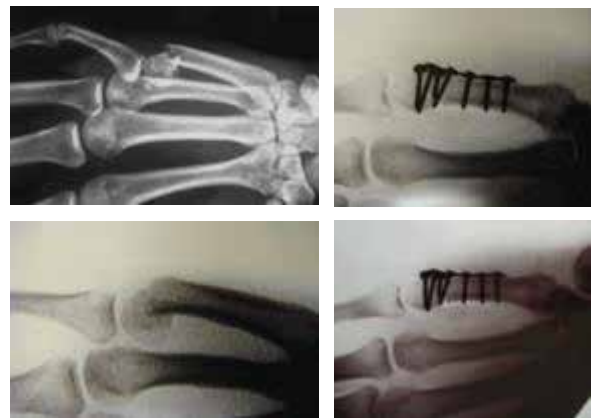


Figure 52

Closed Y plate cluster (first series of photos) and web plate distal cluster (second series of photos).

vi. Use of Plate Design with Distal Screw Cluster

A distal cluster of holes can be designed with any multi-armed plate to achieve subarticular Locking Screw fixation. A Y plate can be modified to create a triad at the distal end of the plate. Other options include a closed Y plate with two parallel multi-hole arms and a modified web plate with a four-hole distal cluster (Figure 52).

A.L.P.S. Hand Fracture System

Advanced Plating Guide



Preoperative radiographs 4th, 5th metacarpal bases



Initial incision showing large articular fragment



Dissected fragments



1.5 mm A.L.P.S. Y plate application



Final radiographs

Figure 53

Patient presented with fracture dislocation of 4th and 5th metacarpal bases. Many might consider closed management. The first clinical photo shows the finding of a large articular 5th metacarpal base fragment after skin incision. The second clinical photo demonstrates the exposed 5th metacarpal fractures. Due to the severity of comminution, a spanning plate was used to treat this fracture dislocation. A 1.5 mm TY plate spans from hamate to metacarpals, with the three-hole Y end reaching the metacarpals. An additional three-hole plate was used to hold the lateral contour of the 5th metacarpal. Notice restoration of normal anatomy.

Plating Fracture Dislocations

Temporary plating of unstable fracture dislocations is a concept similar to bridge plating. Although this procedure is not frequently performed, it is an alternative to external fixation or pin fixation. Internal plating in this instance functions as an 'internal external fixator.' This procedure can be used when there is a desire to unload the joint while maintaining joint reduction (Figure 53).



Figure 54
Example of MCP fusion



Figure 55

Gunshot wound with soft tissue wound and severe articular trauma. Ring finger MCP joint managed with A.L.P.S. 2.5 mm plate as a bridge plate.



Figure 56

1.5 mm straight plate for bridging complex defect

Fusions

Wrist and finger fusions can be managed with plates contoured to desired fusion angles (Figure 54).

Bridge Plating

Bridge plating is an advanced plating technique used to provide temporary fixation across severely injured fractures or joints. The purpose is to bring the digit to length and provide temporary stability or definitive treatment. Several situations require temporary stability. Temporary stability is non-definitive treatment in sick patients who will ultimately need further treatment. With severe soft tissue wounds, such as gunshot wounds, bridge plating provides temporary stability during the soft tissue reconstruction and while soft tissues heal (Figure 55).

A definitive surgical procedure, whether it is bone graft, joint replacement or fusion, can then be performed. In the best case scenario, bridge plating, or bridge plating with articular open reduction internal fixation, can help protect the joint until it heals, with the intention that the articular function will return when the bridge plate is removed. Sometimes the articular fragments are too small to fixate, and, with ligamentotaxis, the fragments reduce, and the bridge plate acts like an 'internal external fixation' device (Figures 56 and 60).

A.L.P.S. Hand Fracture System

Advanced Plating Guide

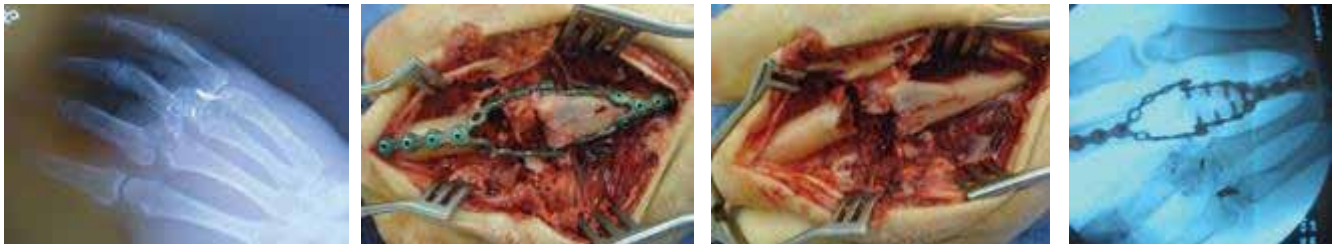


Figure 57

Unusual plating example of a healed thumb fusion, where no trapezium exists. A 2.5 mm straight plate was curved from 1st to 2nd metacarpal in a predominant coronal bend. The additional shorter plate has a predominant axial bend.



Plating with articular capabilities showing neutral, extended, and flexed positions.



Severe articular fracture from gunshot wound. Patient with other significant morbidities, as well as soft tissue wound from gunshot wound. Bridge plate applied to keep finger and soft tissues stable and out to length.

Figure 58

Bridge plating with articular capabilities

Unusual Plating Scenarios

The advantage of the A.L.P.S. Hand Fracture System, specifically the ability of the plates to bend while still providing strong locking fixation, gives opportunity for the surgeon to create some unique plating scenarios. The multiple arms and their variability provide potential to manage fracture plating with creative concepts (Figures 57, 58, and 59).

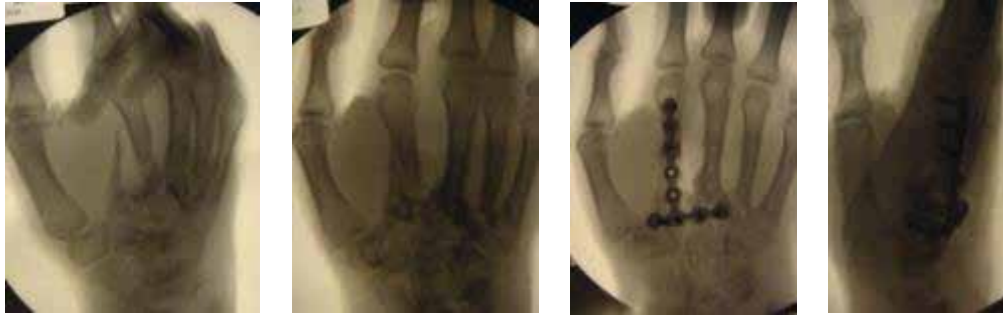


Figure 59

Plating management of a metacarpal nonunion. With the prospect of poor fixation in the second metacarpal base, additional fixation was placed in the base of the third metacarpal using a long T arm from a 2.5 mm A.L.P.S. Hand plate.



Figure 60

A.L.P.S. 1.5 mm straight plate for bridging joint defect after circulating saw accident.

Errors and Pitfalls

i. Over bending

Extreme over bending of a plate may weaken the plate. The geometry, grade and structure of the Type II anodized titanium used in the A.L.P.S. Hand plates allows for bending up to a certain degree, depending on the type of bend. Adhering to these bending guidelines should yield adequate bent plating constructs (Table 1). Multiple high angle bends should not be performed in the process of plating. Ultimately, if no bony healing occurs, if the plate is too small for the application, or if the stresses are too high, any plate can potentially fail.

ii. Lack of Plate Apposition

Plates with a lack of precise adherence to bone could interfere with gliding tissues. A proud plate or lack of plate apposition to bone is a likely result from lack of reduction or from early placement of Locking Screws.

A.L.P.S. Hand Fracture System

Advanced Plating Guide

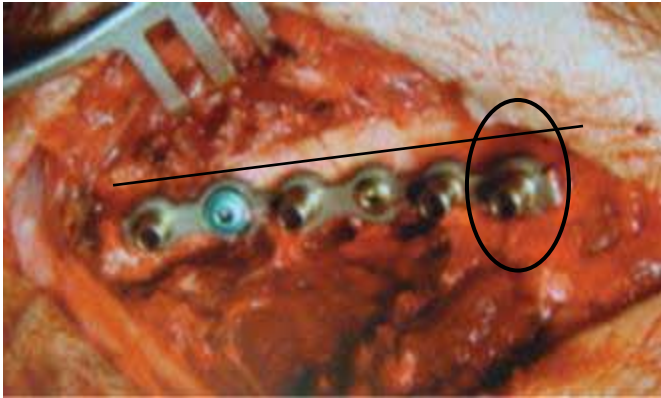


Figure 61

Sagittal bend used to reposition plate end.

iii. Sharp Plate Edges

Proper in-situ bending and placement of end nodes away from tendons and joints may reduce the risk of irritation and friction from plate edges.

The first method to avoid sharp plate edges is to perform proper plate shortening. This includes creating smooth cuts with the shears or creating smooth plate edges when using the plate bending technique of plate shortening. The backup management plan also includes redirecting sharp plate edges away from gliding structures. If a sharp barb is created, the end of the plate can be repositioned with a bend. A coronal bend may bend the barb into the bone, and sagittal and axial bends can potentially be used to bend the plate out of the plane of the gliding tissue. In (Figure 61), a sagittal bend was used to bend this laterally applied plate such that the last hole was buried toward the palm and away from the dorsal extensors.

iv. Long Screws

The use of final fluoroscopy exam helps detect long screws. Flexor and extensor tendon motion is at risk with proud screw tips.

v. Fighting or Scissoring Screws

The scenario of fighting or scissoring screws occurs when screw paths meet each other. In the case of Locking Screws, there is such little room for play that the drill will not advance around the interfering screw. This situation can occur with the Y and T plates where screw trajectories end up pointing at each other. Solutions include aiming one of the F.A.S.T. Guides/screw paths to place the second screw slightly offset; or remove the F.A.S.T. Guide insert, free hand drill, and place a multidirectional locking or a non-Locking Screw.

vi. K-wires and F.A.S.T. Guide Inserts

Inadvertent attempts at placement of a .035 inch K-wire through the smaller F.A.S.T. Guide inserts in the 1.5 mm plates can result in a jammed and stuck K-wire inside an F.A.S.T. Guide insert. Always make sure to check the K-wire diameter, which should be .028 inches in the 1.5 mm plates, by using the measurement tool on the K-wire caddy.

vii. F.A.S.T. Guide Insert Planning

Since two F.A.S.T. Guide inserts are required to create an in-situ bend, F.A.S.T. Guide insert planning needs to be considered. Think one step ahead so that at least two F.A.S.T. Guide inserts are available on a plate that needs contouring. Of course, if only one F.A.S.T. Guide insert remains, a strategic screw can be temporarily removed and replaced with an F.A.S.T. Guide insert for the bend, and then the screw can be reinserted. The single F.A.S.T. Guide insert situation generally occurs at the end of a plate arm or at a Y or T confluence.

Conclusion

The A.L.P.S. Hand Fracture System allows for conventional plating while offering a wide variety of options for hand fracture plating. Plating constructs can be created to manage more complicated fractures including plating of comminuted, articular, high energy fractures previously managed with pins, non-locking plates, fixators or amputation. Low profile, contourable locking plating adds an important tool for small bone fixation. The addition of the multiple armed plate configurations with the in-situ bending capabilities creates an expanded range of fixation possibilities compared to what was previously available. Using the strategies and techniques in this guide can help you become more comfortable with the capabilities the A.L.P.S. Hand Fracture System, creating appropriate treatment options for each fracture and patient.

A.L.P.S. Hand Fracture System

Advanced Plating Guide

Part Number	Size
1.5 / 1.3 mm Module Components	
2312-20-008	1.5mm Stocking Module
Non Locking Screw 1.3mm	
1312-20-308	Non Locking Screw 1.3 mm x 8 mm
1312-20-309	Non Locking Screw 1.3 mm x 9 mm
1312-20-310	Non Locking Screw 1.3 mm x 10 mm
1312-20-311	Non Locking Screw 1.3 mm x 11 mm
1312-20-312	Non Locking Screw 1.3 mm x 12 mm
1312-20-313	Non Locking Screw 1.3 mm x 13 mm
1312-20-314	Non Locking Screw 1.3 mm x 14 mm
1312-20-315	Non Locking Screw 1.3 mm x 15 mm
1312-20-316	Non Locking Screw 1.3 mm x 16 mm
1312-20-318	Non Locking Screw 1.3 mm x 18 mm
1312-20-320	Non Locking Screw 1.3 mm x 20 mm
1312-20-322	Non Locking Screw 1.3 mm x 22 mm
1312-20-324	Non Locking Screw 1.3 mm x 24 mm
Non Locking Screw 1.3mm (Sterile)	
151220308	1.3x8 mm Non Lock Screw STE
151220309	1.3x9 mm Non Lock Screw STE
151220310	1.3x10 mm Non Lock Screw STE
151220311	1.3x11 mm Non Lock Screw STE
151220312	1.3x12 mm Non Lock Screw STE
151220313	1.3x13 mm Non Lock Screw STE
151220314	1.3x14 mm Non Lock Screw STE
151220315	1.3x15 mm Non Lock Screw STE
151220316	1.3x16 mm Non Lock Screw STE
1.5mm Locking Plates	
1312-20-151	1.5 mm Locking plate, Straight
1312-20-152	1.5 mm Locking plate, T-Shape
1312-20-153	1.5 mm Locking plate, Y-Shape
1312-20-154	1.5 mm Locking plate, T/Y Shape
1312-20-155	1.5 mm Locking plate, Web
1312-20-157	1.5 mm Locking plate, Small T-Shape
1.5mm Locking Plates (Sterile)	
151221151	1.5 mm Locking plate, Straight
151220152	1.5 mm Locking plate, T-Shape
151220153	1.5 mm Locking plate, Y-Shape
151220154	1.5 mm Locking plate, T/Y Shape
151220155	1.5 mm Locking plate, Web
151220157	1.5 mm Locking plate, Small T-Shape

Part Number	Size
Non Locking Screw 1.5mm	
1312-20-408	Non Locking Screw 1.5 mm x 8 mm
1312-20-409	Non Locking Screw 1.5 mm x 9 mm
1312-20-410	Non Locking Screw 1.5 mm x 10 mm
1312-20-411	Non Locking Screw 1.5 mm x 11 mm
1312-20-412	Non Locking Screw 1.5 mm x 12 mm
1312-20-413	Non Locking Screw 1.5 mm x 13 mm
1312-20-414	Non Locking Screw 1.5 mm x 14 mm
1312-20-415	Non Locking Screw 1.5 mm x 15 mm
1312-20-416	Non Locking Screw 1.5 mm x 16 mm
1312-20-418	Non Locking Screw 1.5 mm x 18 mm
1312-20-420	Non Locking Screw 1.5 mm x 20mm
1312-20-422	Non Locking Screw 1.5 mm x 22 mm
1312-20-424	Non Locking Screw 1.5 mm x 24 mm
Non Locking Screw 1.5mm (Sterile)	
151220508	1.5x8 mm Non Lock Screw STE
151220509	1.5x9 mm Non Lock Screw STE
151220510	1.5x10 mm Non Lock Screw STE
151220511	1.5x11 mm Non Lock Screw STE
151220512	1.5x12 mm Non Lock Screw STE
151220513	1.5x13 mm Non Lock Screw STE
151220514	1.5x14 mm Non Lock Screw STE
151220515	1.5x15 mm Non Lock Screw STE
151220516	1.5x16 mm Non Lock Screw STE
151220518	1.5x18 mm Non Lock Screw STE
151220520	1.5x20 mm Non Lock Screw STE
Locking Screw 1.5mm	
1312-20-408	1.5X8 mm Locking Screw
1312-20-409	1.5X9 mm Locking Screw
1312-20-410	1.5X10 mm Locking Screw
1312-20-411	1.5X11 mm Locking Screw
1312-20-412	1.5X12 mm Locking Screw
1312-20-413	1.5X13 mm Locking Screw
1312-20-414	1.5X14 mm Locking Screw
1312-20-415	1.5X15 mm Locking Screw
1312-20-416	1.5X16 mm Locking Screw
1312-20-418	1.5X18 mm Locking Screw
1312-20-420	1.5X20 mm Locking Screw
1312-20-422	1.5X22 mm Locking Screw
1312-20-424	1.5X24 mm Locking Screw
Locking Screw 1.5mm (Sterile)	
151220408	1.5X8 mm Locking Screw STE
151220409	1.5X9 mm Locking Screw STE
151220410	1.5X10 mm Locking Screw STE
151220411	1.5X11 mm Locking Screw STE
151220412	1.5X12 mm Locking Screw STE
151220413	1.5X13 mm Locking Screw STE
151220414	1.5X14 mm Locking Screw STE
151220415	1.5X15 mm Locking Screw STE
151220416	1.5X16 mm Locking Screw STE
151220418	1.5X18 mm Locking Screw STE
151220420	1.5X20 mm Locking Screw STE

Part Number	Size
2.5 mm Module Components	
2312-20-007	2.5mm Stocking Module
2.5mm Locking Plates	
1312-20-251	2.5 mm Locking plate, Straight
1312-20-252	2.5 mm Locking plate, T-Shape
1312-20-253	2.5 mm Locking plate, Y-Shape
1312-20-254	2.5 mm Locking plate, T/Y Shape
1312-20-255	2.5 mm Locking plate, Web
2.5mm Locking Plates (Sterile)	
151220251	2.5 mm Straight Plate STE
151220252	2.5 mm T Locking Plate STE
151220253	2.5 mm Y Locking Plate STE
151220254	2.5 mm T/Y Locking Plate STE
151220255	2.5 mm WEB Locking Plate STE
Screw Peg 2.5 mm	
SP08000	Screw Peg 2.5 mm X 8 mm
SP09000	Screw Peg 2.5 mm X 9 mm
SP10000	Screw Peg 2.5 mm X 10 mm
SP11000	Screw Peg 2.5 mm X 11 mm
SP12000	Screw Peg 2.5 mm X 12 mm
SP13000	Screw Peg 2.5 mm X 13 mm
SP14000	Screw Peg 2.5 mm X 14 mm
SP15000	Screw Peg 2.5 mm X 15 mm
SP16000	Screw Peg 2.5 mm X 16 mm
SP18000	Screw Peg 2.5 mm X 18 mm
SP20000	Screw Peg 2.5 mm X 20 mm
SP22000	Screw Peg 2.5 mm X 22 mm
SP24000	Screw Peg 2.5 mm X 24 mm
SP26000	Screw Peg 2.5 mm X 26 mm
SP28000	Screw Peg 2.5 mm X 28 mm
Screw Peg 2.5 mm (Sterile)	
131212508	Screw Peg 2.5 mm X 08 mm
131212509	Screw Peg 2.5 mm X 09 mm
131212510	Screw Peg 2.5 mm X 10 mm
131212511	Screw Peg 2.5 mm X 11 mm
131212512	Screw Peg 2.5 mm X 10 mm
131212513	Screw Peg 2.5 mm X 13 mm
131212514	Screw Peg 2.5 mm X 14 mm
131212516	Screw Peg 2.5 mm X 16 mm
131212518	Screw Peg 2.5 mm X 18 mm
131212520	Screw Peg 2.5 mm X 20 mm
131212522	Screw Peg 2.5 mm X 22 mm
131212524	Screw Peg 2.5 mm X 24 mm
131212526	Screw Peg 2.5 mm X 26 mm
131212528	Screw Peg 2.5 mm X 28 mm

Part Number	Size
Fully Threaded Peg 2.5 mm	
FP08	Fully Threaded Peg 2.5 mm X 8 mm
FP09	Fully Threaded Peg 2.5 mm X 9 mm
FP10	Fully Threaded Peg 2.5 mm X 10 mm
FP11	Fully Threaded Peg 2.5 mm X 11 mm
FP12	Fully Threaded Peg 2.5 mm X 12 mm
FP13	Fully Threaded Peg 2.5 mm X 13 mm
FP14	Fully Threaded Peg 2.5 mm X 14 mm
FP15	Fully Threaded Peg 2.5 mm X 15 mm
FP16	Fully Threaded Peg 2.5 mm X 16 mm
FP18	Fully Threaded Peg 2.5 mm X 18 mm
FP20	Fully Threaded Peg 2.5 mm X 20 mm
FP22	Fully Threaded Peg 2.5 mm X 22 mm
FP24	Fully Threaded Peg 2.5 mm X 24 mm
FP26	Fully Threaded Peg 2.5 mm X 26 mm
FP28	Fully Threaded Peg 2.5 mm X 28 mm
Fully Threaded Peg 2.5 mm (Sterile)	
131212610	Fully Threaded Peg 2.5 mm X 10
131212612	Fully Threaded Peg 2.5 mm X 12
131212614	Fully Threaded Peg 2.5 mm X 14
131212616	Fully Threaded Peg 2.5 mm X 16
131212618	Fully Threaded Peg 2.5 mm X 18
131212620	Fully Threaded Peg 2.5 mm X 20
131212622	Fully Threaded Peg 2.5 mm X 22
131212624	Fully Threaded Peg 2.5 mm X 24
131212626	Fully Threaded Peg 2.5 mm X 26
131212628	Fully Threaded Peg 2.5 mm X 28
2.5 mm Threaded Washer	
1312-20-025	2.5 mm Threaded Washer
2.5mm Threaded Washer (Sterile)	
151220025	2.5 mm Threaded Washer
2.5 mm MDTP Screws	
1312-11-108	MDTP 2.5 mm X 8 mm
1312-11-109	MDTP 2.5 mm X 9 mm
1312-11-110	MDTP 2.5 mm X 10 mm
1312-11-111	MDTP 2.5 mm X 11 mm
1312-11-112	MDTP 2.5 mm X 12 mm
1312-11-113	MDTP 2.5 mm X 13 mm
1312-11-114	MDTP 2.5 mm X 14 mm
1312-11-115	MDTP 2.5 mm X 15 mm
1312-11-116	MDTP 2.5 mm X 16 mm
1312-11-118	MDTP 2.5 mm X 18 mm
1312-11-120	MDTP 2.5 mm X 20 mm
1312-11-122	MDTP 2.5 mm X 22 mm
1312-11-124	MDTP 2.5 mm X 24 mm
1312-11-126	MDTP 2.5 mm X 26 mm
1312-11-128	MDTP 2.5 mm X 28 mm
1312-11-130	MDTP 2.5 mm X 30 mm

A.L.P.S. Hand Fracture System

Advanced Plating Guide

Part Number	Size
2.5 mm MDTP Screws (Sterile)	
131212410	Multi-Directional Threaded Peg 2.5 mm x 10 mm
131212411	Multi-Directional Threaded Peg 2.5 mm x 11 mm
131212412	Multi-Directional Threaded Peg 2.5 mm x 12 mm
131212413	Multi-Directional Threaded Peg 2.5 mm x 13 mm
131212414	Multi-Directional Threaded Peg 2.5 mm x 14 mm
131212415	Multi-Directional Threaded Peg 2.5 mm x 15 mm
131212416	Multi-Directional Threaded Peg 2.5 mm x 16 mm
131212418	Multi-Directional Threaded Peg 2.5 mm x 18 mm
131212420	Multi-Directional Threaded Peg 2.5 mm x 20 mm
131212422	Multi-Directional Threaded Peg 2.5 mm x 22 mm
131212424	Multi-Directional Threaded Peg 2.5 mm x 24 mm
131212426	Multi-Directional Threaded Peg 2.5 mm x 26 mm
131212428	Multi-Directional Threaded Peg 2.5 mm x 28 mm
DISPOSABLES—Single Use Devices	
2312-11-002	MDTP Driver Bit
2312-20-200	1.0 mm Drill Bit w/ Mini-Quick Connect
2312-20-201	1.3 mm Drill Bit w/ Mini-Quick Connect
2312-20-202	FAST 1.1 mm Drill Bit w/ Mini-Quick Connect

Part Number	Size
2312-20-203	1.5 mm Drill Bit w/ Mini-Quick Connect
2312-20-204	FAST 2.0 mm Drill Bit w/ Mini-Quick Connect
2312-20-205	2.5 mm Drill Bit w/ Mini-Quick Connect
2312-20-206	1.3 mm / 1.5mm Countersink
2312-20-207	2.0 mm / 2.5mm Countersink
2312-20-208	1.3 mm Driver Bit
2312-20-209	1.5 mm Driver Bit
2312-20-211	2.0mm / 2.5 mm Driver Bit
1642-06-028	K-Wire 6" Trocar Point .028 OD
1642-06-035	K-Wire 6" Trocar Point .035 OD
1642-06-045	K-Wire 6" Trocar Point .045 OD
1642-06-062	K-Wire 6" Trocar Point .062 OD
DISPOSABLES—SINGLE USE DEVICES (Sterile)	
231221200	1.0X56mm Drill MQC STE
231221201	1.3MM Drill Bit Mini Quick Connect
231221202	1.1X56mm Drill Fast MQC STE
231221203	1.5X56mm Drill MQC STE

Indications

For stabilization and fixation of small bone fragments in fresh fractures, revision procedures, joint fusion and reconstructions of small bones of the hand, foot, wrist, ankle, humerus, scapula, finger, toe, pelvis and craniomaxillofacial skeleton, particularly in osteopenic bone.

Contraindications (orthopaedic screws, intramedullary nails, plates, compression hip screws, pins and wires):

- Cases where there is an active infection.
- Conditions which tend to retard healing such as, blood supply limitations, previous infections, etc.
- Insufficient quantity or quality of bone to permit stabilization of the fracture complex and/or fusion of the joints.
- Conditions that restrict the patient's ability or willingness to follow postoperative instructions during the healing process.
- Foreign body sensitivity – where material sensitivity is suspected, appropriate tests should be made and sensitivity ruled out prior to implantations.
- Cases where the implant(s) would cross open epiphyseal plates in skeletally immature patients.

Additional Contraindications – Orthopaedic Screws and Plates Only:

- Cases with malignant primary or metastatic tumors which preclude adequate bone support or screw fixations, unless supplemental fixation or stabilization methods are utilized.

References

1. Nicklin, S; Ingram S; Gianoutsos, M; Walsh, W; In Vitro Comparison of Lagged and Nonlagged Screw Fixation of Metacarpal Fractures in Cadavers. Journal of Hand Surgery (J Hand Surg) 2008;33A: 1732-1736.
2. Roth, J; Auerbach, D; Fixation of Hand Fractures with Bicortical Screws. Journal of Hand Surgery (J Hand Surg) 2005;30A: 151-153.
3. Fulkerson E; Egol KA; Kubiak EN; Liporace F; Kummer FJ; Koval KJ Fixation of diaphyseal fractures with a segmental defect: a biomechanical comparison of locked and conventional plating techniques. The Journal Of Trauma [J Trauma] 2006 Apr; Vol. 60 (4), pp. 830-5.
4. Miller DL; Goswami T; Prayson MJ Overview of the locking compression plate and its clinical applications in fracture healing. Journal Of Surgical Orthopaedic Advances [J Surg Orthop Adv] 2008 Winter; Vol. 17 (4), pp. 271
5. Roberts JW, Grindel SJ, Rebholz B, Wang M. Biomechanical evaluation of locking plate radial shaft fixation: unicortical locking fixation versus mixed bicortical and unicortical fixation in a sawbone model. J Hand Surg Am. 2007 Sep;32(7):971-5.
6. Haug RH; Street CC; Goltz M Does plate adaptation affect stability? A biomechanical comparison of locking and nonlocking plates. Journal Of Oral And Maxillofacial Surgery: Official Journal Of The American Association Of Oral And Maxillofacial Surgeons [J Oral Maxillofac Surg] 2002 Nov; Vol. 60 (11), pp. 1319-26.
7. Bottlang M; Doornink J; Byrd GD; Fitzpatrick DC; Madey SM A nonlocking end screw can decrease fracture risk caused by locked plating in the osteoporotic diaphysis. The Journal Of Bone And Joint Surgery. American Volume [J Bone Joint Surg Am] 2009 Mar 1; Vol. 91 (3), pp. 620-7.
8. Drobetz H; Bryant AL; Pokorny T; Spitaler R; Leixnering M; Jupiter JB Volar fixed-angle plating of distal radius extension fractures: influence of plate position on secondary loss of reduction--a biomechanical study in a cadaveric model. The Journal Of Hand Surgery [J Hand Surg [Am]] 2006 Apr; Vol. 31 (4), pp. 615-22.
9. Prevel CD; Eppley BL; Jackson JR; Moore K; McCarty M; Sood R; Wood R corrected to Sood R Mini and micro plating of phalangeal and metacarpal fractures: a biomechanical study. The Journal Of Hand Surgery [J Hand Surg [Am]] 1995 Jan; Vol. 20 (1), pp. 44-9.
10. Sohn, R; Jahng, K; Curtiss, K; Szabo, R; Comparison of Metacarpal Plating Methods. Journal of Hand Surgery (J Hand Surg) 2008;33A:316-321.

Acknowledgement

Written by: Lloyd Champagne, M.D.

To Brian Hartigan, M.D. who originated some of these A.L.P.S. concepts.

This material is intended for health care professionals and the Biomet sales force only. Distribution to any other recipient is prohibited. All content herein is protected by copyright, trademarks and other intellectual property rights owned by or licensed to Biomet Inc. or its affiliates unless otherwise indicated. This material must not be redistributed, duplicated or disclosed, in whole or in part, without the express written consent of Biomet.

Check for country product clearances and reference product specific instructions for use. For complete product information, including indications, contraindications, warnings, precautions, and potential adverse effects, see the package insert, www.Biomet.com, or contact your local Biomet representative.

This technique was prepared in conjunction with licensed health care professionals. Biomet does not practice medicine and does not recommend any particular orthopedic implant or surgical technique for use on a specific patient. The surgeon is responsible for determining the appropriate device(s) and technique(s) for each individual patient.

Not for distribution in France.

CE Mark on the surgical technique is not valid unless there is a CE Mark on the product (description) label.

BIOMET
TRAUMA

One Surgeon. One Patient.

©2015 Biomet Trauma • Form No. BMET1288.0 • REV0515



Legal Manufacturer
Biomet Trauma
56 East Bell Drive
P.O. Box 587
Warsaw, Indiana 46581
USA

www.biomet.com



Authorised Representative
Biomet UK Ltd.
Waterton Industrial Estate
Bridgend, South Wales
CF31 3XA
UK

CE0086