A Systematic Review of Knee Pain with Respect to Suprapatellar Versus Infrapatellar Tibial Nailing

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Received: February 24, 2020; Published: March 10, 2020

Abstract

Introduction: The preferred technique for management of acute tibial shaft fractures is intramedullary nailing. While traditional nailing techniques utilise an infrapatellar approach, this has been associated with anterior knee pain when used to treat tibia fractures. The suprapatellar approach has gained popularity in recent years and is postulated to mitigate some of the complications associated with traditional techniques, including that of knee pain. This paper provides a systematic review of anterior knee pain with respect to suprapatellar nailing (SPN) versus infrapatellar nailing (IPN) in acute fractures of the tibia.

Methods: A systematic review was conducted through keyword search of electronic databases (MEDLINE, Embase and Pubmed). Exclusion criteria included cadaveric, descriptive and animal studies and studies only comparing radiographic outcomes. Studies where clinical and patient reported outcome measures were used as the assessment of anterior knee pain were included. The critical appraisal skills programme (CASP) was used to assess the methodological quality of included studies.

Results: Twenty published studies were found in the databases searched. Four studies were eligible for inclusion. Two studies were randomised prospective studies. One study was a prospective study only of suprapatellar nail and one study was a retrospective study. Three studies used visual analogue score and one used the Kujala knee score. In the studies a total of 270 tibial fractures were managed with intramedullary nail. 153 were treated with suprapatellar nail and 117 were treated with infrapatellar nail. One study with 162 patients found statistically significant reduction of anterior knee pain at 6,12,24 months in suprapatellar nail. One study with a patient number of 15 found no significant difference anterior knee pain between the two techniques. A study of 36 patients treated with suprapatellar nail only, found no patients complaining of anterior knee pain at 12 months. The retrospective study followed 59 patients and found no statistically significant in anterior knee pain between the two approaches.

Conclusion: Limited evidence exists to draw strong conclusions about the difference in anterior knee pain between infra and suprapatellar nailing. The best designed study showed higher levels of anterior knee pain with infrapatellar nailing after six months, although this has not been replicated in other smaller studies.

Keywords: Supra-Patellar Nail; Suprapatellar Nail; Anterior Knee Pain; Fracture Tibia; Intramedullary Nail Tibia

Introduction

The tibia is the second largest long bone in the body and is the most commonly fractured bone in the lower limb [1]. The management of acute tibial shaft fractures is dependent on both the fracture pattern, and the associated soft tissue injury. Operative stabilisation of tibial fractures aims to reduce and stabilise the fracture and restore normal functional activity. Whilst previous studies have shown functional bracing is applicable in minimally displaced fractures [2,3] operative fixation may offer faster return to function [4] and intramedullary nailing (IMN) has now become the accepted gold standard for management of tibial fractures.

Traditional nailing techniques utilise an infrapatellar approach (IP), which can be either paratendinous or transtendinous. A parapatellar approach with entry point at the medial aspect of the tendon is most commonly used, particularly for fractures in the middle and distal thirds of the tibia. However, this approach can lead to valgus malalignment when used to treat proximal tibial fractures. A parapatellar approach with entry point at the lateral aspect of the tendon aids in maintaining fracture reduction with proximal tibial fractures but requires mobilization of the patellar tendon. Transtendinous or patellar tendon splitting approach gives direct access to entry point but is used less commonly due to inadvertent damage to the patellar tendon.

Anterior knee pain (AKP) is a well-recognised complication after IMN using the infrapatellar technique. The pathophysiology of AKP is not well known, with different studies suggesting several theories. These include injury to the patella fat pad, with resulting hypertrophy or impingement [5-7]. Other causes include nail prominence [8], infrapatellar nerve injury [9], quadriceps weakness [10] and intraarticular injury [11].

The technique and physical patient set up for nailing the tibia has evolved over time. Classically traction of the tibia was used for fracture reduction. This was then modified by allowing the affected limb to hang off the operating table in a flexed position with traction applied by gravity. This position was cumbersome to the surgeon and to the radiographer intra-operatively. A modification of this was to put a radiolucent triangle under the flexed knee to gain access to the nail entry point whilst also permitting radiographs to be taken [12].

Granville-Chapman introduced the freehand figure of 4 position in 2013. This attempted to overcome the awkward position of the leg in the previous positioning, potentially making the operation simpler for the surgeon and the radiographer [13].

Suprapatellar approach

The suprapatellar approach has gained popularity in recent years. In this approach the tibial nail is inserted in an extended knee position and via the retropatellar portal. The incision is located proximal to the patella and the nailing instruments are passed behind the patella through the knee joint.

The position of extended leg nailing for tibial fractures is not new. Tornetta described a semi-extended position for tibial nailing to overcome complications of apex anterior deformity in nailing of proximal fractures with the traditional IPN methods [14]. In fractures of the proximal-third of the tibia, the quadriceps muscle exerts deforming forces on the proximal fragment leading to apex anterior valgus deformity. Flexing the knee increases the pull and fracture reduction tends to be difficult. The aim of the semi-extended position is to counteract the deforming quadriceps deforming force. Through a partial medial parapatellar arthrotomy, he was able to insert the tibial nail with the knee only in fifteen degrees of flexion. Later this approach was modified and developed to result in the suprapatellar approach by Cole [15].

AKP does have an impact on functional recovery and return to activity and work. Because of the relatively high incidence of AKP in IMN of tibia fractures we hypothesised that the AKP is approach related. Moving the surgical incision from below the knee to above the knee might decrease AKP as some studies suggested that AKP is due to injury of the patellar fat pad during the nailing in IP approach [5-7] or infrapatellar nerve injury [9].
Methods

The paper provides a systematic review of anterior knee pain with respect to SPN versus IPN in acute fractures of the tibia. We hypothesize that literature might show evidence that AKP is less in SPN of the tibia with respect to the traditional IPN.

Prior to starting the systematic review, the PROSPERO (International prospective register of systematic reviews in health and social care) database was searched for any similar reviews of this nature [16]. We used the keywords supra-patellar nail, suprapatellar nail, anterior knee pain, fracture tibia, intramedullary nail tibia.

The systematic review of literature searching the relevant databases for studies investigating the management of acute tibia fractures and relationship with knee pain specifically with reference to SPN vs IPN was conducted on 15th October 2017. Electronic databases MEDLINE, Embase and PubMed were searched through the Ovid platform from their commencement to the 15th October 2017. We used the keywords supra-patellar nail, suprapatellar nail, anterior knee pain, fracture tibia, intramedullary nail tibia.

For unpublished literature the online electronic databases UK Clinical Trials Gateway, British Library Integrated Catalogue, OpenGrey, and the Cochrane Central Register of Controlled Trials from commencement to 15th October 2017 were also searched. We used the same keywords [17].

Randomised and non-randomised control trials comparing supra and infrapatellar approaches in fixation of tibia fractures were reviewed. Any cadaveric or animal study was excluded. Any descriptive study was excluded. Studies that compared radiological outcomes only were excluded. No studies were found published in languages other than English.

The senior authors of this study reviewed the title and abstract of all studies. No disagreement arose between the reviewers in respect to included or excluded papers.

Outcome measures

The primary outcome measure was any clinical or patient reported assessment of anterior knee pain. 3 papers used Visual Analogue Score (VAS, 0 = excellent, 10 = extreme pain) [18] measured at 6 weeks, 3, 6 and 12 months postoperatively for assessment of anterior knee pain. The 4th paper used Kujala Knee Score [19].

Critical appraisal

We used the Critical Appraisal Skills Programme (CASP) [20] to assess the methodological quality of the included studies. Each paper included was screened through the 10 checklist questions and all included papers proved eligible.

Data analysis

Studies were analysed by the primary outcome measure. The primary outcome measure was anterior knee pain score on the scoring test whether it was VAS or Kujala Knee Score. VAS was used in three studies and Kujala Knee Score was used in the fourth one.

Results

No previous systematic reviews regrading AKP in SPN versus IPN were found on the PROSPERO database.

Twenty published studies were found by searching MEDLINE, Embase and PubMed databases. Four studies were eligible for inclusion in the systematic review. Four cadaveric studies, four studies that described the approach and eight studies assessing radiological outcomes were all excluded.

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When searching for unpublished studies we found one clinical trial investigating anterior knee pain in infrapatellar and suprapatellar nailing of the tibia [17].

The four papers which compared the incidence and degree of AKP between the suprapatellar technique and the infrapatellar technique in the management of acute tibial shaft fractures are summarised below.

Qi Sun conducted a randomised prospective study at a level 1 trauma centre to compare outcome of both approaches on 162 skeletally mature patients. 81 acute tibia fractures had an SPN and 81 patients had an IPN. Out of those patients, 75 who had an SPN and 74 with an IPN completed follow up, a total of 149 tibia fractures. Qi Sun recorded patients’ VAS score at 1, 3, 6, 12 and 24 months. VAS recorded was significantly lower in SPN at 6, 12 and 24 months however it was comparable at 1 and 3 months. There were 2 SPN cases complaining of moderate AKP and 4 IPN cases complaining of moderate AKP [21].

Chan conducted a randomised prospective controlled pilot study on 41 patients with acute tibia fractures. 25 patients completed follow up of 12 months. 11 patients were treated with a SPN. 14 patients were treated with an IPN. They recorded VAS during follow up at 6 weeks, 3, 6 and 12 months. The average VAS recorded for IPN was 1.5. 11 patients treated with IPN scored less than 1 on VAS, 1 patient scored 3 and 2 scored 8 and 10 respectively. The average VAS for patients with SPN was 0.36. 9 patients treated with SPN scored 0 on VAS, 1 scored 1 and 1 scored 3. There was no AKP recorded in the SPN group. They reported no significant statistical difference in VAS between SPN and IPN. Two patients had AKP in IPN [22].

Sanders conducted a prospective non-randomised study that evaluated the outcome of 56 tibia fractures treated with SPN. 36 patients with 37 acute tibia fractures completed follow up for minimum 1 year. One patient (2.7%) complained of mild pain at the scar, but no patient complained of AKP. Patients were followed up at 2 weeks and monthly intervals. VAS was recorded. The recorded VAS was 0 in 35/36 patients (97.2%). One patient scored two on the VAS at the incision site [23].

Jones conducted a retrospective radiographic and questionnaire-based assessment of patient-reported outcomes and complications after tibial nailing in SPN and IPN. 38 acute tibia fractures were treated with SPN. 36 acute tibia fractures were managed with IPN. AKP was assessed using Kujala Knee score. 59 patients completed follow up. 30 patients were of the SPN group. 29 patients were of the IPN group. Patients treated with IPN complained of AKP more than patients treated with SPN. Kujala knee score used for AKP assessment showed no significant difference between both groups (p = 0.217). 8 patients (27%) in the SPN group had no knee pain and another 12 (40%) had slight knee pain. 8 patients (28%) in the IPN group had no knee pain and 16 patients (55%) had slight knee pain [24].

Discussion

Anterior knee pain is a common complication following intra-medullary nailing of the tibia. There are several pathophysiological theories as to the aetiology of AKP after IMN of the tibia including fat pad and infra-patellar nerve injury, scar prominence and pain, nail prominence, and malalignment. Given that some of these may arise directly due to a surgical incision and approach below the patella, such as the fat pad and nerve injuries, and the others may result from less accurate insertion (a higher risk in IPN vs SPN), we pose the question as to whether moving the surgical approach to above the patella might reduce the incidence AKP [21-24].

We hypothesised that AKP is less with SPN compared to IPN. Due to a relatively narrow search parameter of AKP in SPN compared to IPN, only four papers were included in the systematic review. In these studies, a total of 270 tibia fractures were managed with IMN. 153 were treated with a suprapatellar approach and 117 were treated with an infrapatellar approach.

Qi Sun in his randomised prospective study comparing SPN and IPN found that AKP assessed by VAS was statistically non-significant at 1 and 3 months. At 6, 12 and 24 months AKP was less in SPN compared to IPN with statically significant values. The authors think that the
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The aetiology of AKP is multifactorial and related to soft tissue and nerve injury. As the potential sources of pain was theoretically avoided in SPN, this might be the reason behind lower VAS scores at 6, 12 and 24 months. In this study all surgeries were performed by the same senior orthopaedic surgeon who was well trained in both techniques, therefore eliminating surgeon's experience factor. The follow up lasted for a minimum of 2 years with 149 participants finished follow ups, however a long-term prospective randomised study with a larger scale is needed to further evaluate efficiency of SPN [21].

Chan in his randomised prospective controlled pilot study concluded that there was no significant difference between SPN and IPN groups on VAS recorded at 6 weeks, 3, 6 and 12 months. However, when looking at the VAS scores in both groups there were 2 patients with scores 8 and 10, due to severe pain at the incision site in the IPN group. On the same time the highest score for the SPN was 3 due to mild pain in the knee joint with knee flexion. 9 out of 11 patients had a VAS of 0 in the SPN group while in the IPN group none scored 0. They concluded that AKP in is less prevalent in SPN in comparison to IPN. They propose that the reason behind the better AKP outcome in SPN group is due to moving the surgical incision above the knee rather than being in the infrapatellar area and thus will avoid injury to the Infra Patellar branch of Saphenous nerve - a recognised theory as to the cause of AKP. The main limitation in this study is the relatively small sample size [22].

Sanders showed in his prospective, non-randomised, non-consecutive study that 35 out of 36 patients scored 0 on VAS score at 12 months follow up. The only patient that complained of knee pain was pain at the surgical site rather than AKP. On a knee diagram 3 patients pointed pain at the medial joint line. It was documented preoperatively that 2 of the 3 patients had meniscal tear and degenerative arthritis and the 3rd patient was a polytraumatised patient. Although they stated that the reasons of having AKP is unknown, they propose the patients in their study did not suffer with AKP due to not manipulating the patellar tendon and the surrounding soft tissues. They state the theory that patella tendon manipulation is one of the main reasons of AKP in IPN. The limitations in this study include are primarily that it was a non-randomised, non-controlled study with a relatively short follow up period [23].

Jones in his retrospective study hypothesised that there was no difference in AKP between SPN and IPN. Their results proved their hypothesis showing no significant difference in AKP on Kujala Knee score between SPN and IPN. 27% of the SPN group reported no knee pain and 28% of the IPN group reported no knee pain. Jones concluded from his results that the aetiology of AKP is multifactorial and cannot be attributed to one single factor. Weaknesses in this study include small number of cases studied and short follow up period [24].

Finally, the term (pain) is very broad and we must understand that what is described as pain in a specific culture and community is sometimes described as a norm in another culture or ethnic group. Pain is a private experience; however the social, cultural and psychological factors translate this private experience into a public behavioural pain [25].

No studies available describes this difference regards knee pain specifically, but we do believe that this difference might exist. If we look at Middle Eastern communities, we might find that they might complain of AKP after IMN of the tibia more than others as these communities tend to kneel and sit on the floor at least five times per day during their prayers and this might relate to increased pain perception. Up to our knowledge no study investigates the difference of AKP perception between different cultures and communities.

It is also notable that main scoring systems like Kujala Knee Score does not include questions on kneeling and is considered as a limitation in that scoring system. Some questions in the Kujala Knee Score needs explanation, although it is intended to be completed without instructions, specially questions about muscle atrophy and knee flexion deficiency, but we noticed this problem with other systems using the same medical terms and once explained the patients can answer [26].
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Conclusion

This systematic review showed no significant difference in AKP using the SPN in comparison to the IPN for acute tibial fractures. The number of papers included and the number of patients in the studies were not enough to show a statistically significant difference. Further clinical trials and studies are required.

Conflict of Interest

The authors declare that they have no conflict of interest.

Funding

There is no funding source.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Bibliography

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Volume 11 Issue 4 April 2020
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