Technical Note

# Incisionless Synovium and Bone Biopsy of a Painful Total Knee Arthroplasty

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**Abstract:** Knee arthroscopy has evolved greatly from its inception in the 20th century. Arthroscopic synovectomy is performed in the case of infection or significant synovitis. We continue to develop more minimally invasive procedures, and the NanoScope (Arthrex, Naples, FL) has provided a new generation of possibilities. The system does not require the use of a standard incision or portal, and using the GraftNet (Arthrex), we can harvest tissue with a standard shaver for further evaluation. This technique provides an option to perform a synovial and bone biopsy in a painful total knee arthroplasty without the use of standard arthroscopy portals through an incisionless approach. This technique provides distinct advantages over a more open approach in the setting of a prosthetic joint. Specifically, this technique is useful for a difficult-to-diagnose painful total knee arthroplasty.

Synovial and bone biopsy of the knee is a procedure that has been well described using various arthroscopic and open procedures. Indications for such knee procedures include septic arthritis, inflammatory conditions, and synovial tumors. The diagnosis of periprosthetic joint infection (PJI) is sometimes difficult, occasionally requiring a histologic sample when arthrocentesis is inconclusive. Collecting synovial samples has been described by use of various arthroscopy portals. Even with the newest arthroscopic approaches, obtaining tissue samples has been difficult. For our technique, we combine a more minimally invasive nanoscopic approach with a GraftNet (Arthrex, Naples, FL) to harvest the tissue.

The NanoScope (Arthrex) is an advanced miniaturized arthroscope with a single-use camera opposite a 1.9-mm-diameter viewing cannula that can be inserted into a joint without the need for a traditional incision. In addition to less blood loss, a shorter procedure time, and the potential for a quicker recovery, the NanoScope enables a minimally invasive procedure, thus decreasing the chance of contamination of a prosthetic joint. The NanoScope has been gaining momentum as an option in the office setting as opposed to the traditional operating room setting, thus lowering the associated cost of such a procedure. When combined with the GraftNet, we can obtain significant amounts of tissue without an incision and without damaging or creating contamination of a possibly sterile prosthetic joint.

Most of the literature regarding arthroscopic synovial biopsy and synovectomy has centered around native knee infections. Panjawani et al.[1] conducted a systematic review and meta-analysis to compare outcomes between arthroscopy and arthrotomy of septic native knees.[1] Seven studies were included, comprising 723 patients who underwent arthroscopic irrigation and debridement (I&D) and 366 patients who underwent open I&D. The relative risk of reoperation was significantly lower in the arthroscopy group, whereas the length of stay was lower in the arthroscopy group in all included studies, and one study reported better functional outcomes with arthroscopy. Furthermore, in a retrospective study of 1 institution, Johns et al.[2] compared open versus arthroscopic I&D of native knees. They included 166 knees: 123 treated with arthroscopic I&D and 43 treated with open I&D. They found that 71% of knees in the open I&D group and

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50% in the arthroscopic I&D group required repeated irrigation should be listed as source 2. In addition, the arthroscopic group underwent a lower total number of irrigation procedures and had better mean postoperative range of motion ($P < .05$). We describe an incisionless approach for synovial and bone biopsy of a prosthetic knee joint to aid in the diagnosis of PJI.

## Surgical Technique

### Patient Setup

Figures 1 through 7 and Video 1 show the surgical technique. The patient is placed in the supine position with the operative extremity in a leg holder and a tourniquet applied to the operative thigh. The nonoperative extremity is placed over a well-padded pillow in slight flexion. The operative extremity is exsanguinated, and the tourniquet is inflated.

### NanoScope Insertion

A spinal needle is inserted into the superolateral joint space while the knee is in full extension. A nitinol wire is inserted into the needle, and the needle is removed (Fig 1). A high-flow 3.4-mm cannula is then inserted over the wire, and the wire is removed. Care should be taken when inserting the 3.4-mm cannula because it can cause damage during insertion. Inflow is then placed onto the cannula, and the NanoScope is inserted for visualization of the joint (Video 1). A standard diagnostic arthroscopy is then performed in the patellofemoral joint. Alternatively, one could begin by placing the Nanoscope in the anterolateral portal; however, we recommend establishing the superolateral portal, which can be used later as a working portal. The other portals will be established in the anterolateral joint space and anteromedial joint space and in a similar fashion, with the knee in flexion (Fig 2).

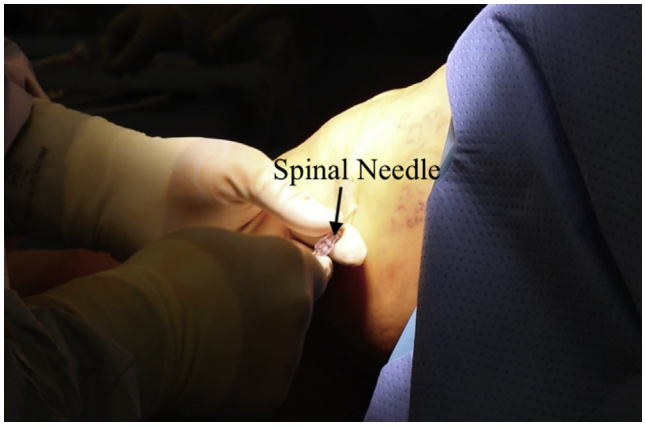


**Fig 1.** With the left knee in extension, a spinal needle with a nitinol wire is placed through the needle into the superolateral aspect of the patellofemoral joint.

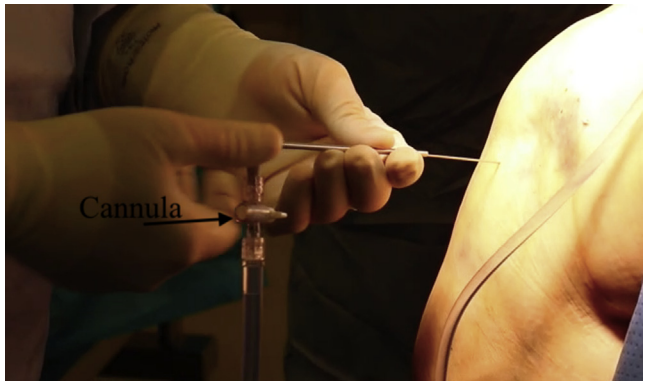


**Fig 2.** With the left knee in flexion, a high-flow cannula is placed into the anterolateral portal.

### Diagnostic Arthroscopy

By use of the NanoScope through the superolateral portal and with the knee in extension, the patellofemoral synovium is examined and found to be hypertrophic, hyper-vascularized, and inflamed. The NanoScope is then placed through the anterolateral joint space through the high-flow cannula, and the patellofemoral joint is viewed and examined.

### Synovial Biopsy

Viewing through the anterolateral joint space with the knee in extension, we place a shaver through the superolateral joint space. The GraftNet is attached to the shaver, and synovial biopsy specimens are obtained. Care is taken to obtain samples from the medial aspect,

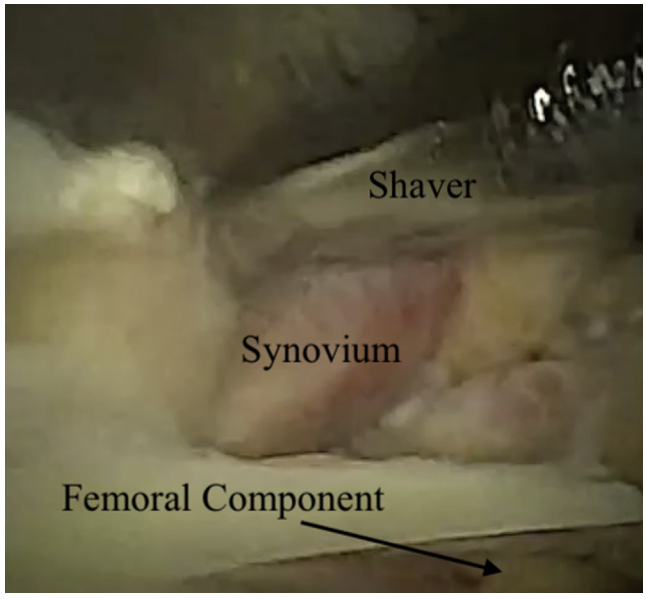


**Fig 3.** With the patient supine and the left knee in extension, while viewing with a 0° NanoScope from the anterolateral portal, with the shaver coming in percutaneously through the superolateral portal, we perform the patellofemoral synovial biopsy.

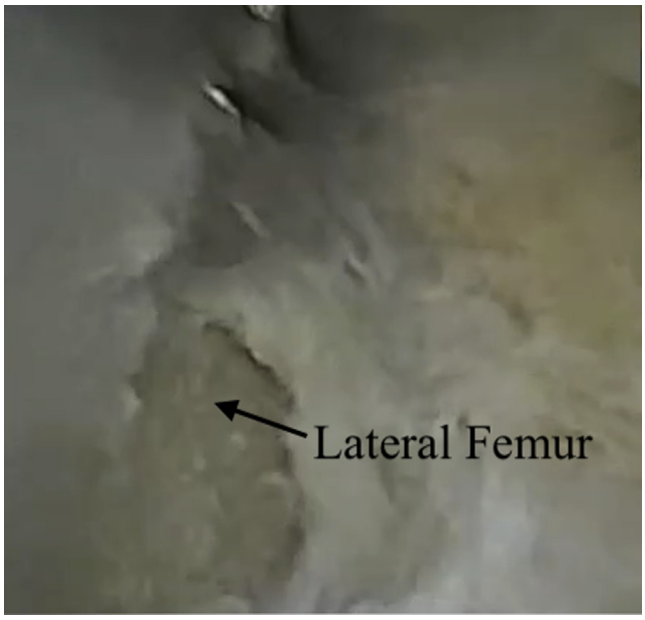


**Fig 4.** With the patient supine and the left knee in extension, while viewing with a 0° NanoScope from the anterolateral portal, with the shaver coming in percutaneously through the superolateral portal, we perform the lateral bone biopsy.

lateral aspect, and superior aspect (Fig 3). Next, a shaver with the GraftNet is placed through the anteromedial portal, and further biopsy specimens can be obtained. The knee is then brought into flexion, and after use of the anteromedial portal as the working portal, the shaver is placed through the anterolateral portal and the anterior synovium is biopsied. Care is taken to view the tibia-cement interface and anterior compartment.

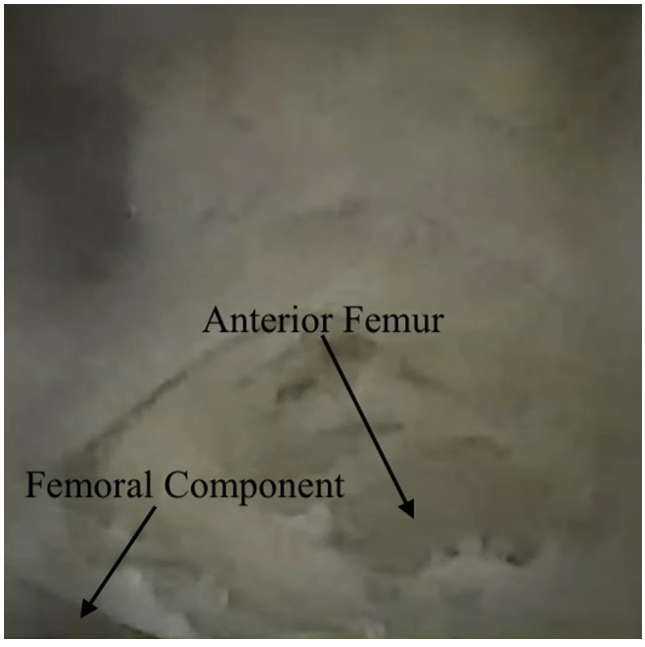


**Fig 5.** With the patient supine and the left knee in extension, while viewing with a 0° NanoScope from the anterolateral portal, the anterior femur is shown after the bone biopsy has been performed.

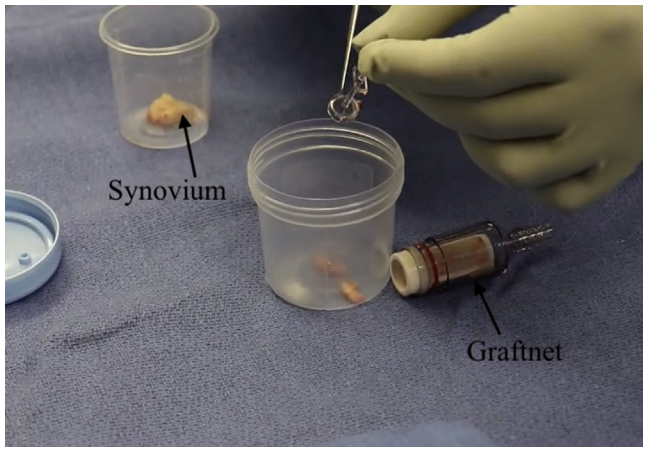


**Fig 6.** The GraftNet is shown on the table, and the synovial biopsy specimens are placed into sterile cups.

### Bone Biopsy

With the NanoScope placed through the anterolateral portal and the shaver placed through the superolateral portal, areas on the lateral flange-bone and anterior flange—bone interface are shaved down to bone. Then, the GraftNet is applied to the shaver, and bone biopsy specimens are obtained. First, we take a biopsy specimen from the lateral femur; then, the anterior bone is biopsied (Figs 4-7). Care must be taken not to resect too much bone.

## Discussion

The criteria for the diagnosis of PJI after total knee arthroplasty have been established and were updated in 2018 by the Musculoskeletal Infection Society[1]: 2 positive culture results or the presence of a sinus tract are

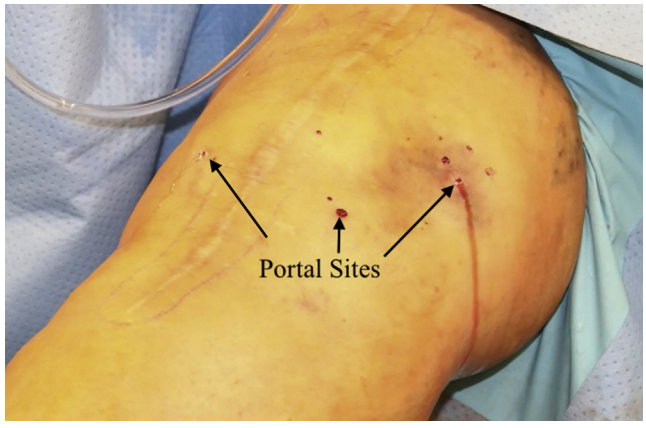


**Fig 7.** The patient is supine and the left knee is shown in full extension, with only small portal sites and no incisions.

**Table 1.** Pearls and Pitfalls of Incisionless Synovial and Bone Biopsy

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| Pearls |
| A nanoscopic high-flow cannula should be used to increase flow. |
| Using a 3.0-mm shaver percutaneously through one of the portals prevents the need for larger incisions. |
| At least 3 synovial biopsy specimens and 1 bone biopsy specimen should be taken. |
| Pitfalls |
| Care should be taken not to debride too much bone from the anterior bone-cement interface. |
| Using too much suction can decrease visualization. |

**Table 2.** Advantages and Disadvantages of Incisionless Synovial and Bone Biopsy

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| Advantages |
| Allows tissue diagnosis by a minimally invasive approach |
| Can be used in patients who may be intubated or in the ICU to help with diagnosis |
| Less contamination of the joint than an open approach |
| Disadvantages |
| Most likely requires anesthesia and a trip to the operating room |
| Possibility of infection in a knee that may not be infected |
| Technically difficult for surgeons not comfortable with standard arthroscopy |

ICU, intensive care unit.

considered major criteria and diagnostic of PJI. The calculated weights of an elevated serum C-reactive protein level (>1 mg/dL), D-dimer level (>860 ng/mL), and erythrocyte sedimentation rate (>30 mm/h) are 2 points, 2 points, and 1 point, respectively. Furthermore, the calculated weights of an elevated synovial fluid white blood cell count (>3,000 cells/μL), α-defensin level (signal-to-cutoff ratio > 1), leukocyte esterase level (++), polymorphonuclear percentage (>80%), and synovial C-reactive protein level (>6.9 mg/L) are 3 points, 3 points, 3 points, 2 points, and 1 point, respectively. Patients with an aggregate score of 6 points or greater were considered to have an infection, whereas a score between 2 and 5 points required the inclusion of intraoperative findings to confirm or refute the diagnosis. Intraoperative findings of a positive histology, purulence, and a single positive culture result were assigned 3 points, 3 points, and 2 points, respectively. Combined with the preoperative score, a total of 6 points or greater was considered an infection; a score between 4 and 5 points, inconclusive; and a score of 3 points or less, no infection.[3-5]

In patients with a score of 2 to 5 points, or "possible infection," according to the Musculoskeletal Infection Society criteria, the use of an updated technique catered to prosthetic joints, similar to that previously described in native knees by Lavender et al.,[6] is appropriate. In this article, we describe a technique in which a NanoScope and GraftNet are used to obtain synovial and bone tissue samples in a patient with prior total knee arthroplasty. The goal of the biopsy is to aid in the diagnosis of possible culture-negative infection or inflammatory pathology causing knee pain and swelling. The incidence of culture-negative infection varies from 5% to 42%, and patients are at higher risk of this if given antimicrobial therapy prior to culture.[7] Obtaining a synovial biopsy specimen through an incisionless technique can be performed with low morbidity compared with open I&D to obtain tissue samples.

There are several pearls to our technique that make it more simple and effective. It is helpful to use the high-flow nanoscopic cannula for inflow and a larger 3.0-mm shaver percutaneously to obtain tissue (Table 1). Disadvantages to the technique are that it most likely requires anesthesia and a patient with a likely infection could be treated and receive a diagnosis in one setting versus the diagnostic procedure we describe. Another disadvantage is possible infection if the knee was not infected (Table 2). Limitations to this technique are that it can be technically demanding and has a learning curve. Working with the 0° NanoScope can be challenging with the reflection of the knee prosthesis. Other limitations are the added cost versus an open synovectomy approach. However, in patients who have significant comorbidities and are at high risk of complications from a large knee procedure, nanoscopic synovectomy and I&D comprise an attractive alternative with diagnostic value, less blood loss, and a shorter operating time.

The minimally invasive view from a NanoScope enables the surgeon to inspect the prosthetic knee joint. Important information can be obtained regarding the polyethylene locking mechanism, bone-cement-implant interface, and prosthetic patellofemoral tracking. Adding the GraftNet to obtain a tissue diagnosis may be an increasingly attractive option in those knees that are difficult to diagnose as having an infection. We believe that this is an attractive technique in patients with difficult-to-diagnose painful total knee arthroplasty.

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