



# CASE STUDIES

## KneeAlign®

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# CASE STUDY 1

Use of Portable, Precision Alignment Technology for:

## Severe valgus deformity with retained large distal femoral locking plate

Michael Ast, M.D.

Hospital for Special Surgery, NYC, NY

### Introduction

The patient is an 80-year old female who sustained a right distal femur fracture and underwent a successful ORIF about 1 year prior. The fracture healed uneventfully, but presented with increasing right knee pain and deformity and increasing inability to ambulate. She complained of severe pain when walking on uneven surfaces or trying to go up and down stairs. She denied any signs or symptoms of infections.

### Presentation

The patient presented with significant pain and difficulty walking even with a cane or walker. She had a severe valgus deformity with a valgus thrust and mild recurvatum of the knee. On exam, she had significant crepitus and limited ROM. Her prior incisions were well healed without evidence of erythema or drainage.

X-rays were taken showing collapse of the lateral femoral condyle and severe DJD. There was good healing of the prior distal femur fracture. There was significant valgus deformity. The hardware in place consisted of a distal femoral locking plate running almost the entire length of the femur. There were also four smaller screws that appear to be outside of the plate crossing perpendicular to the fracture site.

### Pre-Op Plan

Due to the significant valgus deformity, recreation of the mechanical alignment was paramount. Further, due to the hardware in the femur that was both extensive and difficult to remove, the decision was made to proceed with OrthAlign technology for the procedure.

This would allow accurate recreation of the mechanical alignment of the right lower extremity and allow us to perform this without the need to remove the proximal hardware, especially the screws that were outside of the plate and may be difficult to find intra-operatively. We planned to use constrained style components due to the severe valgus deformity and laxity of the MCL.



^ Pre-Op Clinical Photo



^ Pre-Op AP X-Ray

# Operative Findings and Approach

Intra-operatively, the lateral femoral condyle was found to have severe AVN and had simply sheared off the distal femur. There were exposed distal 4.5 screws from the lateral plate. The midline exposure was carried proximally to allow removal of the distal 4.5 screws. The smaller screws were found to be buried underneath the plate and could not be removed without removing the entire plate. OrthAlign technology was used to perform the distal femoral resection neutral to the mechanical axis as well as neutral to the sagittal plane of the femur. A minimal lateral resection was performed as would be expected. OrthAlign technology was then used to perform the proximal tibial resection and the remainder of surgery was performed using our standard modified Gap Balancing/Measured Resection techniques. Femoral rotation was determined by Whiteside's line. A constrained prosthesis was used as per plan with a tibial stem and a revision style femur without a stem extension due to the presence of intramedullary hardware.

## Follow Up

At the 6-week postoperative clinical exam, the x-rays showed good positioning of all components and excellent long-leg alignment. The patient returned at six weeks with greater than 90 degrees of flexion and full extension and said, "I cannot remember the last time my knee didn't hurt and was so straight!"

## Clinical Benefits

For this case, the use of OrthAlign technology was imperative. This case could not have been performed with standard intramedullary guides without removal of all of the patient's hardware, which would have been a significantly increased morbidity to the patient and increased operative time and costs. Further, with such severe valgus and a prior fracture, using intramedullary guides would not have been able to produce the precise alignment needed to avoid putting the knee back into mechanical valgus and putting undue stress on the implants.

The presence of pre-operative hardware is a continuing challenge to arthroplasty surgeons. When the hardware is within the surgical field it can often simply be removed. However, when hardware extends well beyond the surgical field, such as a long plate with screws, the use of conventional arthroplasty instrumentation often requires the removal of this hardware, either in a single or staged procedure. This issue is often combined, as with this case, with significant bony or ligamentous deformities that must be accurately addressed in order to give the best chance of long-term success. The use of intra-operative imageless navigation, such as OrthAlign, is a simple, accurate and precise way to address all of these issues with a single intra-operative tool without the need to change any other aspects of the patient's surgery.



^> Post-Op Clinical Photos



^ Post-Op AP X-ray

# CASE STUDY 2

Use of Portable, Precision Alignment Technology for:

## Previous mid-diaphyseal femoral shaft fracture with resultant valgus and recurvatum deformities

Stephen Duncan, M.D.

University of Kentucky- Lexington, Lexington, KY

### Introduction

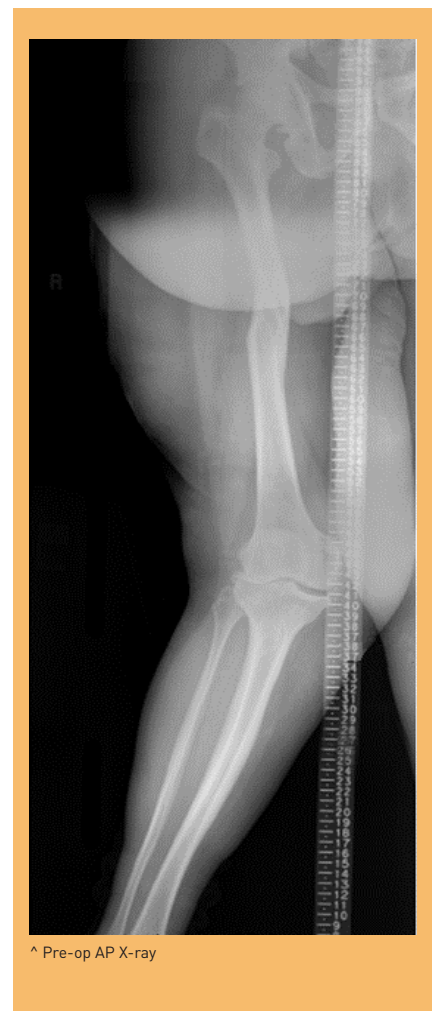
The patient is a 62-year-old male who sustained a mid-diaphyseal femoral shaft fracture thirty years ago. This was treated closed reduction and with longitudinal traction. The fracture went on to heal, but resulted in both residual valgus and recurvatum deformity. The patient developed end stage arthritis as a result of the deformity with the resultant change in his overall long leg alignment. He had worked as a farmer in the past, but had to retire due to the knee pain.

### Presentation

The patient presented with significant pain and disability of the right lower extremity. He required the use of a walker for assistance with ambulation and had developed significant muscular atrophy of the affected limb. He had symptomatic instability of the knee with varus-valgus laxity of 30° and a significant valgus thrust with ambulation. His knee pain had caused him to lose his range of motion with flexion to 80°, but had 10° of recurvatum. He had attempted bracing in the past, but due to the patient's deformity and body habitus, this was unsuccessful.

### Pre-op Plan

Due to the diaphyseal deformity in both the femur and tibia, using standard intramedullary instrumentation would not be able to be used. The use of extramedullary alignment for the femur was felt to not reliably correct both the valgus and the recurvatum of the femur. The use of custom cutting blocks would have required additional time and cost to obtain a CT scan or MRI and time to manufacture the cutting blocks. As this patient had claustrophobia, placing him in the CT or MRI scanner was not a great option. In order to add minimal time to the case and avoid placing pins in the femur or the tibia, the OrthAlign system was chosen to make the distal femoral and proximal tibial cuts to ensure that proper sagittal and coronal alignment could be attained. Given the varus/valgus laxity, the plan was to use a constrained device with short stems to provide stability but also to prevent early aseptic loosening.



^ Pre-op AP X-ray

# Operative Findings and Approach

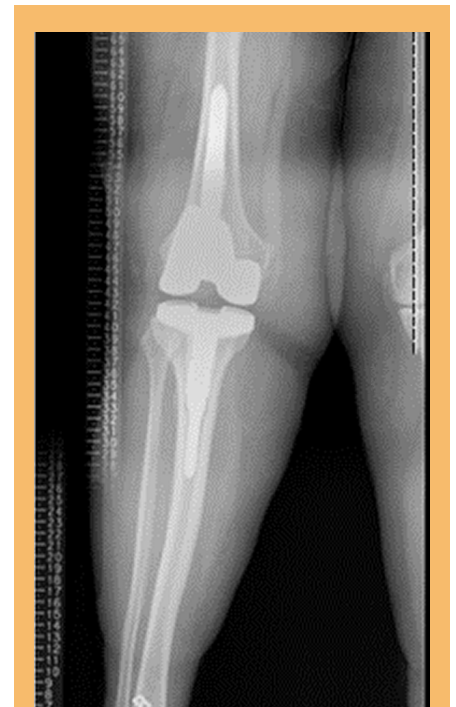
A standard midline medial parapatellar approach was utilized. The OrthAlign system was used to make the distal femoral cut perpendicular to the mechanical axis in both the coronal and sagittal planes. The patient had a hypoplastic lateral femoral condyle, so minimal resection was required laterally to restore proper alignment. To verify that the cuts had restored the proper mechanical axis, fluoroscopy was utilized once the cuts had been obtained. Using a combination of measured resection/gap balancing, the trial implants were placed to obtain full extension to 130° of flexion with proper patellar tracking. Revision components were utilized with a constrained liner and short stems to both the femur and tibia to prevent early aseptic loosening.

## Follow-Up

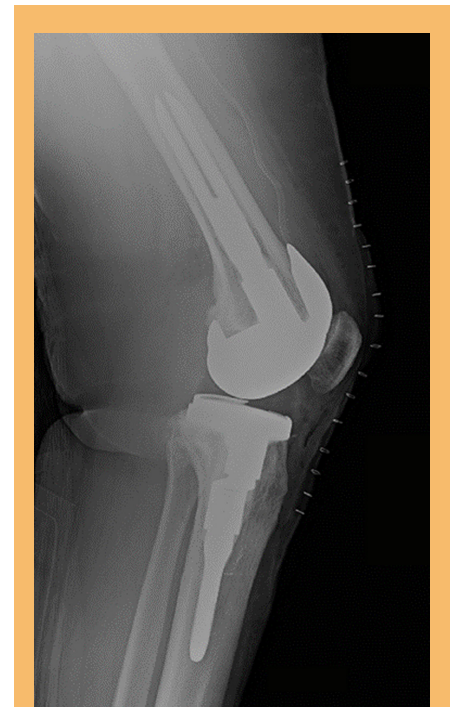
At the 6-week follow-up, postoperative long leg films demonstrated restoration of proper long leg alignment with the mechanical axis going through the center of the knee. Clinically, the patient is now 3 months post-op and ambulating without assistive devices and has 0° – 130° range of motion. Patient said that he likes having a “straight leg” again.

## Discussion

OrthAlign allowed for an accurate recreation of proper mechanical alignment. Due to this patient’s previous fracture, the use of standard instrumentation with intramedullary guides was not an option. As compared to standard computer assisted navigation, the need for additional imaging is not needed, saving on additional time and cost savings. In addition, expensive capital costs associated with computer assisted navigation is avoided using OrthAlign. Being able to utilize the system for this complex case added little additional time to the procedure with the huge clinical benefit of improved alignment and hopefully long-term survivorship of the surgery with a high level of patient satisfaction.



^ Post-op AP X-ray



^ Post-op Lateral X-ray

# CASE STUDY 3

Use of Portable, Precision Alignment Technology for:

## Severe valgus deformity with residual screw ends in the intramedullary canal

Tadashi Fuji, M.D.  
Nara, Japan

### Introduction

The patient is a 73-year-old male who suffered from left femoral fracture due to MVA at 19-years-old and sustained severe valgus deformity for 54 years after ORIF in another hospital. He started to feel persistent pain on his left knee 10 years ago and it worsened, year by year. He is still working in a chopstick manufacturing company.

### Presentation

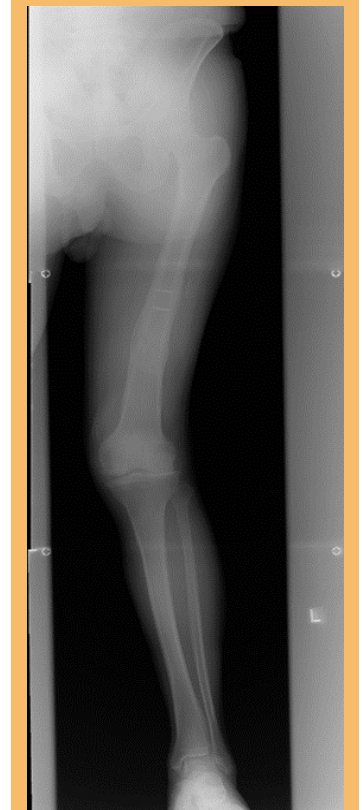
The patient visited a clinic and undertook numerous HA injections, but his pain has never disappeared. He could not walk more than 100m without a cane or crutch and felt unstable with ambulation. A preoperative TUG test recorded 9.96 seconds. His left knee retained good flexion (145°), but had slight recurvatum (extension 10°). The pre-operative weighted whole leg AP view showed that the HKA angle was 166°. The CTA was calculated to be 7° on preoperative CT and there showed no hypoplasia of the lateral condyle related to the congenital valgus deformity. The function score was 64 points and VAS at night, at rest, and in active were 35, 59, and 55 points, respectively. There is no obvious ligament imbalance.

### Pre-op Plan

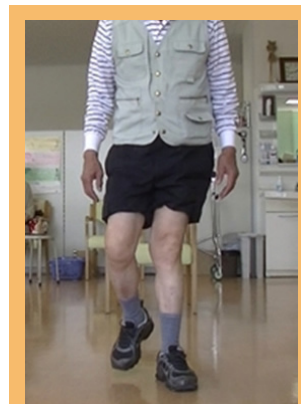
The plate and screws had already been removed, but 2 screw ends remained intramedullary in the femur. Considering additional operation and time of removal for the intramedullary rod in the distal femoral bone cut, risk for the femoral fracture, and so on, we employed OrthAlign navigation technology for the procedure.



^ Pre-Op AP X-ray



^ Pre-Op standing, weight-bearing AP X-ray



^ Pre-op clinical photo

# Operative Findings and Approach

Medial para-patellar approach was used and both cruciate ligaments remained, but the ACL was mildly deteriorated. OrthAlign technology was used for the coronal alignment of the leg (distal femur and proximal tibia). The femur was cut at neutral to the mechanical axis in the coronal plane and 3° of flexion in the saggital plane. For the tibia, neutral axis from the tibia to the ankle joint and 3° posterior inclination in the saggital plane was targeted. The flexion gap was decided by a gap balancing technique, as well as considering anatomic landmarks. Final rotational alignment was decided to be 3°, although the original CTA was approximated to be 6° during surgery.

## Follow-up

The HKA angle improved to 180°. The  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ , setting angles were 98°, 89°, 7.8°, and 88°, respectively. Final CTA was 4° on the postoperative epicondylar view and lift off angle was 0°.

He started to walk with a walker on POD1 and gait with a cane was acquired on POD4. He could climb and descend stairs on POD8. ROM on POD14 was 135°/0°. TUG on POD14 was still recovering at the time of this follow-up (12.95 seconds).

## Clinical Benefits

OrthAlign technology accomplished perfect coronal alignment without any substantial damages to the bones due to pinning for the markers.

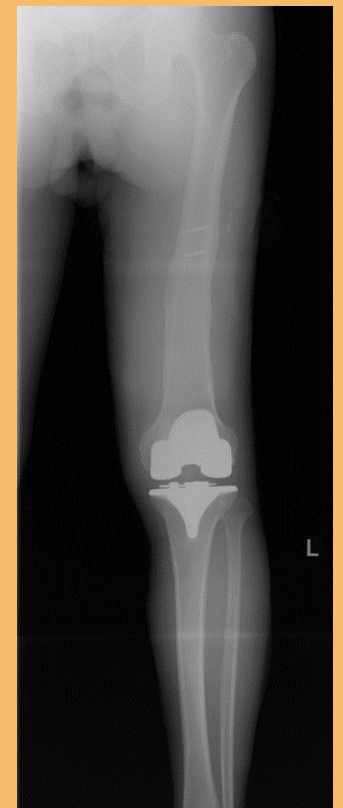
Compared to standard computer assisted navigation, it is free from initial cost and occupying space in the OR. Additional imaging and following preoperative procedures and/or measurements on a PC by the surgeon are not required. Accuracy for OrthAlign technology is at a satisfying level and the learning curve is very short. Surgeons are promptly able to use OrthAlign technology without hesitation.

The additional time is faint and we can use not only for such complex cases as the one in this Case Study, but also for regular primary TKA candidates.

In Japan, we experience heavy bowing of the femur, severe tibia vara cases, and post HTO, all of which create obstacles for the surgeon to properly determine the mechanical axes. OrthoAlign technology may be the answer in solving the problem.



^ Post-Op AP X-ray



^ Post-Op standing, weight-bearing AP X-ray



^ Post-op clinical photo

# CASE STUDY 4

Use of Portable, Precision Alignment Technology for:

## Patient-specific roadblocks including IM nails, interference screws, and retained staples

Tarun Bhargava, M.D.  
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### Case Series Introduction

The goal of total knee arthroplasty is to provide the patient with a well-functioning, pain-free knee that will last for many years. In order to improve implant survival, the goal is to position the prosthesis in a way that restores proper biomechanical alignment. Advances in technology have enabled arthroplasty surgeons to produce accurate results on a more consistent basis. One of these advances is the use of computer navigation to assist in proper component alignment.

Navigation has been shown to produce accurate restoration of the biomechanical axis consistently and more reliably than conventional techniques [1,2]. Although there are not many long-term studies on the impact of navigation on function and implant survival, studies have shown that functional scores and revision-free survival are at least equivalent to conventional arthroplasty [3].

One area where navigation has proved exceptionally useful is in the area of pre-existing femoral deformity or retained hardware. A number of case reports exist where navigation has been used to assist the surgeon in positioning the bony cuts without any need for prior hardware removal [4, 5, 6].

We present a case series on patients undergoing TKA with retained femoral hardware. Two patients had intramedullary femoral fixation, precluding the use of a conventional intramedullary alignment guides. The third patient had an interference screw from a previous ACL reconstruction that would interfere with the intramedullary alignment guide. We employed a novel navigation guide that enabled performance of TKA without the need for prior surgery for hardware removal.

### Case #1 Introduction

The patient is a 52 year-old female, presenting with a chief complaint of right knee pain. She had a remote history of right intertrochanteric hip fracture, treated surgically with a long antegrade cephalomedullary fixation nail. Her fracture did proceed to union, and she was able to bear weight on the affected extremity, as tolerated. However, since her previous surgery, she did go on to develop anterior and lateral right knee pain that she described as dull, constant, and aching.



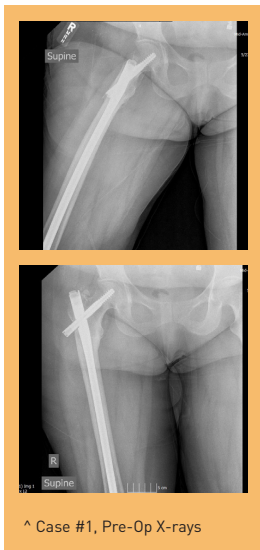


# Presentation

The patient's pain was accompanied by crepitation. Use of stairs and prolonged sitting exacerbated her symptoms. Attempts to control her pain using rest, ice, heat, NSAIDs, and acetaminophen were unsuccessful. She had no desire to try corticosteroid injections. She was functionally limited by her pain, as she was only able to ambulate less than one block, although she did not require any ambulatory aids. She was eager to proceed with right total knee arthroplasty.

Radiographs obtained in the office demonstrated patellofemoral and lateral compartment joint space narrowing. Subchondral sclerosis and osteophyte formation were seen. The presence of a long antegrade cephalomedullary nail with two distal interlocking screws was noted.

Her exam demonstrated correctable valgus deformity of the knee. Her active range of motion was from 0-110 degrees. She had a mild effusion with crepitus throughout a range of motion and tenderness to palpation, both anteriorly and laterally.



## Pre-op Plan

The patient was subsequently scheduled for right total knee arthroplasty. Given the presence of the long antegrade cephalomedullary fixation nail, the decision was made to use the OrthAlign smart alignment technology to assist in positioning of the bone cuts to obviate the need to extract the femoral hardware prior to total knee arthroplasty.

## Operative Findings and Approach

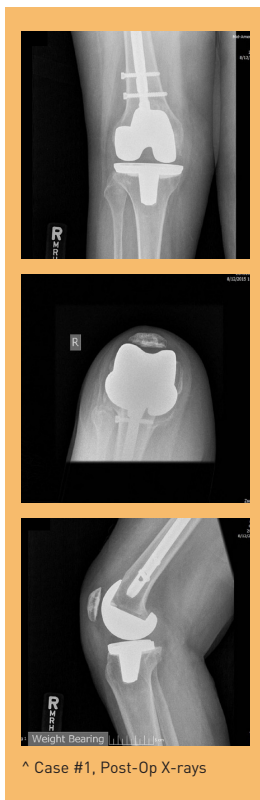
A standard midline incision was used with a medial parapatellar arthrotomy. Surgery proceeded as usual with the addition of the use of the OrthAlign system to determine the femoral and tibial cuts, instead of the intramedullary and extramedullary alignment rods, respectively. Surgical course was without complication. Total tourniquet time was 41 minutes at 300mm Hg.

Her post-operative course was without complication. She was mobilized and ambulated with physical therapy the afternoon of surgery. The therapists immediately began working on range of motion. She met the criteria for discharge on post-operative day two and was discharged home with a prescription for outpatient physical therapy.

## Follow-up

At her six week post-operative visit, the patient was doing well and was pain free. Her incision had healed without any complications. She had been performing outpatient physical therapy and achieved good range of motion from 0-125 degrees. Her knee was stable on exam and well-aligned radiographically. She was walking unlimited distances with a cane and she was using stairs in a reciprocal manner with a rail. Her objective Knee Society Score was 100 and her functional Knee Society Score was 85.

At this point, she was instructed to continue formal physical therapy for an additional four to six weeks to continue working on range of motion and strengthening, in addition to her home exercise program. She planned to begin transitioning away from her cane use while ambulating. Her next follow-up visit will be six months after surgery.



# Case #2 Introduction

The patient is a 62 year-old female presenting with a chief complaint of right knee pain. She was a polytrauma victim, suffering a boating accident ten months prior to presentation. She sustained a number of fractures throughout her body requiring open reduction internal fixation, including the spine, pelvis, femur, ankle, and clavicle. Her right femur was treated with a retrograde femoral nail with three distal interlocking screws. Her right knee pain was located anteriorly and medially.

## Presentation

Her pain had been progressively worsening. She described the pain as dull, aching, and throbbing. It was associated with crepitus throughout her range of motion. The use of stairs, as well as prolonged standing and walking, exacerbated her pain. Her pain had not been relieved with rest, ice, heat, NSAIDs, acetaminophen, or corticosteroid injections. She is now confined to a wheelchair for ambulation. She is eager to pursue right total knee arthroplasty to help with her pain, as well as restore her mobility. The patient did also note some discomfort over the two lateral-to-medial distal interlocking screws and requested that these be removed during surgery as well.

Radiographs obtained in the office demonstrate a healed fracture of the distal femur at the metaphyseal-diaphyseal junction. A retrograde femoral nail is visualized with two proximal and three distal interlocking screws.

Her exam revealed a correctable varus deformity of the right knee. Her active range of motion was from 10-105 degrees. Crepitus was noted throughout a range of motion. A moderate effusion was noted along with tenderness along the medial joint line.

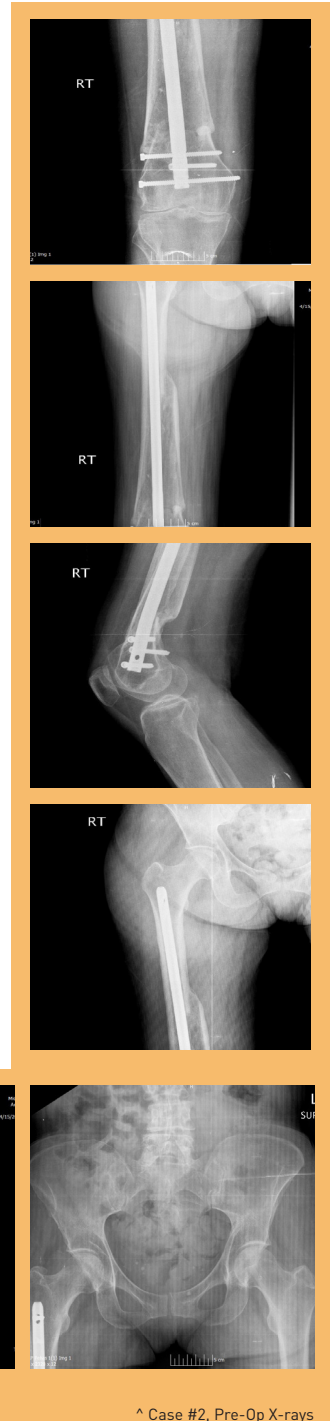
## Pre-op Plan

The patient was subsequently scheduled for right total knee arthroplasty. Given the presence of the retrograde femoral nail, the decision was made to use the OrthAlign smart precision technology to assist in positioning of the bone cuts to obviate the need to extract the femoral hardware prior to total knee arthroplasty.

## Operative Findings and Approach

Patient had a healed midline incision from previous surgery, and this was incorporated into her midline incision. Medial parapatellar arthrotomy was performed. Surgery proceeded as usual with the addition of the use of the OrthAlign's KneeAlign® application to determine the femoral and tibial cuts, instead of the intramedullary and extramedullary alignment rods, respectively. The two symptomatic distal interlocking screws were removed. Surgical course was without complication. Total tourniquet time was 48 minutes at 300mm Hg.

Her post-operative course was without complication. She was mobilized and ambulated with physical therapy the afternoon of surgery. The therapists immediately began working on range of motion. She met the criteria for discharge on post-operative day two and was discharged home with a prescription for outpatient physical therapy.



# Follow-up

At her six week post-operative visit, she was doing well and was pain free. Her incision had healed without any complications. She had been performing outpatient physical therapy and achieved good range of motion from 0-125 degrees. Her knee was stable on exam and well-aligned radiographically. She was walking unlimited distances without any assistive device and she was using stairs in a reciprocal manner with a rail. Her objective Knee Society Score was 100 and her functional Knee Society Score was 90. At this point, she was instructed to continue working on range of motion and strengthening as part of her home exercise program. Her next follow-up visit will be six months after surgery.



^ Case #2, Post-Op X-rays

## Case #3 Introduction

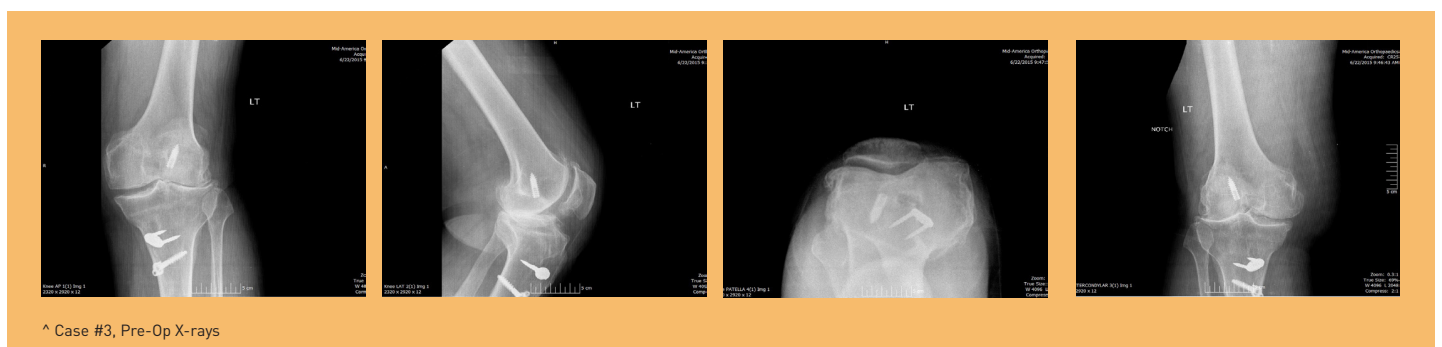
The patient is a 60 year-old male with a chief complaint of left knee pain. Twenty years ago, he sustained an ACL rupture while playing sports, and he subsequently underwent an ACL reconstruction. He now complains of anterior and lateral left knee pain.

## Presentation

Patient's pain had been progressively worsening. He described the pain as dull, aching, and throbbing. It was associated with crepitus throughout his range of motion. The use of stairs, as well as prolonged standing and walking, exacerbated the pain. His pain had not been relieved with rest, ice, heat, NSAIDs, acetaminophen, or corticosteroid injections. He is now limited to ambulating two to five blocks at a time. He is interested in left total knee arthroplasty.

Radiographs obtained in the office demonstrate previous ACL reconstruction with interference screws in both the femur and tibia as well as a staple in the tibia. There is loss of lateral and patellofemoral compartment joint space with significant sclerosis and osteophyte formation.

Examination reveals a five degree valgus deformity with range of motion from 5-120 degrees. There is lateral and patellofemoral compartment crepitation through a range of motion, as well as tenderness to palpation.



^ Case #3, Pre-Op X-rays

## Pre-Op Plan

The patient was subsequently scheduled for left total knee arthroplasty. It was felt that the tibial screw and staple would need to be removed for placement of the tibial component. Removal of these were incorporated as part of the patient's standard midline incision and medial parapatellar arthrotomy. Given the presence of the femoral interference screw, the decision was made to use the OrthAlign precision alignment system to assist in positioning of the bone cuts to obviate the need for a screw, prior to total knee arthroplasty.

## Operative Findings and Approach

Surgery proceeded as usual with the addition of the use of the OrthAlign precision alignment system to determine the femoral and tibial cuts, instead of the intramedullary and extramedullary alignment rods, respectively. A posterior stabilized implant was employed. After making the box cut on the femoral side, the interference screw was protruding about 1cm into the femoral box. It was subsequently removed. The remainder of the surgical course was without complication. Total tourniquet time was 63 minutes at 300 mm Hg.

His post-operative course was without complication. He was mobilized and ambulated with physical therapy the afternoon of surgery. The therapists immediately began working on range of motion. He met the criteria for discharge on post-operative day two and was discharged home with a prescription for outpatient physical therapy.

## Follow-Up

By his six week post-operative visit, he was doing well and was pain free. His incision had healed without any complications. He had been performing outpatient physical therapy and achieved good range of motion from 0-130 degrees. His knee was stable on exam and well-aligned radiographically. He was walking unlimited distances without any assistive device and he was using stairs in a reciprocal manner with a rail. His objective Knee Society Score was 100 and his functional Knee Society Score was 90. At this point, he was instructed to continue working on range of motion and strengthening as part of his home exercise program. His next follow-up visit will be six months after surgery.

## Conclusions

Here, we presented three cases of navigation-assisted total knee arthroplasty in the setting of retained femoral hardware, precluding the use of an intramedullary alignment guide. The use of navigation had no adverse impact on the patients' total time in the operating room or tourniquet time. The post-operative course was not adversely affected and all patients' pain and function were improved at six-week follow-up.

Based on these results, navigation presents physicians with an effective option for performing total knee arthroplasty in patients with pre-existing hardware. It obviates the need for a prior surgery to remove the retained implant. This saves the patient the risk and subsequent morbidity of a second surgery. This could conceivably also improve patient rehab and outcomes. Furthermore, it also reduces the cost to the patient and the health care system through decreased number of surgeries and total operating room time. Further research using randomized, prospective studies would be beneficial to directly compare outcomes in single-stage total knee arthroplasty using navigation versus two-stage surgery with hardware removal.



## Case Study #4 References

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- 2 Blakeney, W., Khan, R., & Wall, S. (2011). Computer-Assisted Techniques Versus Conventional Guides for Component Alignment in Total Knee Arthroplasty. *Journal of Bone and Joint Surgery American*, 93(15), 1377-1384.
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- 6 Hamada, Daisuke, Hiroshi Egawa, Tomohiro Goto, Tomoya Takasago, Michihiro Takai, Tetsuya Hirano, Yoshiteru Kawasaki, and Natsuo Yasui. «Navigation-Assisted Total Knee Arthroplasty for Osteoarthritis with Extra-Articular Femoral Deformity And/or Retained Hardware.» *Case Reports in Orthopaedics Online* (2013). Web. 9 Aug. 2015.



# OrthAlign

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