Intraarticular Findings After Gunshot Wounds Through the Knee
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No financial support of this project has occurred. The authors have received nothing of value.
This manuscript does not contain information about medical devices.

Abstract
Objectives: To compare the radiographic findings in patients with a low-velocity gunshot wound through the knee with the intraarticular pathology as documented by arthroscopy, and to evaluate arthroscopic management of these injuries.

Study Design: Retrospective review of a protocol.

Materials and Methods: Thirty-three patients with low-velocity gunshot wounds through the knee, no significant soft tissue injury, and no fracture requiring repair were studied. Radiographs were evaluated for bullet fragments, loose bodies, and debris. All patients were treated with arthroscopic evaluation and management of intraarticular pathology. The arthroscopic findings were compared with the radiographic findings.

Results: Five chondral injuries and fourteen meniscal injuries not suspected on the basis of plain films were found during arthroscopic evaluation. Seven patients had no radiographic evidence of debris, loose bodies, or bullet or bone fragments in the joint. Five of these seven (71%) had debris and meniscal damage. Debridement of all loose bodies was possible using arthroscopy and occasional miniarthrotomy. No patient in the series had an infection.

Conclusions: Patients who sustain a low-velocity gunshot through the knee have soft tissue injuries not visible on plain radiographs in most cases, and therefore operative treatment is warranted. Arthroscopic management of these injuries appears to be a safe and effective method of treatment.

Gunshot wounds have become increasingly more common. New handguns legally sold in the United States number over 2.5 million annually, and the number of nonfatal unintentional injuries from guns averages over 50,000 per year, along with 59,000 fatal shooting injuries (3,14).

The treatment for gunshot injuries through the knee is not clearly defined in the literature. It has been generally accepted that low-velocity gunshot wounds to the extremity require only superficial debridement, tetanus prophylaxis, and oral or intravenous antibiotics (2,5,8). The main rationale for operative treatment after violation of the knee joint has been to prevent the mechanical effects of loose bodies and to avoid systemic lead toxicity (1,9,10). Others have emphasized the need for adequate debridement followed by irrigation to dilute the possible bacterial contamination (6,12).

The purpose of our study was to compare the arthroscopic and radiographic findings in patients who had low-velocity missiles penetrate their knee joints and to evaluate arthroscopic management of these injuries.

MATERIALS AND METHODS
During 1989-1994, a treatment protocol using arthroscopy for the management of low-velocity gunshot wounds through the knee without significant soft tissue injury and not requiring open reduction and internal fixation of any fractures was in effect. One hundred forty-two patients were treated by this protocol. One hundred two patients were eliminated from the review because of the need for operative fixation of large fractures, miscoding (wounds that did not involve the knee), gunshot wounds that were high velocity, or wounds that had significant soft tissue damage. This left forty patients who met the criteria and were subsequently retrospectively reviewed. Thirty-three
patients with thirty-three injuries had complete information available and form the basis of the study. There were five female and twenty-eight male patients aged thirteen to sixty-two years (mean: 44 years). All patients were treated with a standard protocol of tetanus toxoid and cephalothin in the emergency room. All patients had a bullet that passed through or into the knee joint and had no fractures requiring fixation based on preoperative radiographs. After radiographic assessment, irrigation and debridement by arthroscopy/arthrotomy was performed on an urgent basis. Arthroscopy was performed using standard portal placement in thirty-two patients. Miniarthrotomies were performed if debris was too large for removal through the arthroscopic cannula. Extension of the arthroscopic portal was considered a miniarthrotomy. Miniarthrotomies were performed for twelve knees to remove bullets (n = 7) or for debridement of the wound edges (n = 5), and were placed using arthroscopic location as described by Parisien and Esformes (10). All knees were thoroughly examined, all visible debris was removed, and damaged intraarticular structures treated. Meniscal injuries were treated with partial excision or debridement. Chondral injuries were drilled if they were partial thickness and debrided and drilled if they were full thickness. All joints were closed at the index procedure. Closed-suction drainage was not used. Intravenous antibiotics were given for variable amounts of time after surgery, averaging two days (range: 1-5).

RESULTS

Radiographic

Of the thirty-three patients, sixteen had bony fragments (seven femur, seven tibia, two patella), nineteen had a bullet, and ten had debris (intraarticular loose bodies that could not be specifically identified as bone or bullet) in the joint as determined by the preoperative radiographs. Nine patients had both bony fragments and an intraarticular bullet. Seven patients had evidence of bony fragments alone and ten patients had an intraarticular bullet alone. Seven patients had no radiographic evidence of bony fragments, debris, or an intraarticular bullet.

Operative Versus Radiographic

At the time of surgery, five chondral injuries not seen on the plain films and fourteen meniscal injuries were identified in the thirty-three patients. Seventeen had debris in the joint (Table 1).

<table>
<thead>
<tr>
<th>Radiographic findings</th>
<th>Bone only (N = 7)</th>
<th>Bullet only (N = 10)</th>
<th>Bone and bullet (N = 9)</th>
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<td>Meniscal tear</td>
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</tr>
<tr>
<td>Debris</td>
<td>5</td>
<td>3</td>
<td>7</td>
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</table>

TABLE 1. Radiographic vs. arthroscopic findings

All seven of the patients without radiographic findings had intraarticular pathology found during arthroscopy. Five (71%) had a meniscal tear and five (71%) had free-floating debris. For patients with radiographic findings, meniscal tears were present in three of the nine (33%) patients with bony fragments and an intraarticular bullet, three of the seven (43%) with bony fragments alone, and three of the ten (30%) with an intraarticular bullet alone.

The average hospital stay was three days. All patients were seen in the clinic at least once at an average of twenty-one days after discharge, and fifteen were followed for more than six months. No patient in the series had an infection during their hospital course or clinic follow-ups. None was readmitted for infection. No attempt at long-term functional assessment was made because of the poor long-term clinic attendance by this series of patients.

DISCUSSION

Low-velocity gunshot wounds through the knee can cause significant injury to the knee (1,2,11). When fracture reduction is required, the joint is irrigated and debrided as an open fracture. Without an accompanying fracture, treatment is not well established (1,2,7,10,13,14).

Management of these injuries is directed at avoiding infection, lead toxicity, and mechanical third-body wear. Previous beliefs that autosterilization of bullets creates an antiseptic wound without the risk of infection have been disproven conclusively (15-17). Infection may also arise from debris introduced into the joint with the bullet. Parisien and Esformes (10) and Berg and Ciullo (2) noted significant amounts of foreign material in knees with gunshot wounds treated arthroscopically. Debris included bullet fragments, hair, skin, and clothing. Supporting these concerns,
Collins and Temple (6) and Patzakis et al. (13) have demonstrated 43% and 19% rates of positive wound cultures, respectively, after type 1A (no significant fracture or soft tissue injury) gunshot wounds through the knee.

Lead toxicity is a significant risk in patients who have a retained intraarticular bullet. Lewin and Leonard (9) found that lead is soluble in synovial fluid. Blood lead concentrations may rise to a peak four to six months after injury (4). Lead also diffuses through the synovial membrane and can precipitate in the subsynovial tissue, causing periarticular fibrosis and chondrolysis. This can eventually lead to severe hypertrophic arthritis even in the absence of mechanical impingement (4).

The final potential problem is that of mechanical third-body wear. Any retained loose body in the knee can cause articular wear. For this reason, all intraarticular, free-floating fragments of bone, cartilage, and metal should be debrided.

Several authors have recommended arthroscopic treatment of gunshot wounds to the knee (2,6,7,10,11,13). Advantages over open treatment include a lower morbidity and a faster recovery. The arthroscope can also aid in finding an intraarticular bullet and hold it against the capsule to identify the ideal location for removal by a miniarthrotomy (10).

In this series, we found that arthroscopic evaluation of the joint revealed findings not seen on the plain films. Specifically, intraarticular debris (e.g., bone, bullet fragments, skin, clothing) and meniscal injuries were found in 71% of the knees with no radiographic findings. This was a greater percentage than in the knees with radiographic findings. Our findings are consistent with several smaller reports in the literature that also identified clothing, skin, hair, and bullet fragments in the joint (2,10,11). These findings confirm that arthroscopic evaluation, debridement, irrigation, and treatment of associated intraarticular injuries is a reasonable treatment protocol for type 1A gunshot wounds through the knee. The use of intravenous antibiotics combined with arthroscopic treatment resulted in no infections in this series. However, this was a specific subset of patients without severe soft tissue injury and without fractures requiring fixation. More aggressive treatment may be required for larger wounds (6).

In conclusion, based on our results, it appears that a lack of radiographic findings does not rule out intraarticular debris, chondral injury, or meniscal pathology in low-velocity gunshot wounds to the knee. Therefore, negative knee radiographs should not be used as the basis for nonoperative treatment in these injuries.

REFERENCES


Key Words: Gunshot; Knee joint; Penetrating injury

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| Table 1 |

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