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TRAUMA

The management of low velocity transarticular gunshot injuries: A pilot study

Maqungo S[1], Swan A[1], Naude P[1], Held M[1], Kruger N[2], McCollum G[1], Laubscher M[1]

[1] FC Ortho; OrthoBallistics Research Unit, Department of Orthopaedic Surgery, University of Cape Town, Groote Schuur Hospital, Cape Town, South Africa
[2] FCS SA Orth; OrthoBallistics Research Unit, Department of Orthopaedic Surgery, University of Cape Town, Groote Schuur Hospital, Cape Town, South Africa

Corresponding author: Prof Sithombo Maqungo, Department of Orthopaedic Surgery, H49 Old Main Building, Main Road, Observatory, Groote Schuur Hospital; tel: +27214045108; email: sithombo@msn.com

Abstract

Objectives: To prospectively evaluate the incidence of superficial and deep wound sepsis in a cohort of patients who sustained low velocity transarticular gunshot wounds.

Methods: We performed a prospective, randomised, non-blinded pilot study of all adults presenting to a single institution between November 2011 and January 2015 that sustained a transarticular gunshot injury with no definite indication for surgery. We defined indications for surgery as: retained bullet or bullet fragments that warranted surgical removal or the presence of skeletal injuries that required surgical intervention. Patients were randomised into two treatment groups. The conservative treatment group received anti-tetanus toxoid and antibiotics alone, and the surgical treatment group received anti-tetanus toxoid and antibiotics, as well as formal arthrotomy, debridement and irrigation.

Setting: Single Level 1 University Hospital Trauma Centre.

Main outcome measurements: The two groups were assessed for development of septic arthritis or superficial wound infection.

Results: We identified 30 transarticular gunshot wounds in 29 patients with an average age of 29.5 years (range 18–74). Sixteen (53%) were treated conservatively and 14 (47%) had a formal arthrotomy and washout. The median follow-up period was 20 days (range 5–84) for the conservative group and 30 days (range 8–84) for the operative group. No wound or intra-articular sepsis was observed for any of the 30 gunshot wounds.

Conclusion: It can be concluded, with appropriate caution, that there may be a place for non-operative treatment of low-velocity transarticular gunshot injuries without a demonstrable increased risk of infection.

Level of evidence: Level 2

Key words: septic arthritis, wound infection, civilian gunshot wounds, transarticular injuries

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Introduction

South Africa has a high incidence of interpersonal violence, including penetrating trauma. Gunshot-related injuries and death form a significant portion of this.[1] Transarticular gunshot injuries remain uncommon, but due to an increasing number of civilian gunshot injuries, they are becoming more prevalent. The management of transarticular gunshot wounds with significant skeletal injuries as well as retention of bullet fragments in joints is well established. This involves operative fracture fixation and removal of any retained shrapnel, which can be achieved via open or arthroscopic means.

The literature does not firmly dictate management of low velocity transarticular gunshot injuries that do not require skeletal fixation or shrapnel removal. The question of whether these injuries should be treated non-operatively or surgically with joint debridement and irrigation remains unanswered. The few available studies are based on high velocity injuries sustained in military conflict. There is a high degree of contamination and tissue damage that accompanies high velocity gunshot injuries and as such formal debridement and arthrotomy are deemed mandatory.[2]

Objective

The aim of this study was to prospectively evaluate the incidence of superficial and deep wound sepsis in a cohort of patients who sustained low velocity transarticular gunshot wounds not requiring internal fixation, or removal of retained intra-articular bullets or fragments. Patients were managed either non-operatively or surgically.

Our hypothesis was that the infection rate would be low and similar in both treatment groups.

Methods

A prospective, randomised, non-blinded pilot study was conducted on a consecutive series of patients presenting to a single Level 1 Trauma Unit. All patients that met the inclusion criteria were recruited into the study. Informed consent was obtained in all patients.

The proposal was reviewed and approved by the Human Research Ethics Committee of our institution.

Inclusion criteria

Inclusion criteria were: a patient sustaining a low velocity transarticular gunshot injury with no definite indication for surgery.

Indications for surgery included: retained bullet or bullet fragments that warranted surgical removal or the presence of skeletal injuries that required surgical intervention.

Index group

The index group received non-operative treatment which consisted of anti-tetanus toxoid administration and a single dose of intravenous prophylactic antibiotics (penicillin or clindamycin if allergic to penicillin). This was administered at presentation to our institution, if they had not already received a dose of antibiotics from the referral centre.

Control group

The control group received antibiotics as per the index group protocol. In addition, they underwent surgical debridement of the bullet tract, as well as arthrotomy and irrigation of the involved joint. A routine pre-operative single dose of intravenous cephazolin or clindamycin was administered prior to surgery. A tourniquet was used when possible.

Outcomes

The primary outcome was the development of superficial wound infection or a septic arthritis.

Patients were followed up for clinical signs of superficial and deep sepsis during admission and at routine clinic follow-up appointments at two, six and twelve weeks. Superficial infection was defined as infection that was limited to the skin or subcutaneous tissue, not requiring surgical debridement. Deep infection was defined as infection of the deep tissues or joint space requiring formal surgical debridement.

If superficial sepsis was diagnosed, the protocol was to send a wound swab for microscopy, culture and sensitivity, and monitor inflammatory markers using erythrocyte sedimentation rate (ESR). Wounds were to be managed topically and with oral antibiotics. The type and duration of antibiotic therapy in both groups was to be recorded.

If deep wound sepsis was diagnosed the protocol was again to monitor ESR and perform formal debridement and irrigation of the infected wound. Tissue samples were to be sent for microscopy, culture and sensitivity.

Randomisation

Simple random sampling was obtained utilising sealed envelopes.

Blinding

The patient, attending clinician and principal investigator were not blinded to the treatment groups.

Statistical analysis

Simple descriptive statistics were to be used to describe categorical data.

Results

Thirty transarticular gunshot injuries in 29 patients met the inclusion criteria during the recruitment period from November 2011 to January 2015. One patient sustained bilateral knee gunshot injuries. Sixteen (53%) injuries were randomised to the non-operative treatment group, and 14 (47%) to the operative treatment group.

The mean age of patients was 30 years (range 15–59) for the non-operative group and 30 (range 18–74) for the operative treatment group. Twenty-seven of the 29 patients were males.

The most commonly injured joints were knees (83%), with 13 gunshot injuries treated non-operatively, and 12 injuries treated operatively (*Table I*). The median follow-up period was 20 days (range 5–84) for the conservative group and 30 days (range 8–84) for the operative group.

No superficial or deep sepsis was observed in any of the 30 injuries across both groups. Statistical significance could not be demonstrated with these limited patient numbers.

Table I. Distribution of operative and non-operative transarticular gunshot injuries

	Operative	Non-operative
Knee	12	13
Shoulder	1	3
Elbow	1	0
Total	**14**	**16**

Discussion

Ganocy[3] *et al*. reviewed the literature on low-velocity transarticular gunshot and identified three key factors in the management algorithm, namely: bullet or bullet fragments' ultimate location, contamination as well as fracture configuration.

Based on these factors a classification system was proposed to guide the management of these injuries. In fractures not requiring internal fixation, with absence of contamination, and no intra-articular bullet or fragments, conservative management with antibiotics was proposed. It was recommended that bullet fragments lodged in bone or soft tissue that are in communication with the intra-articular space should be treated on an individualised basis, unless there had been obvious bacterial contamination of the projectile. The presence of retained intra-articular bullet or fragments mandates formal surgical debridement, irrigation and removal of the projectile.[3]

There is a common misconception that the heat generated in firing a projectile results in auto-sterilisation. This has been disproven in both experimental and animal models. It has been demonstrated that bacterial contamination of the wound usually occurs immediately as bacteria are sucked into the wound by the vacuum effect, or contamination of the projectile as it passes through clothing or skin.[4-6] The clinical relevance of this remains disputed, and there is no firm recommendation in the literature for or against the use of prophylactic antibiotics in the management of low velocity extra-articular, or intra-articular fractures not requiring internal fixation.[7,8] However, it is recommended that treatment with antibiotics for intra-articular fractures be considered on clinical grounds.[7]

In a retrospective case series by Junkin *et al*.[9] consisting of 18 patients with transarticular gunshot knee injuries, all patients received early intravenous cephalosporin or clindamycin. On average follow-up of 16.6 days post discharge, no sepsis was observed for four patients managed conservatively, nine who had surgical debridement, or five who had surgical debridement and internal fixation.[9] Long *et al.* in an analysis of transarticular gunshot injuries of the hip concluded that transarticular low velocity gunshot injuries to the hip without bowel penetration, minimal bone injury, and with the bullet no longer in contact with synovial fluid, could be managed conservatively.[10] This is confirmed in our results with no difference in sepsis rates shown between treatment groups.

One needs to be aware that these injuries may often be difficult to appreciate on plain radiographs.[11] In two case series of seven and eight patients undergoing arthroscopy of the knee following transarticular gunshot injury with no definite indication for surgery, foreign material such as clothing, shrapnel and osteochondral fragments not appreciated on plain films were found in the majority of patients.[12-13] Tornetta *et al*.[14] in a similar series of 33 patients identified 14 meniscal injuries, five chondral injuries and five cases of intra-articular of debris or bullet fragments not suspected on plain radiographs. It was recommended to inspect the clothing for defects when possible, as this may hint at retained foreign material in the wound tract or joint.[14]

Other clinical parameters such as time to union, range of motion or mechanical symptoms of the affected joint were not assessed in our study.

Limitations

A small cohort of patients, a high drop-out rate and short follow-up periods are obvious limitations of this study. These are rare injuries and this sub-group of patients is notoriously a difficult group to follow up as shown in other studies[15,16]

We also did not run any statistical analysis on the results as there were no clinical differences between the two groups. With an estimated infection rate of 5% extrapolated from open fracture data, power analysis meant we would require an estimated 274 patients in each arm to demonstrate the lack of statistical difference between conservative or operative management. Our study is therefore underpowered.

This study is best viewed as a pilot study to inspire and guide a well-designed and properly powered clinical research study.

Conclusion

It can be concluded, with appropriate caution, that there may be a place for non-operative treatment of low-velocity transarticular gunshot injuries without a demonstrable increased risk of infection.

Ethics statement

This study adheres to the Helsinki Declaration of 2008.
The proposal was reviewed and approved by the Human Research Ethics Committee of our institution.

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