



Complications resulting from tracker pin-sites in computer navigated knee replacement surgery

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Intra-osseous pin sites used in Computer Navigated knee Arthroplasty are known to cause complications including infection, neurovascular injury, thermal necrosis and peri-prosthetic fracture. Many studies have looked at ways of reducing these risks to improve results in computer-navigated surgery. We present our complication rates and techniques used to reduce complications in a retrospective study of 321 patients performed by a single surgeon in between 2009 and 2013. One patient was identified with a superficial pin site infection. No major complications were recorded during a mean follow up period of 31 months. Attention to detail in every aspect of pin insertion reduces the rates of both minor and major complications. In particular rates of peri-prosthetic fracture were shown to be lower when using a unicortical drilling technique compared with the use of bicortical drilling in other studies.

Keywords :

Problems with pin sites can vary in significance from minor issues such as superficial wound infection or pain to more severe risks such as neurovascular injury, thermal necrosis or peri-prosthetic fracture.

In recent years many groups have reported such complications (7,9,13). Beldame *et al* reported an incidence of 1.38% of femoral fractures in their series of 385 TKR (1). Hoke *et al* reported three tibial fractures in their series of 220 TKR giving an incidence of 1.3% (7). Sikorski *et al* reported an incidence of 3.0% of minor complications including superficial wound infections and 6.5% of major complications including peri-prosthetic fractures and nerve injuries to the lateral cutaneous nerve of the thigh (12). Berning & Fowler also presented a patient with osteomyelitis of the proximal tibia resulting from thermal damage from pin tracker site (2). There has been one case report of a vascular injury from a

INTRODUCTION

Computer-assisted navigation during total knee replacement has been advocated to improve component alignment and hence reduce failure rates and improve quality of life (3,4). Percutaneous bone pins inserted in the femur and tibia allow placement of navigation trackers that are used during the operation. Concerns have been raised regarding complications arising from these tracker pin sites (11).

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Table I. — Summary of other case series. Minor complications include superficial wound infection and post-operative pin site pain. Major complications comprise nerve injury and peri-prosthetic fracture

| Authors | Minor complications | Major complications |
|----------------------------|---------------------|---------------------|
| Sikorski <i>et al</i> 2005 | 3.0% | 6.5% |
| Wysocki <i>et al</i> 2008 | N/A | 1% |
| Beldame <i>et al</i> 2009 | N/A | 1.4% |
| Owens & Swank 2010 | 1.7% | |
| Hoke <i>et al</i> 2011 | | 1.3% |

femoral pin site (6). Complication rates found in other studies are summarised in table I.

This a retrospective cohort study presenting the post-operative complication rates related to tracker pin sites of computer navigated knee arthroplasty from a single surgeon in a single NHS hospital.

METHODS

A retrospective analysis was completed of all patients undergoing knee arthroplasty using the Stryker Navigation System performed by a single surgeon in a single centre between 2009 and 2013. A total of 321 patients were identified ; 287 total, 29 uni-condylar and 5 patellofemoral knee arthroplasty. The mean age of the patients was 69.4 years [range 48-89], with 131 male and 190 female and a mean BMI of 30.1 [17.8-52.3]. All patients were included with a mean follow up of 31 months [range 3-60 months]. Patient (paper and electronic) records were reviewed for evidence of specific pin site complications (infection, pain, neurovascular injury, fracture, thermal necrosis) and documented.

Operative technique

A consistent operative technique was used in each case of pin site placement. The patient was positioned in a standard position for a knee replacement with a thigh tourniquet applied but not inflated and prepped and draped as standard for all joint replacements. We did not use impervious drapes as a routine.

The pins were inserted away from the operative field in order to reduce the chance of the trackers interfering with the surgical approach and instrumentation. A generous 1cm longitudinal skin incision was performed for each pin site with blunt dissection down to bone. Active bleeding was encountered as the tourniquet was not in-

flated at this stage. Self-drilling, self-tapping, 4 mm diameter Stryker Apex pins were used and inserted using a drill. Two uni-cortical pins were placed perpendicular to the bone and held with a pin clamp to improve stability. To ensure correct positioning drilling is stopped when resistance is felt in the second cortex. Figures I and II show positioning of tibial and femoral pins inserted medial to the tibial crest and laterally on the femur in cortical bone. Following appropriate positioning the tourniquet was inflated in order to continue with surgery.

Following completion of surgery the pins were removed, the wounds closed with skin clips and dressed with sterile dressings.

RESULTS

In our series one patient (0.3%) had superficial infection of the tibial pin site and was treated successfully with oral antibiotics. There were no other minor or major complications.

DISCUSSION

Our complication rates from tracker pin sites used in computer navigated knee arthroplasty were very low compared with those published previously. Our attention to detail during pin placement may be the cause of the exceptionally low complication rates. Owens and Swank reported similar low (1.7%) minor complication rates from pin site placement in a series of 984 patients undergoing computer navigated knee arthroplasty (11).

We believe our use of more generous incisions with blunt dissection compared with a percutaneous technique minimises soft tissue trauma. Berning and Fowler and Ferreira and Marais reported



Fig. 1. — Tibial Pin placement via generous skin incisions

increased skin tension and excessive tissue motion contribute to local tissue necrosis and infection and can both be reduced using larger skin incisions (2,5).

Operative technique of pin placement seems to be important (11). High cortical temperatures over 50°C during drilling can result in irreversible changes in bone structure. Some series have reported temperatures up to 100°C during drilling (10). To minimise heat generation it has been demonstrated that high rotational velocity and low torque should be used when drilling (10). Choice of equipment is also important as the use of sharp, self-drilling, self tapping pins reduces the force required for cortical penetration with rapid debris removal that minimises the risk of thermal necrosis (7). Hoke *et al* also proposed that non-fluted pins with shorter pitch led to increased thermal necrosis after reporting three cases of tibial fracture using the Stryker proprietary pins rather than the Stryker Apex pins (7).

Application of an inflated tourniquet also has a theoretical effect on thermal necrosis during pin site insertion. Active bleeding during pin insertion may



Fig. 2. — Femoral pin placement from lateral to medial via generous skin incisions.

cool the bones and pins and hence reduce the effect of heat on the bone and soft tissues.

Uni-cortical drilling is another technique that may have reduced the likelihood of complications in our series. Other series with reported peri-prosthetic fractures have used bi-cortical drilling with 1.5-3.2 mm diameter pins (see Table II) in overweight or obese patients. Femoral fractures seem to occur more frequently in the literature than tibial fractures. Junctional areas between diaphyseal and metaphyseal bone appear to be best avoided as they are thought to be particularly susceptible to fracture. Wyskoski *et al* suggested a critical point when the bone defect reaches 10-20% of the bone diameter (13).

Other authors have recommended the use of metaphyseal rather than diaphyseal pins. Our technique using two unicortical diaphyseal pins and offers adequate stability for the trackers compared with bi-cortical drilling. The resultant tracker positioning does not interfere with the operative field (1,7,11). We believe that the use of bicortical drilling is a more important risk factor for peri-prosthetic fractures than pin placement. The lack of periprosthetic fractures in our series may offer some support to this hypothesis (1,9,13).

The lateral approach may pose a risk to the superior medial geniculate artery and femoral artery during bicortical drilling, but these structures are unlikely to be damaged using a careful unicortical technique (8). The main advantage of lateral as opposed to anterior pin placement is reducing the

Table II. — Comparison of patients with Peri-prosthetic fractures reported in the literature

| | Age (mean) | BMI (mean) | Fracture | Pins | Placement |
|---------------------------|------------|------------|----------|--|---|
| Wysocki <i>et al</i> 2008 | 46 | | Femoral | 2 × 3.2 mm self-drilling, self-tapping threaded pins | Bicortical femoral diaphysis Bicortical tibial diaphysis |
| Wysocki <i>et al</i> 2008 | 77 | | Femoral | 2 × 3.2 mm self-drilling, self-tapping threaded pins | Bicortical femoral diaphysis Bicortical tibial diaphysis |
| Li <i>et al</i> 2008 | 53 | 37 | Femoral | 3 × 3.0 mm self-tapping pins femur 2 × 3.0 mm self-tapping pins tibia | Bicortical femoral diaphysis Bicortical tibial diaphysis |
| Beldame <i>et al</i> 2009 | 73.2 | 32.57 | Femoral | 2 × 1.5 mm threaded pins | Bicortical femoral diaphysis Bicortical tibial diaphysis |
| Hoke <i>et al</i> 2011 | 74 | 30.2 | Tibial | 2 × 3.0 mm pins tibia | Bicortical tibial diaphysis |
| Hoke <i>et al</i> 2011 | 64 | 39.5 | Tibial | 2 × 3.0 mm pins tibia | Bicortical tibial diaphysis |
| Hoke <i>et al</i> 2011 | 68 | 36 | Tibial | 1 × 3.0 mm pin femur 2 × 3.0 mm pins tibia | Bicortical metaphyseal femur Bicortical diaphyseal tibia |

chance of the trackers compromising the operative field.

Obesity, which is a documented risk factor for pin-site infection was a problem in our cohort of patients as the mean BMI was consistent with the WHO definition of obesity (BMI > 30) and small minority of our patients had a BMI > 50 (1). Other risk factors such as osteoporosis, rheumatoid arthritis and corticosteroid use were also present in 3.7%, 2.4% and 3.1% of our patients respectively (9). Diabetes, which may impact on infection rates, was present in 21.8% of patients.

We recognise the limitations of a retrospective study and some complications may have been missed, however with a minimum of 3 month follow up (these 10 patients were lost to follow up after this point) we feel most pin site complications would have revealed themselves in this time frame. Some studies have suggested 5 weeks to 5 months as an adequate follow up period for major complications such as fracture (7). Superficial wound infections may have been treated in the community so this figure may also not be wholly accurate but if present were not documented at follow up.

A post-hoc power analysis based on a comparison with studies demonstrating minor complications (Owens and Skank ; Sikorski and Blythe) was completed (11,12). This study revealed 0.3% minor complication rate vs a combined rate of 2.0% in the 2 studies. With a 0.05 type 1 error rate the power is

71%. Larger sample sizes would have been required in order to achieve higher power in the study.

In conclusion there are many lessons that can be learnt from this study and applied to pin site placement in other areas of orthopaedics. Pin placement without an inflated tourniquet and generous skin incisions may reduce soft tissue infection and thermal necrosis of bone. Uni-cortical pin placement may help to reduce the risk of causing peri-prosthetic fractures.

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