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Original Research Article

Comparative analysis of landmark-guided intra-articular knee injections in outpatient clinics versus ultrasound-guided injections: a quality improvement study

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ABSTRACT

Background: Osteoarthritis (OA) of the knee is a prevalent cause of chronic pain and reduced mobility. Intra-articular steroid injections are a key management option when oral analgesics fail to improve symptoms and surgery is not imminent. These injections can be performed using ultrasound guidance or anatomical landmark techniques ("blind") depending on clinician expertise and hospital setting. However, referring patients for ultrasound (US) -guided procedures may increase waiting times and costs imposing a significant burden on hospital resources.
Methods: A closed-loop audit at a London district general hospital evaluated the clinical and economic impact of US-guided versus landmark-guided intra-articular knee injections for osteoarthritis in an outpatient orthopaedic setting. The first (retrospective) cycle covered January–December 2023, and the second (prospective) cycle May–December 2024. Data from electronic health records, Picture Archiving and Communication Systems (PACS), and National Health Service (NHS) cost databases were analysed for waiting times (weeks) and procedural costs (£).
Results: In 2023, 391 US-guided injections had an average waiting time of 16.2 weeks and cost ~£700 each, while 182 landmark-guided clinic injections averaged 15 weeks and cost ~£600. In 2024, 346 US-guided and 234 landmark-guided injections were performed, reducing US waiting times to nine weeks. A revised costing model achieved annual savings of ~£96,000. Increased clinic-based procedures reduced US demand, with no reported adverse events.
Conclusion: Clinic-based, landmark-guided knee injections provide a safe, cost-effective and efficient alternative to US-guided procedures, significantly reducing waiting times, and preserving radiology resources while improving care delivery without compromising patient outcomes.

Keywords: Osteoarthritis, Knee injections, Ultrasound-guided, Landmark-guided, Cost-effectiveness

INTRODUCTION

Osteoarthritis (OA) of the knee is a common degenerative joint condition that significantly impairs mobility and quality of life. A significant proportion of patients with OA do not achieve adequate pain relief with analgesics often due to contraindications, intolerance, or insufficient response to nonsteroidal anti-inflammatory drugs (NSAIDs).[1] In such scenarios, major clinical guidelines including the National Institute for Health and Care Excellence (NICE) framework typically recommend intra-articular therapies as a second-line treatment within the spectrum of conservative management.[2] Intra-articular corticosteroid injections are commonly used to provide short- to medium-term symptom relief in osteoarthritis, allowing increased bioavailability and therapeutic

effectiveness while reducing systemic exposure and side effects, particularly when analgesics are unhelpful and surgery is not yet indicated.[3] Traditionally, knee injections have been performed without imaging using only physical examination and anatomical landmarks for guidance.[4] In contrast, several systematic reviews have shown that ultrasound-guided injections are more accurate than landmark-guided or "blind" injections although there is limited literature and studies evaluating the efficacy and cost-effectiveness of both techniques.[5] It is still unclear whether the increased accuracy of ultrasound-guided injections leads to better outcomes for patients.[6] However, routine use of ultrasound can contribute to increased waiting times, higher procedural costs, and greater demand on radiology services often outpacing service capacity.[7] The NHS Constitution outlines clear expectations for timely access to care: at least 92% of patients referred from primary to secondary care (referral-to-treatment or RTT) begin treatment within 18 weeks and no patient should wait longer than 52 weeks from time of referral.[8] In a novel, transformative model for all new, non-emergency knee referrals called "The Mass Knee Clinic", patients that required additional imaging were given 3 weeks to attend outpatient radiology appointments to minimise disruption on the pathway and improve efficiency.[9] Nevertheless, long waiting times for musculoskeletal (MSK) imaging have been documented with typical waits of 3-4 months due to rising demand outpacing service capacity.[10]

The aim of this study was to evaluate whether performing knee injections in outpatient clinics provides a safe, efficient and cost-effective alternative to ultrasound-guided injections for patients with knee OA by reducing the burden on radiology services and shortening overall waiting times. Prior to the second audit cycle, we re-emphasised on the use of clinic-based knee injections to assess their feasibility and safety. As part of this evaluation, we compared waiting times and procedural costs between ultrasound and clinic-based knee injections.

METHODS

Study design

This was a closed-loop audit, both retrospective (1st cycle) and prospective (2nd cycle), conducted at a District General Hospital in London. The key stakeholders included subspecialty orthopaedic surgeons, trainees, outpatient clinic healthcare professionals, outpatient radiology department and patients. The study aimed to evaluate operational outcomes of intra-articular knee injections performed under ultrasound guidance versus landmark-guided techniques in an outpatient clinic setting.

Time frames

Cycle 1 included retrospective data from 01 January 2023 to 31 December 2023.

A follow-up 2nd cycle covered the period from 01 May 2024 to 31 December 2024.

Inclusion criteria

Patients aged 18 years or older with a diagnosis of OA of the knee were included if they were assessed in an orthopaedic outpatient clinic and deemed appropriate for an intra-articular corticosteroid injection.

Exclusion criteria

Patients were excluded if they had contraindications such as prosthetic knee joints, acute fractures, or severe joint destruction. Additionally, patients with presence of local skin breakdown or systemic infection, hypersensitivity to the injected agent, coagulopathy, or cancelled or deleted appointments were excluded (Table 1).

Table 1: Patient exclusion criteria (2023-2024).

Exclusion criteria	2023 (n=316)	2024 (n=132)	Total =448
Prosthetic knee joint in situ	19	8	27
Acute peri-articular fracture	6	3	9
Severe joint destruction	25	11	36
Local skin breakdown over knee	9	4	13
Systemic infection (e.g. sepsis)	3	1	4
Hypersensitivity to injection	6	3	9
Coagulopathy/ high-INR	9	4	13
No show	239	98	337

Data collection

Radiology data were extracted from the picture archiving and communication system (PACS) and included anonymised medical record numbers (MRNs), as well as injection request dates, appointment dates, and procedure status. Outpatient clinic data were obtained from the iCare and AdHoc systems using documentation tagged as "F2F – procedure performed – knee – injection into joint."

Costing data were calculated using the NHS Agenda for Change Pay Scheme (2023–2025) and Healthcare Resource Group (HRG) coding for both image-guided and non-image-guided procedures. HRG coding terms analysed included: 'injection of therapeutic substance into joint under image control for pain management', 'injection of therapeutic substance into joint for pain management without imaging', 'non-consultant-led trauma and

orthopaedic service - first attendance', and 'non-consultant-led trauma and orthopaedic service -follow-up attendance'.

Metrics evaluated

The primary metrics evaluated included: waiting time: defined as the duration from injection request to the appointment date, cost per procedure: based on national tariffs and HRG codes, and total number of injections performed under each method.

Procedural success was assessed by completion of the injection without immediate complications. Functional outcomes were not formally assessed during quality improvement study.

RESULTS

Study population and demographics

A total of 1,153 patients underwent intra-articular knee injections using either landmark-guided or ultrasound (US)-guided techniques across two audit cycles conducted in 2023 and 2024. The cohort included 721 females (62.5%) and 432 males (37.5%), with a mean age of 55.2±5.6 years (range 47–76 years). Detailed demographic characteristics of the study population are presented in Table 2.

Table 2: Demographic characteristics of the study population (n=1153).

Demographics	Frequency	Percentage
Gender		
Female	721	62.5
Male	432	37.5
Age (years)		
≤55	456	39.5
56-64	502	43.5
≥65	195	16.9

Clinical setting and waiting times

The total number of knee injection procedures performed in outpatient orthopaedic clinics and the ultrasound department during 2023 and 2024, along with corresponding waiting times are summarised in Table 3. Waiting time was defined as the interval (in weeks) from date of referral to date of procedure.

Table 3: Summary of knee injection procedures, appointment attendance, and waiting times by technique (2023-2024).

Cycle	Knee injection technique	Total requests	Completed procedures	Missed appointments	First appointments in clinic	Follow-up appointments in clinic	Average waiting time (first outpatient appointment) (weeks)
2023 (01 January 2023 – 31 December 2023	Ultrasound-guided	698	391	307			16.2
	Clinic-based	191	182	9	94	88	15
2024 (01 January 2024 – 31 December 2024)	Ultrasound-guided	471	346	125			9
	Clinic-based	241	234	7	49	185	16

Information on waiting time provided is updated each week. Patients are managed based on clinical urgency such as severity of pain or functional impairment, rate of symptom progression, failure of conservative management, risk of joint deterioration or complications and surgical waiting list status. The information above relates to all patients on an elective waiting list. Figure 1 illustrates the average waiting time (weeks) by year and technique for knee injection procedures, measured from the date of referral to the date of the procedure.

Cost analysis

Standard cost per procedure for US-guided injections: £724, standard cost per procedure without imaging guidance: £606, cost of first attendance at outpatient orthopaedic clinic (20 min): £160, and cost of follow-up attendance at outpatient orthopaedic clinic (10 min): £92.

In our analysis (Table 4), based on input from our orthopaedic surgeons and musculoskeletal radiologists, we explored an alternative approach to cost savings by considering clinic attendance costs and consumable expenses separately. A first outpatient clinic visit lasting 20 minutes incurs a cost of £160 and a follow-up visit of 10 minutes costs £92.

Assuming the entire procedure—including patient counselling, consent and preparation with consumables—requires approximately 30 minutes, the total cost incurred per case is estimated to be under £200. We compiled a standard list of consumables required for the procedure including sterile gauze, chlorhexidine solution, surgical drapes, needles, syringes, local anaesthetic, and bandages. This collectively amounted to £20-30 per procedure demonstrating an overall cost saving of approximately £500 per case.

Table 4: Cost analysis of knee injection procedures (2023 versus 2024).

Cost category	2023 (£)	2024 (£)
Consumables (per procedure)	£40	£40
Projected cost per clinic procedure	£200	£200
Annual costs		
Ultrasound-guided knee injections	£250,504	£283,084
Clinic-based injections	£110,292	£141,804
Clinic-based (alternative approach)	£36,400	£46,800
Overall cost savings	£95,004	

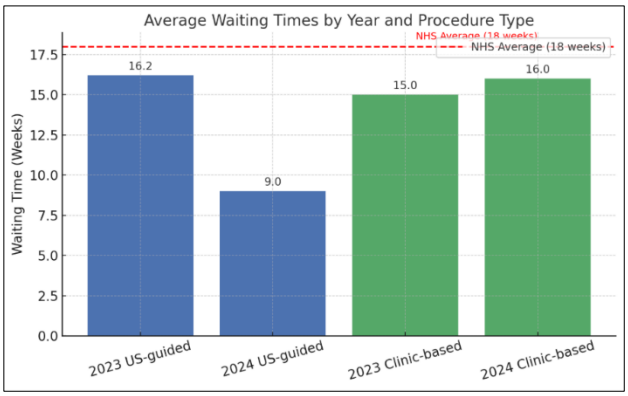

Figure 1: Trends in average waiting times for knee injections by year and procedure type (2023-2024).

DISCUSSION

There have been numerous studies on whether ultrasound-guided knee injections are more effective than landmark-guided injections.[11] While some have studied the accuracy of needle placement and clinical outcomes in patients, limited research exists on cost-effectiveness and ultrasound waiting times.[12]

A randomised double-blind controlled study of US-guided corticosteroid injections in to joints with inflammatory arthritis conducted by Cunnington et al found no significant difference in clinical outcomes between the group receiving US-guided injections and the group receiving injections based on clinical examination (CE). In this study, clinicians who used US guidance reliably assessed the accuracy of joint injection ($p<0.001$), whereas those who used CE guidance did not ($p=0.29$). Furthermore, US-guidance did not improve short-term outcome of joint injections.[13] In contrast, Jackson et al demonstrated palpation-guided injections were 71-93% accurate depending on anatomical approach.[14] Imaging should be reserved for cases unresponsive to landmark-based injections except in cases demanding imaging for accuracy. Long-term benefits of imaging guidance have not been adequately studied to justify its impact on healthcare services.[15]

Wilmer Jr et al conducted a randomized controlled trial of intra-articular corticosteroid injections with conventional anatomical guidance (n=46) performed by experienced proceduralists or ultrasound guidance (n=46) performed by fellows, ultrasound guidance yielded no difference long-term outcomes such as reduction of knee pain at 6 months (6.3±2.9, 6.3±2.6; p=1.0). Additionally, there was no difference in the mean cost per year for hospital outpatients between both groups (8% ($7, ~£5.22) p=0.14).[16]

According to the latest diagnostic waiting times and activity report from NHS England, the six-week threshold, a significant benchmark reflecting the number of patients waiting six or more weeks for an investigation from the time of referral, highlights significant delays in non-obstetric ultrasound with the largest waiting list accounting for 34.9% of the total (562,900 patients), and with the highest activity with 742,500 tests (30.4% of all diagnostic activity) in November 2024.[17] This threshold initially introduced in 2008 as part of the broader referral to treatment (RTT) target within the NHS Constitution, ensures legal rights to treatment within 18 weeks of referral.[18] Despite the NHS operational standard that no more than 1% of patients should wait six weeks or more from referral for any key diagnostic test, this target has not been achieved since November 2013. These persistent shortfalls highlight ongoing pressures on NHS diagnostic services and the urgent need for improvements in capacity and resource allocation to reduce waiting times and enhance patient care.

Following our study, in our first cycle, we found that the average waiting time for ultrasound examinations was 3.7 months (n=391), while the average waiting time for patients to be seen in the orthopaedic clinic was approximately 15 weeks (n=182). Although the cohort sizes were not equal, efforts made to emphasize the cost-effectiveness of alternative strategies, with the aim of reducing demand on ultrasound, the number of in-clinic knee injections we performed increased during the second cycle to 234, with the average clinic waiting time remaining at 15 weeks. Most notably, the ultrasound waiting time decreased significantly to nine weeks, suggesting a positive impact of the implemented changes. Hence, by diverting suitable cases to outpatient clinics, radiology resources were preserved, leading to a reduction in USG injection waiting times therefor ensuring shorter time to treatment and improved access.

For the financial year of 2024-2025, NHS England forecasted a £787 million deficit, an improvement from £1316 million in the previous year. However, the system is projected to face a deficit of £6.6 billion in 2025/26.[19] Williamson et al demonstrated this effectively in their review of carpal tunnel decompression surgery within a district general hospital.[20] By systematically breaking down the procedure, assessing consumables and adopting evidence-based alternatives such as using local anaesthetic with epinephrine (WALANT technique) to avoid

tourniquet use, switching to smaller drapes for field sterility and revising instrument sterilisation, they reduced procedural costs by 63%, saving over £15,000 annually. These changes are safe, sustainable and appear to be transferrable to other minor procedures.

In our analysis, the standard cost per US-guided injection was £724 whereas performing knee injections without imaging guidance cost £606 per procedure, yielding significant cost savings of £118 per procedure. On an annual basis, the total expenditure for US-guided knee injections was £283,084 compared to £272,918 for clinic-based injections, resulting in a yearly reduction of £10,166. Our alternative approach estimated an annual cost saving of approximately £95,000 between both techniques. Our findings indicate that cost optimization is imperative in healthcare systems with limited resources, where greater procedural efficiency with clinic-based knee injections can improve patient access while maintaining quality of care.

A randomized study of 40 patients with greater trochanteric pain syndrome found that landmark-guided corticosteroid injections provide similar pain relief at 2 weeks (US: 1.3±1.9 cm; landmark: 2.2±2.5 cm, p=0.14) and comparable therapeutic duration (US 4.7±1.4 months; landmark 4.1±2.9 months, p=0.48), and time-to-next intervention (US 8.7±2.9 months; landmark 8.3±3.8 months, p=0.62) compared to ultrasound guidance.[21] Landmark-guided injections were 43% more cost-effective annually (US $297±99, landmark $207±95; p=0.017). It was concluded that landmark-guided injections remain the preferred, cost-efficient approach, with ultrasound reserved for complex cases.

Patient safety remains a key consideration when implementing less resource-intensive procedures. In this study, no adverse events were reported following landmark-guided injections in clinic, supporting the safety of the technique when performed by appropriately trained clinicians under sterile conditions. This is consistent with the findings of Kokubun et al's study that demonstrated low complication rates for landmark-guided injections with aseptic techniques and anatomical accuracy (~14% ≤3 injections, ~17% ≥4 injections in 390 patients).

To ensure safety and efficacy, our recommendations include strict adherence to sterile technique and accurate use of anatomical landmarks. Where appropriate, patients should be discharged to physiotherapy with a patient-initiated follow-up (PIFU) plan to support ongoing management and reduce unnecessary appointments. Structured documentation templates should be developed within iCare or AdHoc to standardise practice and improve record-keeping.

Refresher training should be provided on anatomical injection techniques and aseptic practice to maintain clinical competency. Healthcare professionals involved in ultrasound-guided injections possess diverse skill sets and knowledge gaps. While physiotherapists, podiatrists, and orthopaedic surgeons are proficient in clinical examination, blind injection techniques, pharmacology, and consent, they often lack expertise in ultrasound physics, imaging techniques and interpretation. Conversely, owing to the limited availability of MSK radiologists, other sonographers proficient in ultrasound imaging, anatomy, pathology, and reporting may have limited experience with drug administration and consenting. In light of this, tailored training programs and guidelines may be necessary to aid US-guided injection services.

In view of the NHS consistently operating at a significant loss while struggling to maintain financial balance amidst a growing ageing population, hospitals and healthcare professionals must identify ways to maintain quality of care. From an economic standpoint, cost analysis in clinical practice can reveal substantial opportunities for savings without compromising patient safety or satisfaction.

Limitations

Despite its findings, this study has several limitations. It was conducted at a single district general hospital in London, which may limit the generalisability of results to other healthcare settings. Furthermore, the allocation of patients to injection type was not randomised, with more complex or technically challenging cases likely referred for US-guided injections introducing a potential selection bias. Variations in patient characteristics or clinical decision-making could have influenced outcomes independently of the technique used. In the retrospective first cycle of data collection, some documentation inconsistencies were noted within the iCare system, which may have affected data accuracy.

Lastly, while studies have focused on clinical outcomes such as pain reduction and functional improvement, our study emphasizes on cost-effectiveness and waiting times—an area that remains underexplored in existing literature. Future prospective studies should aim to integrate these factors to better understand impact on healthcare services.

CONCLUSION

This QIP demonstrates that landmark-guided intra-articular knee injections, when performed in orthopaedic outpatient clinics, are a safe, efficient, and cost-saving alternative to radiology-based ultrasound-guided procedures. This approach reduces waiting times, preserves imaging resources while maintaining high standards of patient care.

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