How Effective is a Saline Arthrogram for Wounds Around the Knee?

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Abstract Traumatic arthrotomies may predispose patients to subsequent septic arthritis and therefore are regarded as serious injuries requiring emergent treatment. The saline arthrogram is a commonly used test to determine if a patient has a traumatic arthrotomy. We determined the sensitivity of the saline arthrogram to identify known intraarticular wounds in 78 patients (80 knees) undergoing elective arthroscopic procedures. There were 66 infrapatellar and 14 suprapatellar incisions. The average length of the incision was 7.5 mm. Intraarticular position was confirmed with a blunt probe. A saline arthrogram then was performed using 60 mL normal saline. The known arthrotomy (operative wound) was observed during the injection for evidence of saline leakage (positive static test). If no leakage was observed, the knee was brought through a range of motion with continued observation for leakage from the arthrotomy (positive

dynamic test). Twenty-two of 80 knees had a positive test without passive range of motion of the knee (static sensitivity, 36%). Eight additional knees had a positive test with subsequent passive motion (dynamic sensitivity, 43%). Our data suggest a saline arthrogram has low sensitivity for detecting known small traumatic arthrotomy wounds of the knee.

Level of Evidence: Level I, diagnostic study. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

Lacerations near joints are relatively common injuries prompting orthopaedic consultation. These wounds occur from various etiologies, including gunshots, industrial accidents, and sports injuries. Because of the large superficial area of many joints, these wounds are at high risk for extending through the joint capsule, leading to possible microbial inoculation of the joint space. Traumatic arthrotomies may lead to subsequent septic arthritis and therefore are regarded as serious injuries requiring urgent treatment [1, 2].

Currently, the saline arthrogram is the most commonly used test to determine if a patient has a traumatic arthrotomy. First described by Patzakis et al. [4] in 1975, the test involves injecting a certain volume of sterile saline into a joint while observing the wound for evidence of leakage statically and with passive movement. Voit et al. [5] reported the saline arthrogram was superior to clinical evaluation alone for detecting penetration of the knee. However, they assumed the arthrogram had 100% sensitivity in this setting as the basis for their study [5]. Although the saline arthrogram is used routinely in

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orthopaedic practice, there is little evidence in the literature documenting its effectiveness.

We therefore determined the sensitivity of the saline arthrogram for small intraarticular wounds around the knee.

Materials and Methods

We identified 78 patients undergoing elective arthroscopic knee surgery. Inclusion criteria were skeletally mature patients aged 16 to 65 years who were willing and able to give informed consent. We excluded patients with a history of injury or surgery causing capsular disruption or a history of a systemic condition known to affect the integrity of the joint capsule such as inflammatory arthritis or collagen vascular disease. Eighty knees were tested in 37 male and 41 female patients; two patients had a surgical procedure on both knees concomitantly. There were 39 left and 41 right knees. The average age of the patients was 42.5 years

(range, 17–65 years) and their average weight was 83 kg (range, 41–127 kg). We obtained prior Institutional Review Board approval for the study protocol and all patients gave informed consent for study participation.

After standard preparation for the arthroscopic knee operation, one incision was made in the knee to begin the procedure. The location of the incision depended on surgeon preference and was made according to the standard knee arthroscopy technique (Fig. 1). There were 14 suprapatellar and 66 infrapatellar wounds. Average length of the incision was 7.5 mm (range, 4–12 mm). The size of the incisions was that required for the arthroscopic procedure the patient was having performed. Intraarticular position was confirmed by the attending surgeon using a blunt probe (Fig. 2). The probe was removed and a saline arthrogram was performed using 60 mL normal saline. After the test, the probe position was confirmed to be intraarticular by arthroscopy. Injection was performed on the opposite side of the patella and away from the vicinity of the wound. We (AAS, MTB, TEF) observed the known arthrotomy (operative wound) during the injection for evidence of saline leakage, indicating a positive static test (Fig. 3). Any leakage was considered a positive test by

Fig. 1 A standard stab wound arthrotomy at the start of the arthroscopic procedure is created.

Fig. 2 Intraarticular extension of the surgical wound is confirmed with a blunt probe.

Fig. 3 The static saline arthrogram was performed using an injection of 60 mL normal saline away from known arthrotomy and observation of arthrotomy for evidence of any saline leakage from the wound.

definition. If no leakage was observed, the knee was brought through a range of motion (ROM) (0° to $>90^\circ$) to determine if this led to a positive dynamic test (Fig. 4). The knee was ranged a minimum of five times or until a positive finding occurred. After completion of the saline arthrogram, the planned arthroscopic procedure was performed.

Sensitivity and 95% confidence intervals were calculated for the static and dynamic tests. Differences in sensitivity based on location of the arthrotomy were compared using the chi square test.

Results

Twenty-two of 80 patients had a positive test without passive ROM of the knee (static sensitivity, 36%). Eight additional patients had a positive test with subsequent passive motion (dynamic sensitivity, 43%). The average degree of flexion at which the dynamic test became positive was 56° . Of the 30 true-positive tests, 24 were obtained from infrapatellar incisions and six were from suprapatellar incisions. No difference ($p = 0.88$) in the sensitivity of the test was observed between anatomic locations (Table 1).

Fig. 4 The dynamic saline arthrogram required close observation of known arthrotomy for evidence of saline leakage during passive ROM from 0° to greater than 90° flexion a minimum of five times.

Table 1. Results of static (without ROM) and dynamic (with ROM) tests and results for static and dynamic tests based on location

Test/Location	Total number of tests	Number of positive tests	Sensitivity	Confidence interval
Static test	80	22	36%	26%–48%
Dynamic test	80	30	43%	21%–67%
Suprapatellar	14	6	43%	*
Infrapatellar	66	24	36%	*

* Suprapatellar versus infrapatellar sensitivity; $p = 0.88$, chi square test; ROM = range of motion.

Discussion

Periarticular lacerations are common injuries orthopaedic surgeons are asked to evaluate. These injuries occur from various causes and most commonly occur around the knee

[3]. Determining which periarticular wounds violate the joint capsule can be difficult. On physical examination, signs of an intraarticular wound may include a palpable effusion or hemarthrosis, painful ROM, or a palpable capsular defect when probing the wound. Radiographs may reveal an effusion, retained foreign body, or air contained in the joint space. When these methods fail to reveal the presence of an intraarticular wound, then a saline arthrogram typically is performed to determine if the surface wound violated the joint space [5]. Although the saline arthrogram is used routinely in orthopaedic practice, there is little evidence in the literature documenting its effectiveness. We therefore determined the sensitivity of the saline arthrogram for small intraarticular wounds around the knee.

There are several limitations to our study. First, the wounds we tested were small arthroscopy wounds (average incision length, 7.5 mm), and therefore the applicability of our model to larger traumatic wounds may be limited. Although many penetrating wounds result from gunshots and stabbings and are similar in size to the wounds we tested, gunshot wounds may cause more damage to the soft tissue under the skin and potentially could make egress of the fluid easier than in our model. Second, we used a fixed volume of saline (60 mL) as part of our protocol because this seemed a commonly agreed-on amount for testing the knee, and it is what we use clinically in our trauma center. It may be, depending on the size of the joint space in a particular patient, this volume was not enough to create the capsular distention needed before fluid extravasation from the wound. The results from the saline arthrogram may be improved if saline is injected to the point of considerable capsular distention. Finally, one publication documented the difficulty of accurately injecting substances into the intraarticular space [5]. Although the injections were performed by experienced arthroscopic knee surgeons (AAS, TEF), it could be argued a certain number of the saline injections failed to access the intraarticular space, which therefore could have influenced the results of the test.

The original description of the use of the saline arthrogram was included in a report on the use of continuous irrigation in the management of open joint injuries by Patzakakis et al. [4], who studied 140 patients with penetrating joint injuries, including 129 knee injuries. In this report, the authors stated, "Extravasation of saline from the joint into the wound during arthrocentesis..." was used as an adjunctive diagnostic method for wounds in which violation of the joint capsule was not evident by physical examination and radiographs [4]. Voit et al. [5] reported 50

consecutive patients evaluated for open joint injuries and compared the effectiveness of clinical evaluation alone versus the saline arthrogram for detecting intraarticular wounds. They found clinical evaluation alone had relatively high false-positive and false-negative rates and concluded the saline arthrogram was safe and effective over clinical evaluation alone in management of these wounds [5]. However, one flaw of their study was the assumption that the saline arthrogram was 100% sensitive and that it could serve as a standard to which clinical evaluation could be compared. To our knowledge, no report exists documenting the effectiveness of the saline arthrogram using a model with a known arthrotomy.

The data in our study indicate the saline arthrogram has poor sensitivity in detecting known small arthrotomies of the knee. The sensitivity of the static test (36%; 95% confidence interval, 26%–48%) is only modestly improved with passive ROM of the knee (dynamic test, 43%; 95% confidence interval, 21%–67%). This implies the saline arthrogram correctly identifies an intraarticular wound in approximately 50% of cases. These results suggest other factors besides the result of the saline arthrogram should be considered in deciding which patients with periarticular knee lacerations require urgent irrigation and débridement.

Our data suggest the saline arthrogram is not a sensitive diagnostic test for small arthrotomies of the knee and should not be used as the sole means to identify an open knee injury. When the result of the test is negative, then other factors, such as the amount of gross contamination, extent of tissue damage, and an assessment of the patient's ability to identify potential infectious complications and return for prompt management, should be used in determining whether emergent irrigation and débridement are indicated for particular knee wounds.

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