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Methods Article

On How I Do It™...Attachment Preserving Hinge Arthroplasty vs. ORIF for Complex Periarticular Knee Fractures

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The author reviews his experience with this novel technique of tissue preservation in complex knee arthroplasty.

> *My goal is not simply to replace a shattered distal femur. It is to create a stable metal metaphysis while preserving the patient's living soft-tissue envelope—bone fragments, collateral ligament attachments, posterior structures, and the biologic capacity to heal around the implant.*

THE QUESTION IS NOT SIMPLY: CAN I FIX THE JOINT SURFACE?

When I look at a complex distal femur fracture, particularly in an older patient or around a total knee arthroplasty, I start with a different question than the one many of us were taught to ask. The articular surface may be reconstructable, but can the metaphysis support that reconstruction? In elderly, osteoporotic bone, the metaphysis is often the weak link. A technically accurate open reduction and internal fixation (ORIF) can still fail if the bone cannot hold the construct and heal while carrying the demands placed on it.

ORIF remains an excellent operation when I believe I can obtain stable fixation and preserve a biologically favorable environment. I am not arguing that every complex fracture needs a hinge. But when the metaphysis is profoundly compromised—when comminution, bone loss, osteoporosis, or a loose prosthesis makes durable fixation doubtful—I consider replacement early rather than waiting for fixation to fail.

The problem with a traditional distal femoral replacement is that it was largely conceived as a resection operation. The fractured distal femur is removed, the hinge is implanted, and the radiograph can look impressive. Biologically, however, the soft tissues have lost much of the native scaffold to which they attach. The implant becomes a purely load-bearing device surrounded by a diminished envelope.

> *I want the implant to provide immediate mechanical stability, but I want the patient's own tissues to provide the envelope, proprioception, vascularity, and eventual biologic reinforcement.*

WHY I PRESERVE THE ENVELOPE

My approach grew out of two parts of my training. I was a trauma surgeon in the Navy and later completed a joint fellowship. In trauma, you learn to respect every viable fragment with a soft-tissue attachment. In arthroplasty, you learn how to establish joint line, rotation, fixation, and immediate stability. The envelope hinge brings those two ways of thinking together.

If a fragment is viable and carries a meaningful attachment, I leave it. That includes the epicondylar origins of the collateral ligaments, capsular attachments, posterior cortex, metaphyseal fragments, and—when the fracture pattern permits—the extensor mechanism. I do not expect every fragment to unite anatomically as it would after plate fixation. I expect the retained bone and soft tissue to organize around the implant. Bone remodels; gaps fill; and the maturing fibrous tissue links the fragments like the tension wires on an old biplane. The metal supplies the new metaphysis, while the envelope supplies biologic continuity.

The preserved epicondyles do more than retain ligament attachments. They are also reliable landmarks for restoring the joint line. Instead of estimating the level from a segmental prosthesis or from a resected field, I can place the reconstruction where the patient's own epicondyles tell me it belongs.

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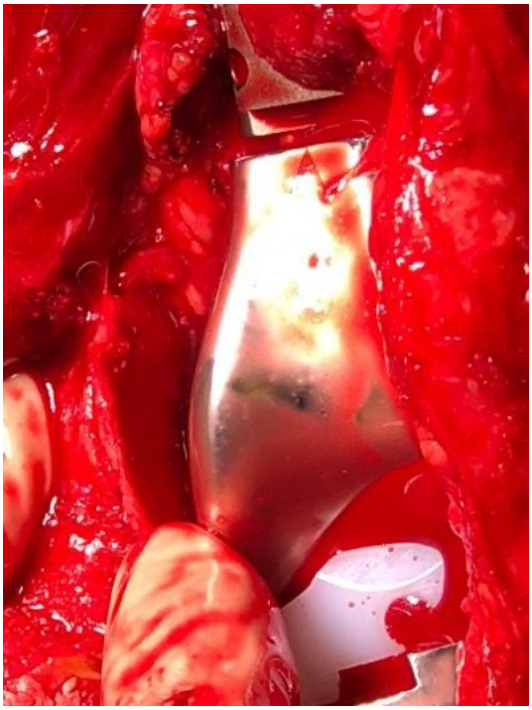


Figure 1. Intraoperative attachment-preserving preparation. A short epicondylar cut retains the collateral-ligament-bearing bone while creating space for the distal femoral replacement. Image provided in the accompanying pilot manuscript.

HOW I DECIDE: ORIF OR AN ATTACHMENT-PRESERVING HINGE

My decision is patient-specific, but the following comparison captures the way I think about the problem. It is a decision framework, not a rigid algorithm.

THE OPERATION: THREE CUTS AND A STABLE METAL METAPHYSIS

The technique is intentionally simple. I expose the fracture sufficiently to understand the pattern, but I avoid stripping the fragments. I preserve the posterior bone and soft tissues, which keeps me away from the neurovascular structures and maintains the envelope behind the prosthesis.

1. Define what must be removed. I remove the failed or loose prosthesis when present and clear only what prevents stable preparation and implantation. I do not excise fractured bone simply because it looks untidy.

2. Make the diaphyseal cut. I create a clean transverse level in the femoral shaft that will accept the stem and establish the proximal end of the reconstruction.

3. Preserve the epicondyles. I make two short, approximately 15-mm epicondylar cuts. Conceptually, the preparation resembles an upside-down U: one diaphyseal cut and two epicondylar cuts. The epicondylar fragments—and their ligament attachments—remain in place.

4. Protect the posterior envelope. I leave the posterior cortical and soft-tissue structures whenever they do not interfere with safe implantation. This protects the neurovascular bundle and avoids unnecessary devascularization.

5. Pot and cement the prosthesis. I prepare and cement a trauma-oriented rotating hinge/distal femoral replacement to create immediate mechanical stability. The retained fragments are laid back against the metal metaphysis rather than being stripped away.

6. Let biology complete the construct. On the femoral side, I generally do not try to turn every fragment into a formal fixation problem. The retained envelope scars and remodels around the prosthesis. Over six months to a year, radiographs can show striking consolidation and incorporation.

WHAT MAKES SURGEONS UNCOMFORTABLE

The greatest technical pitfall is often psychological: the broken bone is still there. Surgeons are accustomed to believing that every fragment left beside a prosthesis will remain painful or become a nonunion problem. In my experience, once the environment is stable, that concern has not played out the way one might expect. The retained fragments organize within scar, and the pain associated with an unstable fracture diminishes as stability and soft callus develop.

A second pitfall is overworking the envelope. If I strip fragments to make them look anatomically perfect, I defeat the biologic purpose of the operation. If I chase the poste-

Table 1. Practical decision factors used in choosing fixation versus attachment-preserving hinge arthroplasty.

Question	Favors ORIF	Favors envelope hinge
Metaphyseal support	Bone can securely hold fixation	Severe osteoporosis, comminution, or bone loss makes fixation unreliable
Implant status	Stable existing components; fracture can be spanned or fixed	Loose or unsalvageable component, or fixation would depend on poor bone
Weight bearing	Patient can safely comply with the required protection	Immediate weight bearing is a major clinical priority
Biologic envelope	Fixation can preserve blood supply and attachments	Fragments can be retained around a stable prosthesis instead of excised
Failure consequence	Revision remains manageable	A failed ORIF would impose a major second operation on a frail patient



Figure 2. Representative native distal femur fracture and attachment-preserving hinge reconstruction. The sequence shows the injury, three-dimensional fracture pattern, early reconstruction, and later remodeling around the metal metaphysis. Images provided in the accompanying pilot manuscript.

rior cortex, I increase risk around the neurovascular structures. The prosthesis must be correctly aligned, securely fixed, and appropriately positioned; the fragments do not all need to be converted into a plate-and-cable reconstruction.

I also resist adding attachment features merely because they are available. On the tibial side I have used cables. On the femoral side, however, a smooth implant surrounded by the retained tissues has produced good motion and a stable-feeling knee. A highly porous or aggressively ingrowth-oriented surface may increase attachment, but it may also encourage stiffness. That balance deserves further study.

POSTOPERATIVE PRIORITIES

The value of this operation is that it changes the early postoperative problem. My patients are permitted to bear weight immediately as tolerated. In a frail older adult, avoiding weeks of protected weight bearing can be as important as the reconstruction itself. Early mobility reduces the cascade of deconditioning, dependence, and medical complications that often follows these fractures.

I still watch the wound and soft-tissue envelope closely, manage swelling, and begin functional rehabilitation with the same respect I would give any major revision knee reconstruction. The hinge provides coronal-plane stability; the preserved extensor mechanism and collateral attachments help the limb behave more like a knee than a resected segment.

WHAT OUR EXPERIENCE HAS TAUGHT ME

In the clinical experience discussed in the interview, we had performed well over 60 cases, with at least two years of follow-up in the reported cohort and an increasing referral

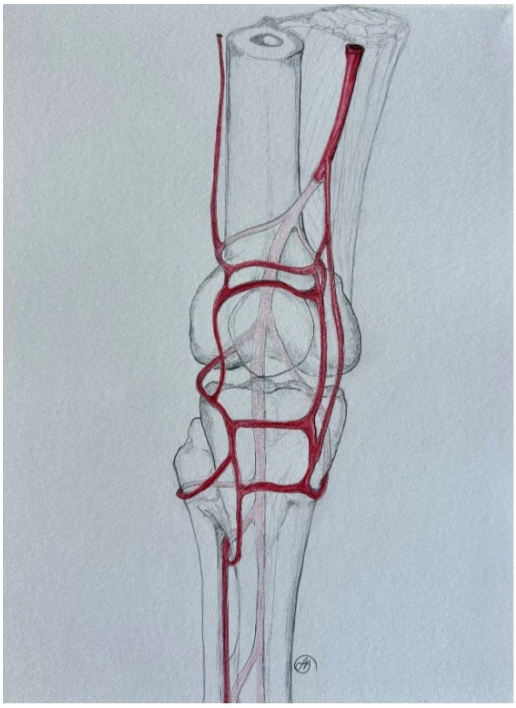


Figure 3. Illustration of vascular perforation zones around the distal femur and proximal tibia—areas being investigated as stereotyped stress risers in fracture propagation. Artwork supplied with the pilot manuscript.

volume. Patients commonly regained motion from full extension to roughly 115 degrees, and gait videos could make it difficult to identify which knee carried the hinge. The accompanying pilot manuscript reports a defined consecutive series of 53 hinge arthroplasties—39 distal femoral and 14 proximal tibial replacements—with immediate weight bearing in all patients, average motion of 110 degrees, one infection, and three revisions. Those numbers are encouraging, but they should not be mistaken for a comparative trial.

The larger lesson is conceptual. A hinge need not mean abandoning biology. If I preserve living, attachment-bearing tissue around a stable prosthesis, I can combine the immediate reliability of arthroplasty with the envelope principles of trauma surgery. That may help explain the low infection burden, useful motion, and radiographic remodeling we have observed.

I also believe there is an economic argument for getting the index operation right. A hinge construct costs more than an initial ORIF, but a failed fixation followed by hardware removal, reconstruction, and prolonged hospitalization can be far more expensive—financially and physiologically. The choice should never be made on implant price alone; it should account for the probability and consequence of failure.

WHERE I THINK THIS GOES NEXT

This technique will only become legitimate if other surgeons can reproduce it. The operation is straightforward, but the indications, implant design, degree of fragment

preservation, and role of surface finish all need independent evaluation. Trauma-specific hinges should be designed around fracture anatomy rather than inherited wholesale from tumor reconstruction. Our work with engineers has focused on where fractures propagate and where vascular channels create recurring stress risers, with the goal of making the implants easier and safer to use in trauma. We also preserve the tibial bone in the same manor for native proximal tibia and peri-prosthetic fractures.

For now, my message is simple: do not discard viable bone merely because you have decided to replace the joint. When fixation is unlikely to survive poor metaphyseal bone, a hinge may be the better mechanical answer. But the best hinge, in my view, is one that keeps the patient's own envelope. Preserve the attachments, restore the joint line, create a stable metal metaphysis, allow immediate mobilization, and let the biology work around the implant.

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