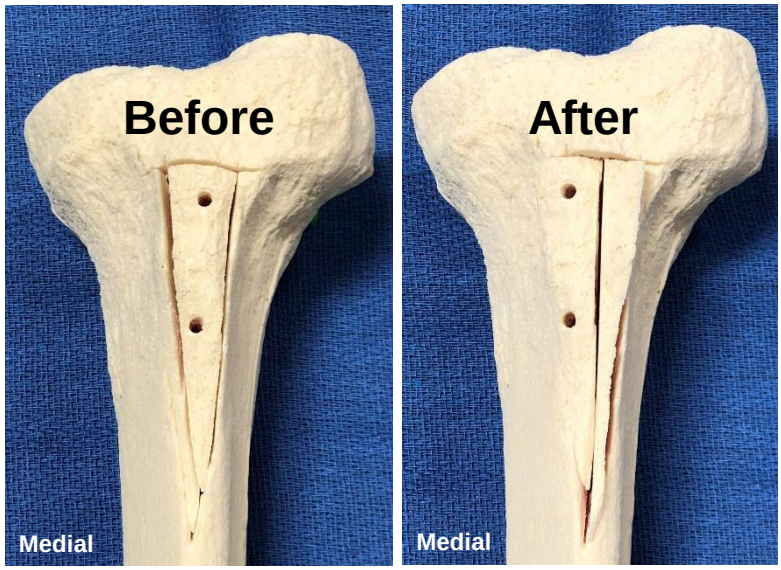
Surgical Technique

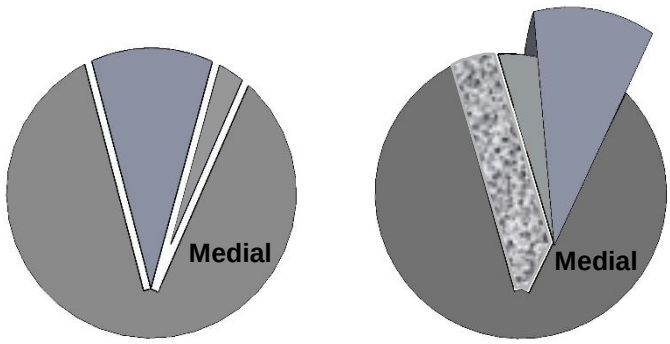
MD3T™

Multi-Directional Tibial Tubercle Transfer

For Medial, AMZ, Anterior, Distal, and Proximal Transfers

Developed by Alan C. Merchant, M.D. [4,5]





Before Transfer **AMZ Transfer**

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US Patents 7,794,466 and 8,828,010

MD3T Surgical Technique

Multi-Directional Tibial Tubercle Transfer

Introduction

Transferring the tibial tubercle (TT) to treat patellofemoral disorders is a time-tested and well-established surgical procedure. Medial transfer has been practiced since 1888 [1], and anterior transfer was introduced by Maquet in 1976 [2]. In 1983, Fulkerson combined these two transfers in the antero-medialization (AMZ) technique [3]. In addition, distal transfer to correct patella alta, and lateral transfer to reconstruct an over-medialized TT, may be indicated. The **Multi-Directional Tibial Tubercle Transfer (MD3T) System** from Kinamed has unique advantages: it enables the surgeon to move the TT in multiple directions in a precise, predictable, and independent manner, while preserving greater cortical integrity to help reduce the risk of a tibial fracture.

The concept of the MD3T technique [4-6] is simple:

A. A compound wedge of bone containing the Tibial Tubercle and its attached Patellar Tendon is created, the **"Primary Wedge."**

B. For corrections that include significant medialization, a **"Secondary Wedge"** of bone is created medial to the Primary Wedge.

C. The Primary and Secondary Wedges are **transposed**, thus transferring the Tibial Tubercle medially. The width of the Secondary Wedge determines the medial transfer distance.

D. For medial transfer, fast-setting bone void filler or bone graft is used to fill the space lateral to the transposed Wedges prior to fixation.

E. For antero-medial transfer, additional fast-setting bone void filler or bone graft is placed lateral and posterior to the transposed Wedges prior to fixation.

F. The medial and anterior transfer distances can therefore be planned independently of one another.

G. Unidirectional anterior, distal, and proximal transfers involve the repositioning of the Primary Wedge only (a Secondary Wedge is not created).

Indications

The MD3T System is indicated for patients who have reached skeletal maturity and are candidates for a tibial tubercle transfer. The flexibility and precision of the MD3T System offers the surgeon the opportunity to address many of the multiple causes of patellofemoral disorders with one instrumentation system. Patients with recurrent patellar dislocation, minimal patellar chondrosis, and tibial tubercle lateralization may benefit from medial transfer alone. For those with more severe chondrosis, appropriate anterior transfer may be added to achieve an anteromedialization, or AMZ. If the patient has a shallow sulcus, the MD3T System gives the surgeon the opportunity, if desired, to reduce the Q angle (measured intra-operatively) below its normal value in order to achieve proper balance of the patella in the dysplastic groove. A progressive, distal release of the lateral retinaculum should be considered if the patella remains tethered laterally. In complex cases, the MD3T System allows the addition of medial patellofemoral ligament (MPFL) reconstruction or other appropriate techniques when necessary.

Caution: *Federal law restricts this device to sale by or on the order of a physician. Prior to use of this device, please review the instructions for use (document B00236) and this surgical technique (document B00237) for a complete listing of indications, contraindications, warnings, precautions, and directions for use.*

References

1. Roux D (1888) Luxation Habituelle de la Rotule. Rev Chir Paris. 8:682-689.
2. Maquet P (1976) Advancement of the tibial tuberosity. Clin Orthop. 115:225-230.
3. Fulkerson JP (1983). Anteromedialization of the tibial tuberosity for patellofemoral malalignment. Clin Orthop. 177:176–181.
4. Merchant AC (2001) Patellofemoral Joint Disorders. In: *Chapman's Orthopedic Surgery*, 3rd ed, pp. 2334-2335, edited by M.W. Chapman. Lippincott Williams & Wilkins, Philadelphia.
5. Sarin, Camisa, Leasure, Merchant (2016) Multi-Directional Tibial Tubercle Transfer Technique: Rationale and Biomechanical Investigation. Journal of Surgical Orthopedic Advances. 25(3):157-164.
6. Merchant T (2019) Preliminary experience with the MD3T, a novel tibial tubercle transfer. Annual Meeting of the International Patellofemoral Study Group. Banff, Canada.

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Multi-Directional Tibial Tubercle Transfer

Planning the Correction

Preoperatively determine the desired transfer direction(s) including magnitude of correction. A planned medial transfer distance can be based on the preoperative tibial tubercle–trochlear groove (TT-TG) distance or correcting the intraoperatively measured Q angle. A planned anterior transfer, if indicated, can be based on the amount and location of patellar chondrosis. For medial transfers, the width of a Secondary Wedge determines the medial transfer distance. For AMZ, because the shape of the Primary and Secondary Wedges will cause the TT to move medially as it is moved anteriorly, the Secondary Wedge should be narrower than it would be when only medial transfer is planned (see Step 4 for details).

1. Attach the Primary Guide

A. Align a vertical incision over the Tibial Tubercle (TT), such that it will be lateral to the TT after transfer, and expose the TT in the usual manner. Stay on bone laterally to avoid injuring the anterior recurrent tibial artery.

B. Dissect out the patellar tendon attachment and center the Primary Guide directly on top of the TT with the proximal end at the top of the TT. Align the Primary Guide with the long axis of the tibia. The proximal surface of the Primary Guide should be just superior to the insertion of the fibers of the patella tendon. Attach the Lateral Cortical Finder to the Primary Guide and press its tip against the lateral tibial cortex in order to position the Primary Guide to avoid cutting the lateral tibial cortex **(Fig. 1).**

C. Hold the Primary Guide in place and use a sharp 3.2mm drill and sleeve to create a unicortical pilot hole through the proximal hole **(Fig. 2)**. Insert a 26mm (4.5x26mm) temporary fixation screw into the proximal hole, but do not tighten it.

D. Repeat Step 1C for the distal hole and insert a 20mm (4.5x20mm) temporary fixation screw into the distal hole. Tighten both temporary fixation screws alternately until the Primary Guide is fixed securely **(Fig. 3)**.

Note: *Use of the shorter temporary fixation screw in the distal hole helps avoid contact with the saw blade.*

Fig 1. Position the Primary Guide.

Fig 2. Drill unicortical pilot holes.

Fig. 3. Primary Guide secured.

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Multi-Directional Tibial Tubercle Transfer

2. Make the 1st Cut (the Lateral Cut) to Define the Primary Wedge

Caution: *The 1st (lateral) cut begins at the lateral side of the TT, staying inside the lateral cortex. Cutting through the lateral cortex here can severely weaken the proximal tibia, possibly causing a subsequent fracture.*

A. Use the lateral side of the Primary Guide to guide the 1st Cut. Avoid the lateral cortex and the lateral patellar tendon, and work from proximal to distal. If the lateral edge of the patellar tendon is exposed, lift it up to avoid cutting it with the saw blade. The Slotted Primary Guide Sleeve may be used to help guide the saw **(Fig. 4)**.

Note: *Use care to avoid hitting the short temporary fixation screws of the Primary Guide.*

3. Make the 2nd Cut (the Medial Cut) to Define the Primary Wedge

Note: *Cuts 1 and 2 define the Primary Wedge (the TT and its attached patellar tendon) as shown in* ***Fig. 5****.*

A. In small knees, where the Primary Guide is wider than the patellar tendon insertion, use the medial side of the Primary Guide to guide the 2nd Cut **(Fig. 5)**. Avoid the medial patellar tendon, and work from proximal to distal. The Slotted Primary Guide Sleeve may be used to help guide the saw for this resection.

B. In average or large knees, where the Primary Guide is narrower than the patellar tendon insertion, do not cut against the Primary Guide. Instead, attach the appropriate Outrigger Guide (A or B) to the Primary Guide with the Set Screw. The flat surface of the Outrigger should face medially. Adjust and lock the position of the Outrigger's cutting slot to avoid cutting the medial patellar tendon and perform the 2nd Cut, working from proximal to distal **(Fig. 6)**.

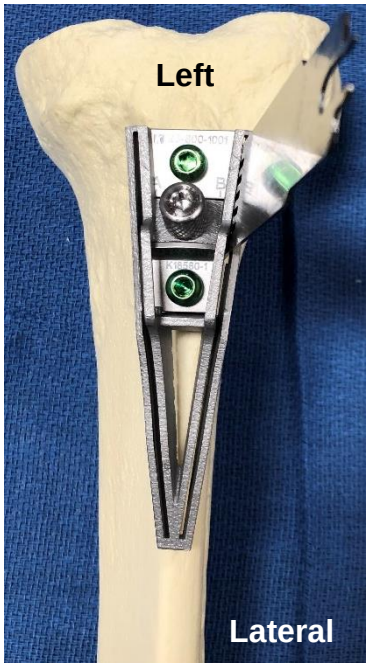

Fig. 4. 1st (Lateral) cut.

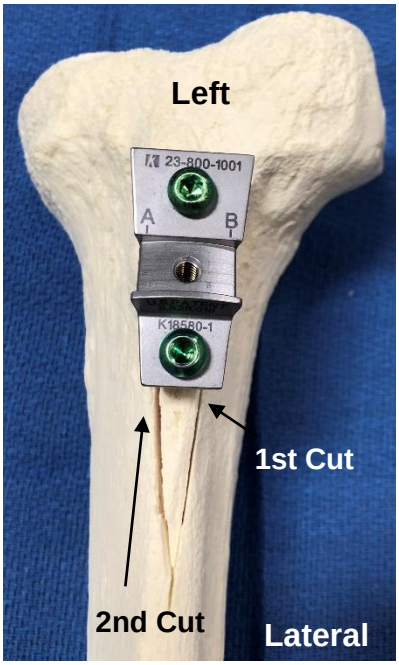

Fig. 5. Primary Wedge.

Fig. 6. 2nd (Medial) cut with Outrigger.

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Multi-Directional Tibial Tubercle Transfer

4. Plan the Transfer & Make the 3rd Cut to Define the Secondary Wedge, if necessary

Note: *Unidirectional anterior, distal, or proximal transfers only require a Primary Wedge (a Secondary Wedge is not necessary). A Secondary Wedge is only required for AMZ transfers that involve ≥ 6mm of medialization.*

A. For unidirectional anterior, distal, proximal, or combined transfers, a Secondary Wedge is not required. Skip to Step 5.

B. For Antero-Medial (AMZ) transfers that involve < 6mm of medialization, a Secondary Wedge is not required. Skip to Step 5.

C. For 'Medial Only' transfers, attach the appropriate Outrigger Guide (A or B) to the Primary Guide with the Set Screw. The flat surface of the Outrigger should face medially. The amount of Medial Transfer will be equal to the width of the Secondary Wedge and its two saw kerfs. Using a Ruler, adjust the Outrigger so that the Secondary Wedge (including the saw kerfs) will have the desired width **(Fig. 7)**. The width of the Secondary Wedge should be measured medially from the edge of the Primary Wedge along the proximal tibial bone surface. Adjust and lock the position of the Outrigger's cutting slot and perform the 3rd Cut, working from proximal to distal. All three cuts should meet distally at the apex. Remove the Outrigger Guide.

D. For Antero-Medial (AMZ) transfers that involve ≥ 6mm of medialization, a Secondary Wedge is required. When anteriorizing, the cross-sectional shape of the wedges will cause the TT to move farther medial as it is moved anterior. For this reason, the Secondary Wedge should be narrower than it would be when only a medial transfer is planned. For example, a planned 10mm medialization & 10mm anteriorization (depicted schematically in **Fig. 8a**) requires a Secondary Wedge (including saw kerfs) that is 5mm wide (in other words, a 10mm anteriorization with a 5mm wide Secondary Wedge will cause the TT to end up being medialized 10mm). The required Secondary Wedge width for several common AMZ transfers is specified in **Table 1**. Adjust and lock the position of the Outrigger's cutting slot and perform the 3rd Cut, working from proximal to distal. All three cuts should meet distally at the apex. Remove the Outrigger Guide.

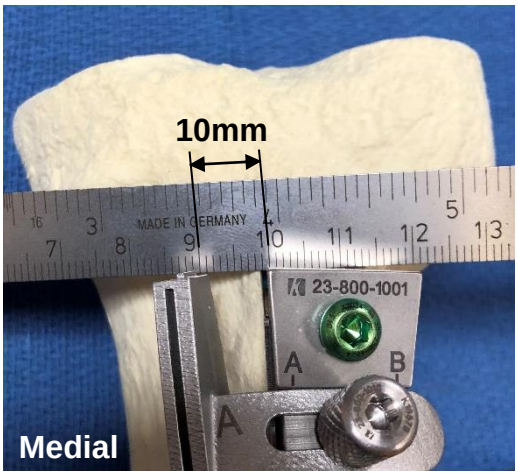

Fig. 7. Planning a 10 mm wide Secondary Wedge.

Caution: *These measurements provide an estimate only. Anatomic variability as well as the width and accuracy of the saw cuts will affect these measurements. It is preferable to err on the side of under-correction (i.e. solving over-correction will require adding bone void filler to the Primary Wedge medially as well as laterally, which is not recommended. Use a sterile goniometer to avoid over-correction as shown in* ***Fig. 11****).*

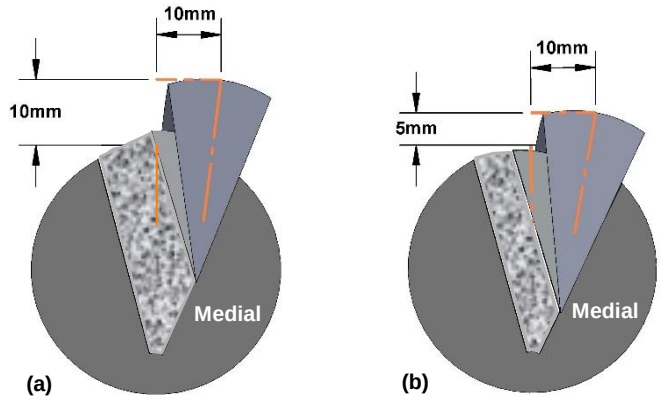

Fig. 8. (a) The width of the Secondary Wedge (including its kerfs) should be 5mm to achieve a 10mm anterior and 10mm medial (AMZ) transfer; **(b)** the width of the Secondary Wedge should be 7mm to achieve a 5mm anterior and 10mm medial (AMZ) transfer. Bone Void Filler (not shown) should fill the space lateral and posterior to the Wedges as described in Step 8.

Width of Secondary Wedge (mm)		Planned Medial Transfer (mm)				
		2	**4**	**6**	**8**	**10**
Planned Anterior Transfer (mm)	**5**	*	*	*4*	*5*	*7*
	10	*	*	*	*4*	*5*
	15	*	*	*	*3*	*4*

Table 1. To achieve the planned AMZ transfer, the width of the Secondary Wedge (measured from the edge of the Primary Wedge along the proximal tibial bone surface) is shown in *italics*. Note that a Secondary Wedge is not needed for the "smaller" medial transfers, as shown by the asterisk (*) entries in the table.

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5. Make the Proximal Cut and Free the Wedge(s)

A. Define the distal end of the Patellar Tendon (PT) and make the proximal cut transversely at the proximal end of the Primary Guide by retracting the PT (medially and laterally, as needed) and using the osteotomes to cut the thin cortical and cancellous bone **(Fig. 9)**. Use care to avoid injuring the PT.

B. Free the Wedge(s) by carefully completing all the cuts using the osteotomes. Use the saw where necessary.

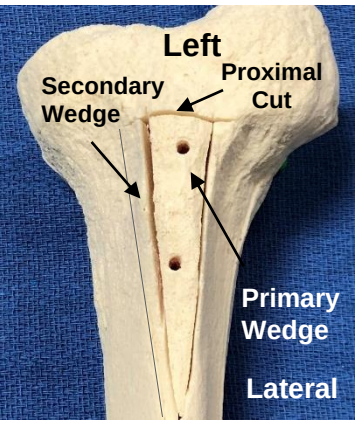

Fig. 9. Wedges freed.

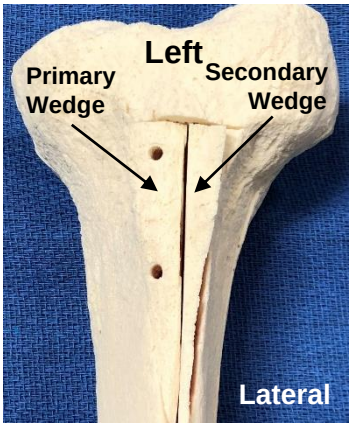

Fig. 10. Wedges transposed.

6. Transpose the Wedges

A. Release the lateral retinaculum distally, if necessary, to allow the TT to be mobilized without tension. Once the wedges are free, transpose the two wedges to transfer the TT to its new position **(Fig. 10)**. Fix a 2.4mm Steinmann Pin through the set screw hole in the Primary Guide to hold the TT in its new position and confirm proper correction and patellar tracking. ***Note:*** *The Primary Guide has been removed in* ***Figures 9-10*** *for better visualization.*

B. Because an MRI cannot be obtained in surgery, a planned and completed medial transfer can be double checked intraoperatively by measuring the Q angle. **(Fig. 11)**. Avoid under-correction by assuring the Q angle is <10° and avoid over-correction by assuring the Q angle is >0°.

Fig. 11. Demonstration of intra-operative clinical Q angle measurement on a Left knee in full extension. Stretch a Bovie cord from the ASIS to the center of the patella and use a sterile goniometer to measure & confirm the corrected Q angle.

7. Finalize the Transfer, Prepare and Apply the Bone Void Filler

A. A clear understanding of the timing sequence for the fast setting bone void filler is required for proper implantation. Immediately prior to placing the bone void filler, the final tubercle position should be verified. Mix the bone void filler according to its Instructions for Use (Instructions for OsteoRepair™ are included in **Table 2**), and implant it around the Wedge(s) as described in Step 8.

Step	*Duration*	*Instruction*
1		*Pour all powder into bowl*
2		*Pour liquid into bowl*
3	*1 min*	*Mix quickly and completely*
4	*2 mins*	*Collect Paste and prepare to implant*
5	*1 min*	*Implant the Paste*
6	*5 mins*	*Setting (Do Not Disturb)*
7	*2 mins*	*Hard Set & Ready to Drill (8 mins > start of implantation)*

Table 2. Mixing instructions for OsteoRepair Paste Bone Void Filler. Prior to use, OsteoRepair Paste must be at or below 77ºF to work properly. Once the product touches the patient, it needs a warm body temperature (above 90ºF) and a wet environment to set properly.

B. With the 2.4mm Steinmann Pin holding the Primary Wedge in its new position, apply the bone void filler based on the type of transfer desired, as described in Step 8.

C. Use an elevator to remove excess bone void filler and smooth it to align the surface with the cortical margins. Extra-osseous bone void filler in the soft tissues should also be removed with a sterile damp cloth at this time.

D. Apply a warm saline compress to ensure proper setting of the bone void filler, especially if a tourniquet is being used.

E. After the bone void filler has hardened with the TT in its desired position, remove the two temporary fixation screws and the Primary Guide from the TT.

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8. Locations for Bone Void Filler Application

For <u>unidirectional</u> Anterior Transfer: Place enough bone void filler lateral to the Primary Wedge to compensate for the resected bone, and posteriorly to anteriorize the tibial tubercle the desired amount. ***Note:*** *Maintain good bony contact medially.*

For Medial Transfer: Place enough bone void filler lateral to the bone Wedge(s) to compensate for the resected bone **(Fig. 12)**.

For <u>unidirectional</u> Distal Transfer: Using preoperative images with known magnification, plan the desired distal transfer distance. Pressing the Primary Wedge distally closes the saw kerfs and moves the tibial tubercle distally. The distal 1-2mm of the Primary Wedge may be resected in order to facilitate the transfer. Measure the amount of distal transfer, and if further distalization is necessary, run the saw blade along one kerf and measure again. This maneuver can be repeated with the other saw kerf if needed. Use Bone Void Filler proximal to the Primary Wedge to resist the pull of the patellar tendon. Alternatively, a bone block may be used to fill the proximal void. If needed, place enough bone void filler lateral to the Primary Wedge to compensate for the saw kerfs. ***Caution:*** *Avoid creating a patella infera (baja) and maintain good bony contact medially and laterally.*

For Antero-Medial (AMZ) Transfer: Place bone void filler both laterally and posteriorly under the bone Wedge(s) to achieve the desired correction.

For <u>unidirectional</u> Proximal Transfer: Carefully resect bone at the proximal end of the Primary Wedge or the tibial defect (i.e. at the location of the 4th Cut). Place enough bone void filler lateral to the Primary Wedge to compensate for the saw kerfs. ***Caution:*** *The amount of proximal transfer is limited because resection of the proximal part of the Primary Wedge can jeopardize the patellar tendon attachment and resection of the proximal end of the tibial defect can weaken the tibial plateau, subjecting it to an increased risk of fracture. Maintain good bony contact medially.*

Fig. 12. Medial transfer completed with bone void filler placed laterally. ***Note:*** *Colored bone void filler is shown for demonstration purposes.*

9. Secure the Fixation (Fig. 13)

Caution: *When drilling the final pilot holes through the posterior cortex, flex the knee to allow neurovascular structures to fall away, and use extreme caution to avoid suddenly plunging through the posterior cortex and damaging these structures.*

A. Starting at the proximal fixation hole, drill a pilot hole with a sharp 3.2 mm drill bit, from anterior to posterior, completely through the posterior cortex. Apply low, even pressure while drilling.

B. Since the MD3T set does not include bicortical screw implants, using instruments from the preferred screw implant set to over-drill the pilot hole to a depth of approximately 3/4 inch below the anterior cortex (to create a lag effect) and countersink the anterior opening. Use a depth gauge to select the proper length 4.5mm diameter (or greater) fixation screw implant. Insert the fixation screw implant until it catches the posterior cortex, but do not tighten it securely.

C. Repeat this process for the distal hole, and then tightened each screw alternately until the construct is secure.

D. <u>If additional security is felt to be necessary</u>, use the same process to place a third fixation screw implant between the proximal and distal screws. Tighten all three screws securely.

E. Check for and carefully round off any sharp or protruding edges to avoid impinging on the patellar tendon during normal range of motion.

F. Move the knee through its range of motion and evaluate patellofemoral tracking.

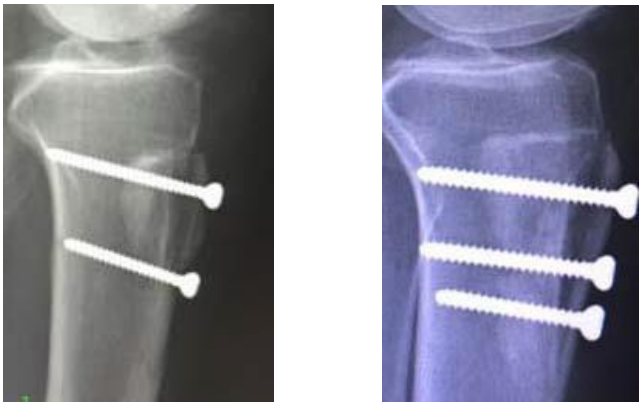
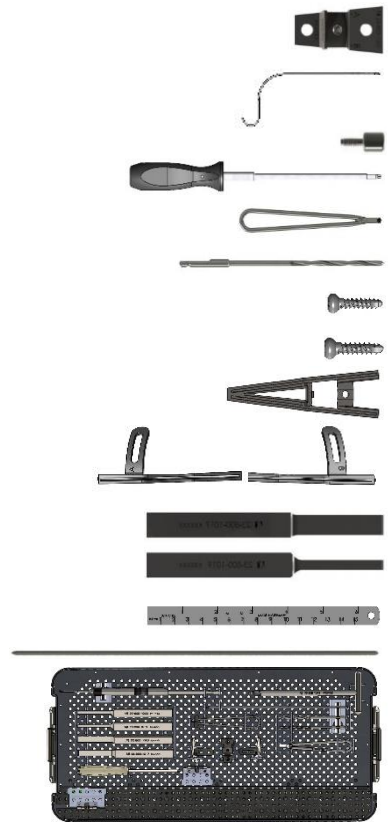


Fig. 13. Tubercle secured via lag-screw technique with two or three 4.5 mm diameter bicortical bone screws (not included).

Part Number Information for the MD3T System

Catalog No.	Description	Qty	Image (not to scale)
Instruments Included in the Set			
23-800-1001	Primary Guide	1	
23-800-1002	Lateral Cortical Finder	1	
23-800-1015	Set Screw	2	
35-860-2062	Driver, 3.5mm Hex	1	
23-800-1003	Drill Sleeve, 3.2mm	1	
23-800-1005	Drill, 3.2mm x 112mm, AO	2	
23-800-4520	Temporary Fixation Screw for Primary Guide (Distal), 4.5x20mm	2	
23-800-4526	Temporary Fixation Screw for Primary Guide (Proximal), 4.5x26mm	2	
23-800-2001	Primary Guide Sleeve, Slotted	1	
23-800-2011	Outrigger Saw Guide, Slotted, B	1	
23-800-2013	Outrigger Saw Guide, Slotted, A	1	
23-800-1018	Osteotome, Non-Tapered, 1/2”	1	
23-800-1020	Osteotome, Non-Tapered, 1/4”	1	
23-800-1028	Ruler	1	
23-800-1029	Steinmann Pin, 2.4mm	2	
23-800-4030	Autoclave Tray	1	
Fast Setting Bone Void Filler			
DB-O-P10CC	MD3T OsteoRepair™ Paste Bone Void Filler, 10cc	1	
DB-O-P5CC	MD3T OsteoRepair™ Paste Bone Void Filler, 5cc	1	
Required (Not Included)			
Various	4.5mm diameter Stainless Steel Cortical Bone Screw **Implants** (Low Profile) of varying lengths (e.g. 25mm to 70mm)	2 or 3	
Recommended (Not Included)			
4125-089-075	Stryker® Dual Cut Sagittal Saw Blade, 0.89 x 25 x 75 mm	2	
2108-140-000	Stryker® 2108 Series Sagittal Blade, 0.64 x 28.9 x 58.7 mm	2	
2296-003-108S5	Stryker® Micro Sagittal Blade, 0.51 x 13 x 50 mm	2	
2029	Innomed® Surgical Goniometer	1	



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