Ther Adv Musculoskelet Dis

2023, Vol. 15: 1–6

DOI: 10.1177/1759720X221149954

A novel infrapatellar approach of ultrasound-guided intra-articular injection of the knee from both lateral and medial side: a case series

King Hei Stanley Lam, Yung-Tsan Wu, Kenneth Dean Reeves, Admir Hadzic, Mario Fajardo Perez and Sau Nga Fu

***Abstract*:** Knee osteoarthritis (OA) is common. Ultrasound-guided intra-articular injection (UGIAI) using the superolateral approach is currently the gold standard for treating knee OA, but it is not 100% accurate, especially in patients with no knee effusion. Herein, we present a case series of chronic knee OA treated with a novel infrapatellar approach to UGIAI. Five patients with chronic grade 2–3 knee OA, who had failed on conservative treatments and had no effusion but presented with osteochondral lesions over the femoral condyle, were treated with UGIAI with different injectates using the novel infrapatellar approach. The first patient was initially treated using the traditional superolateral approach, but the injectate was not delivered intra-articularly and became trapped in the pre-femoral fat pad. The trapped injectate was aspirated in the same session due to interference with knee extension, and the injection was repeated using the novel infrapatellar approach. All patients who received the UGIAI using the infrapatellar approach had the injectates successfully delivered intra-articularly, as confirmed with dynamic ultrasound scanning. Their Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain, stiffness, and function scores significantly improved 1 and 4 weeks post-injection. UGIAI of the knee using a novel infrapatellar approach is readily learned and may improve accuracy of UGIAI, even for patients with no effusion.

Keywords: hyaluronic acid, hypertonic glucose, knee osteoarthrosis case series, platelet-rich plasma, ultrasound-guided intra-articular injection

Received: 5 August 2022; revised manuscript accepted: 21 December 2022.

Correspondence to:
King Hei Stanley Lam
The Hong Kong Institute of Musculoskeletal Medicine, Unit 305 Telford House, 16 Wang Hoi Road, Kowloon Bay, Kowloon, Hong Kong.
drlamkh@gmail.com

Department of Family Medicine, The Chinese University of Hong Kong, Shatin, Hong Kong

Department of Family Medicine, The University of Hong Kong, Pokfulam, Hong Kong

Center for Regional Anesthesia and Pain Medicine, Wan Fang Hospital, Taipei Medical University, Taipei, Taiwan

Center for Regional Anesthesia and Pain Medicine, Chung Shan Medical University Hospital, Taichung, Taiwan

Yung-Tsan Wu
Department of Physical Medicine and Rehabilitation, Tri-Service General Hospital, School of Medicine, National Defense Medical Center, Taipei, Taiwan

Integrated Pain Management Center, Tri-Service General Hospital, School of Medicine, National Defense Medical Center, Taipei, Taiwan

Department of Research and Development, School of Medicine, National Defense Medical Center, Taipei, Taiwan

Introduction

Knee osteoarthritis (OA) has become increasingly widespread. Intra-articular injection is commonly the first-line treatment for patients with osteoarthrosis who failed to respond to conservative treatments and lifestyle modifications. Intra-articular injection of hypertonic glucose,[1] hyaluronic acid (HA), and platelet-rich plasma (PRP) are treatment options to relieve knee OA pain.[2] The most essential point for intra-articular injection is the accurate placement of the needle tip into the joint space to attain the ideal clinical outcomes and prevent local complications.[3] Landmark-guided intra-articular injections (LMGIAI) have been performed in daily practice for decades; however, the accuracy rate of LMGIAI has been proven to be poor, especially in 'dry' knees without effusion.[3,4] Ultrasound-guided intra-articular injection (UGIAI) has been shown to improve the accuracy of intra-articular needle placement, and the superolateral approach is the most accurate approach to date.[5–8] However, it still does not yield 100% accuracy.[3] In addition to wasting expensive injectates, extra-articular injections in the pre-femoral or suprapatellar fat pad or inside the peritenon of the quadriceps[5] may lead to persistent swelling of the joint, pain, audible clicking, or an

Kenneth Dean Reeves
Private Practice PM&R and Pain Management, Roeland Park, KS, USA

Admir Hadzic
NYSORA Education, New York, NY, USA

Mario Fajardo Perez
Ultradissection Group, Madrid, Spain

MOMARC, Madrid, Spain

Vithas Hospital, Madrid, Spain

Sau Nga Fu
Department of Family Medicine, The Chinese University of Hong Kong, Shatin, Hong Kong

Department of Family Medicine, The University of Hong Kong, Pokfulam, Hong Kong

Table 1. Demographic details for the five patients in this case series.

Patients	1 G	2 P	3 P	4 H	5 H
Age (years)	48	49	59	60	52
Sex	Male	Male	Female	Female	Male
Preintervention ambulatory status/ antalgic gait (A)+	Walk unaided/ A+	Walk unaided/ A+	Walk unaided/ A+	Walk unaided/ A+	Walk unaided/ A+
Knee OA grading	Grade 2	Grade 2	Grade 3	Grade 3	Grade 2
Knee side	Left	Right	Right	Right	Left
Pain duration (years)	2	3	4	4	3
Patient's choices of injectates	Hypertonic glucose	PRP	PRP	HA	HA

HA, hyaluronic acid; OA, knee osteoarthritis; PRP, platelet-rich plasma.

Table 2. WOMAC scores of study patients.

Patients	Pain			Stiffness			Function			Total		
	0 week	1 week	4 weeks	0 week	1 week	4 weeks	0 week	1 week	4 weeks	0 week	1 week	4 weeks
1 G	12	8	6	3	2	1	17	10	8	32	20	15
2 P	12	7	5	3	1	1	17	8	6	32	16	12
3 P	13	8	7	3	2	1	20	12	8	36	22	16
4 H	11	6	6	3	1	2	20	10	10	34	17	18
5 H	12	6	6	4	2	1	18	10	8	34	18	15
Mean score	12	7	6	3.2	1.6	1.2	18.4	10	8	33.6	18.6	15.2

uncomfortable sensation of the knee joint with ambulation or movement.

Herein, we report a novel technique of UGIAI, either inferolateral toward the medial side of the trochlea of the femoral condyle or inferomedial toward the lateral side of the trochlea. With this technique, the trajectory of the needle may pass through Hoffa's fat pad (HFP) and the synovial membrane, and hydrodissection is carried out until the needle tip is positioned adjacent to the medial or lateral side of the trochlea of the femoral condyle, respectively. At this point, the injection is performed directly against the femoral condylar trochlear cartilage or against the bone in patients with osteochondral lesions, which are common in patients with knee OA.

Patient information

This case series is reported according to the Equator network case report guidelines (CARE: https://www.equator-network.org/). It includes five patients with grade 2–3 knee OA according to the Kellgren–Lawrence classification. All patients complained of mechanical pain on walking, especially when ascending or descending stairs. The pre-procedure characteristics of the patients are summarized in Table 1. WOMAC scores of the patients are shown in Table 2.

Clinical findings

Musculoskeletal examination revealed increased friction between the patella and the femur in all patients, and the patellar grinding test was positive. Other knee-specific tests were unremarkable, including active and passive range of motion, varus and valgus stress, McMurray, and Lachman tests.

Timeline

All patients had chronic knee pain due to osteoarthrosis with duration of pain ranging from 2 to 4 years (as shown in Table 1). All patients failed on conservative treatments. The conditions of the patients were assessed on the day of intervention, and 1 and 4 weeks after the intervention, respectively (as shown in Table 2).

Diagnostic assessment

Diagnostic X-rays showed the Kellgren and Lawrence gradings of the corresponding knees (Table 1). Musculoskeletal ultrasound scanning of all five patients showed no effusion and one or more osteochondral lesions, either with patches of complete cartilage loss or osteophytes involving the femoral condyles. We excluded patients with knee effusion from our case series because using the traditional suprapatellar approach for such patients would usually be straightforward.

Therapeutic intervention

Written consent for treatment was routinely obtained from each patient. One patient opted for UGIAI of hypertonic glucose, two selected UGIAI of PRP, and two preferred UGIAI of HA. The first patient was initially treated with the traditional superolateral approach for UGIAI; however, the injectate was found in the lateral compartment of the pre-femoral fat pad by post-injection dynamic scanning (Video 1). The knee extension range was restricted and uncomfortable, which was corrected by aspiration of the trapped fluid under ultrasound guidance. Intra-articular injection was performed during the same treatment session, using the novel inferolateral approach with different needle insertion and trajectory. A post-injection dynamic scan confirmed intra-articular injection (Video 2). The other four patients receiving UGIAI had no effusion and had osteochondral lesions.

This study was performed according to the Declaration of Helsinki principles.

https://www.dropbox.com/s/wqmjg-1vjj41iydq/Failed%20suprapatellar%20fossa%20injection.mp4?dl=0

Video 1 shows a failed ultrasound-guided intra-articular injection of 10 ml of injectate by the suprapatellar approach with the entire 10 ml of the injectate loculated in the lateral compartment of the pre-femoral fat pad.

https://www.dropbox.com/s/n1pe217p3p1bx1c/Post%20successful%20FC%20injection%20scan%20.mp4?dl=0

Video 2 demonstrates the subsequent successful intra-articular injection of 10 ml of injectate with the fluid evenly distributed in the joint, without excessive accumulation of fluid in any specific compartment of the joint.

Novel technique description

A high-resolution linear transducer was used with the patient in the supine position, and the knee extended. For the inferolateral approach, the operator sat on the ipsilateral side of the knee to be treated; with the inferomedial approach, the operator sat on the contralateral side. Our preferred ergonomics include placing the ultrasound monitor on the other side of the patient, facing the operator. With the trough of the femoral condyle pointing upward, the transducer was placed in the infrapatellar site transverse to the patellar tendon and tilted to visualize both femoral condyles (Figure 1). When using an inferolateral approach, needle entry was conducted through the lateral retinaculum with the needle directed toward the medial trochlea; when using the inferomedial approach, the needle entry is through the medial retinaculum with the lateral trochlea as the target. Continuous low volume hydrodissection during needle advancement[9] of normal saline is recommended to prevent soft tissue injury within HFP[10] while pushing aside any infra-fat pad vessels in the trajectory of the needle. Strict aseptic techniques were adopted for the entire procedure. The skin of the knee was disinfected with povidone-iodine (Betadine) and allowed to dry for 2 min, and the knee was properly draped

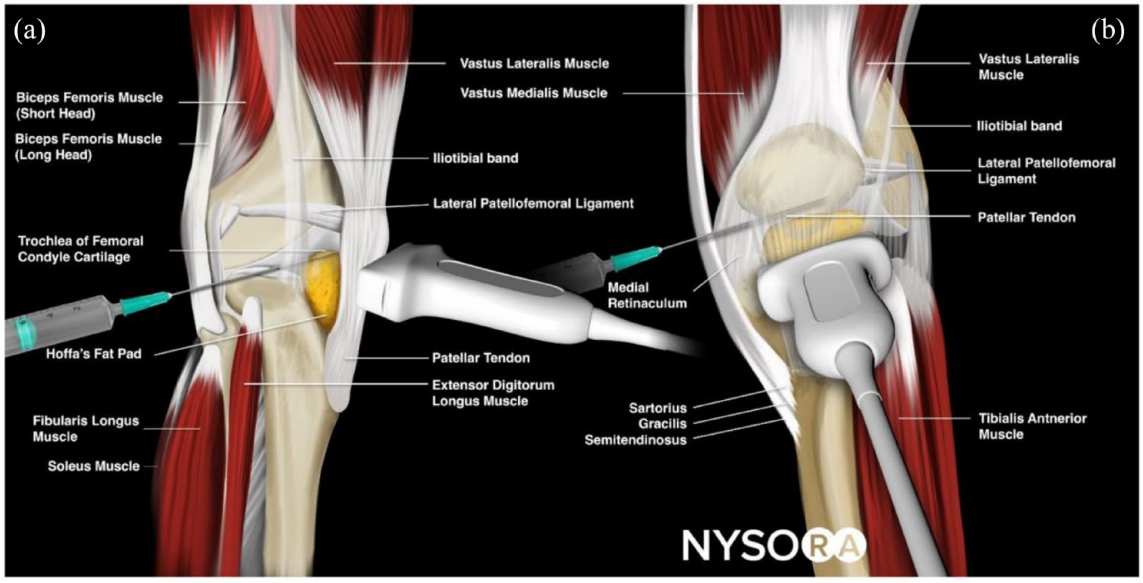

Figure 1. (a) Inferolateral approach. The needle entry point is at the lateral retinaculum, and the needle is directed toward the medial femoral condyle. (b) Inferomedial approach. The needle entry point is at the medial retinaculum, and the needle is directed toward the lateral femoral condyle.

with only the peripatellar areas of skin to be injected exposed. A sterile transducer cover with adhesive (Safersonic-US Inc Highland Park, IL, USA) was used to properly cover the transducer for sterility, and 0.5% chlorhexidine in 70% alcohol was used as the contact media for the procedure. A linear transducer (e.g. GE ML6-15-D General Electric, Boston, MA, USA) was used. After skin anesthesia, an in-plane approach was used to visualize needle advancement from skin entry through HFP and the synovial membrane of the articular capsule of the knee joint. Where available, a dual image (with Doppler) can be useful. As the needle tip approached the synovial membrane by hydrodissection, its bevel was turned facing down, and hydrodissection continued to the cartilage surface[9,11–13] or until the bony cortex of the femoral condyle was reached (in patients with bone exposure due to an osteochondral lesion). Power Doppler can be used to visualize the injectate and assure the absence of spread back to the HFP (Video 3). A dynamic ultrasound scan can then be used to confirm intra-articular injection success by repositioning the transducer over the suprapatellar fossa and compressing the infrapatellar fossa to visualize any fluid accumulation in the suprapatellar pouch. (Video 4). After using the approach described, post-injection dynamic scanning in these patients confirmed fluid accumulation in the suprapatellar pouch and ruled out injectate accumulation in extra-articular compartments (Video 2); the success rate was 100%.

https://www.dropbox.com/s/j2qvws1hbmek4ze/UGIAI%20infrapatellar%20approach%20with%20explanation.mp4?dl=0

Video 3 shows ultrasound-guided inferolateral approach with the needle targeting the osteochondral lesion of the medial femoral condyle.

https://www.dropbox.com/s/5u4q5ndx0eikcvh/During%20FC%20injection%20validation.mp4?dl=0

Video 4 shows dynamic scan with the transducer over the suprapatellar fossa and the needle injecting over the osteochondral lesion of the medial femoral condyle to assure spread of the injectate to the suprapatellar fossa.

Follow-ups and outcomes

The mean pre-treatment composite WOMAC score of 33.6 ± 1.7 improved (reduced) significantly by 44.6% and 63.1% by 1 and 4 weeks post-intervention to 18.6 ± 2.4 and 15.2 ± 2.2,

respectively in these patients. The WOMAC pain score improved from 12.0 ± 0.7 to 7.0 ± 1.0 (41.7%) and 6.0 ± 0.7 (50%); stiffness score reduced from 3.2 ± 0.4 to 1.6 ± 0.5 (50%) and 1.2 ± 0.4 (62.5%); and function score improved from 18.4 ± 1.5 to 10 ± 1.4 (45.7%) and 8 ± 1.4 (56.5%) by 1 and 4 weeks post-intervention, respectively. The procedures were well received and tolerated by all these five patients. There were no adverse events reported.

Discussion

This article describes a novel approach to ultrasound-guided needle placement in the intra-articular space by direct injection against the trochlea of the femoral condyle. Based on our literature search for ultrasound-guided infrapatellar injection methods, this is the first article describing this infrapatellar approach with the needle entry point from both the lateral and medial retinaculum and pointing toward the contralateral trochlea of the femoral condyles. This approach may be particularly useful for intra-articular injection in patients with existing osteochondral lesions, where the needle tip can be guided directly to the exposed bone on the femoral condyle for the injection (Video 3). Using this approach, successful intra-articular placement of injectate was demonstrated in all these five consecutive patients.

The color/power Doppler mode can be used to assess any vascular structure of the HFP and to visualize the flow of the injectate during UGIAI of the knee joint.

We recommend a 25G 2-inch hypodermic needle for injections of hypertonic glucose, steroids, or PRP. A larger, 22G 2.15-inch needle is better suited for injections of HA due to its larger molecular size.

The potential limitations of this novel technique are that the needle passes through the richly innervated HFP, and it points toward the trochlea of the femoral condyle, which may have residual hyaline cartilage. A bevel-down needle approach, hydrodissection to light contact with the condylar cartilage or denuded joint surface, and the hydraulic effect during injection pushing the needle away from firm tissue or bony surface should avoid any significant cartilage irritation[9] or debridement-type effect. Another potential limitation or bias was that the effects observed in these patients could be due to placebo effects. It is unlikely that the benefits from injection of UGIAI that we observed was due to systemic effects of the injections or injectates, given that the post-injection scanning confirmed intra-articular injection with no visible extra-articular component.

This case series describes a novel infrapatellar approach to UGIAI of the knee joint, an approach found to be especially suitable in patients with existing osteochondral lesions over the femoral condyle, and may be a preferred approach in patients with no effusion. However, larger case series are required to confirm the accuracy and efficacy of this novel approach further.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. A formal letter of exemption allowing retrospective chart review was obtained from the International Cellular Medicine Society Institutional Review Board (ICMS-IRB).

Consent for publication

Written informed consent for publication of anonymized case details and any accompanying images were provided by the patients.

Author contributions

King Hei Stanley Lam: Conceptualization; Data curation; Methodology; Project administration; Supervision; Visualization; Writing – original draft; Writing – review & editing.

Yung-Tsan WU: Methodology; Project administration; Writing – review & editing.

Kenneth Dean Reeves: Data curation; Formal analysis; Methodology; Supervision; Writing – review & editing.

Admir Hadzic: Conceptualization; Supervision; Writing – review & editing.

Mario Fajardo Perez: Visualization.

Sau Nga Fu: Writing – review & editing.

Acknowledgements

The authors would like to thank Mr Ismar from NYSORA for drawing Figure 1.

Funding
The authors received no financial support for the research, authorship, and/or publication of this article.

Competing interests
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Availability of data and materials
The data used to support the findings of this study are included in the article.

ORCID iD
King Hei Stanley Lam https://orcid.org/0000-0003-1392-829X

Supplemental material
Supplemental material for this article is available online.

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