

# Accuracy of ultrasound guided versus blind knee intra-articular injection for knee osteoarthritis prolotherapy

## Abstract

**Introduction:** Knee osteoarthritis (OA) is one of the most common joint disabling diseases among adult patients. Ultrasound has been recommended for intra-articular injection, however its accuracy only been compared to blind approach in expert and inexperienced clinicians.

**Objective:** To compare the accuracy of intra-articular injection under ultrasound guide versus blind injection by expert and inexperienced clinician.

**Setting:** Outpatient; adults with mild-to-severe knee OA.

**Participants:** Adults with at least 3 months of symptomatic KOA, recruited from clinical and community settings, participated in the study.

**Methods:** Total of 220 patients with knee osteoarthritis were enrolled from which 100 patients were injected under ultrasound guided and 123 patients injected blindly by supralateral approach. Then patients were divided into two groups, group A was injected by an expert pain physician and group B with an inexperienced physician. The accuracy was determined using fluoroscopy at the same time of injection.

**Results:** In group A (expert), failed intra-articular injection was confirmed by fluoroscopy in 2% from 50 patient in ultrasound guided injection and 4.26% from 47 patients in blind injection but no significant difference between blind and ultrasound injection when it was performed by highly expert clinician ( $p=0.61$ ). In group B (inexpert), failure in intra-articular injection was confirmed by fluoroscopy in 6% from 50 patient in ultrasound guided injections and 16 (21%) from 76 patients in blind injections; and there was significant difference between blind and ultrasound guided injection when it was performed by inexperienced clinician ( $p=0.02$ ).

**Conclusion:** Ultrasound improves accuracy of knee intra-articular injection independent of clinician level of expertise. Blind approaches compose a high failure rate particularly when performed by inexperienced clinicians.

**Keywords:** ultrasound, osteoarthritis, knee, intra-articular

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## Introduction

Knee osteoarthritis (OA) is one of the most common joint disabling diseases among adult patients. Symptomatic knee OA occurs in 10% men and 13% in women aged 60 years or older but is likely to increase due to the aging of the population and the obesity epidemic.<sup>1</sup> Osteoarthritis (OA) is characterized by progressive loss of articular cartilage, subchondral bone sclerosis, osteophyte formation, changes in the synovial membrane, and an increased volume of synovial fluid with reduced viscosity.<sup>2</sup> It is a complex disease with unknown etiology but evidence is growing for the role of systemic factors (such as genetics, dietary intake, estrogen use, and bone density) and of local biomechanical factors (such as muscle weakness, obesity, and joint laxity).<sup>3</sup> Current mainstay of minimally invasive therapy is prolotherapy by intra-articular injections. Prolotherapy with dextrose and with prolozone resulted in the same pain relief or functional improvement in patients with mild to moderate knee OA.<sup>4</sup> A randomized controlled trial (RCT) reported significant improvement in knee OA pain scores when treated with prolotherapy.<sup>5</sup> Prolotherapy results in progressive improvement of knee pain, function and stiffness in long-term follow-ups.<sup>6</sup> Blind intra-articular injection is still the choice of injections

for many clinicians with acceptable success rate.<sup>7</sup> However, it could result in extra-articular approach in some patients. Besides, accidental collision of the needle tip with the superolateral pole of the patella during attempted aspiration or injection of the knee joint could lead to pain, as well as damage to the chondral cartilage of the patella.<sup>8</sup> Although, ultrasound has been recommended for intra-articular injection, however its accuracy only been tested on cadaver.

## Objective

To compare the accuracy of intra-articular injection under ultrasound guide versus blind injection by expert and inexperienced clinician.

## Methods

### Ethics declaration

The study was reviewed and approved by the university Ethics Committee and been performed in accordance with the ethical standards. Information about the study was given comprehensively both orally and in written form to all patients or their accompanying

adult. They gave their informed written consents prior to their inclusion in the study.

## Patient selection

Total of 220 patients with knee osteoarthritis were enrolled from which 100 patients were in injected under ultrasound guided and 123 patients injected blindly by supralateral approach. Then patients were divided into two groups, group A was injected by an expert pain physician and group B with an inexperienced physician. Patients were recruited from pain clinic of our hospital. They were randomly assigned to be injected under ultrasound guided or not (blind injection). Physical examination was conducted by the lead physician (DR) and radiology was performed by the same radiologist. Inclusion criteria were Patient with osteoarthritis diagnosis based on ACR definition (age>50 years, crepitating or morning stiffness less than 35 minutes and radiologic findings), and having symptoms more than 3 month. Exclusion criteria were diabetes, other causes of arthritis such as gout or rheumatoid arthritis, history of surgery or fracture in the knee, history of prolotherapy in past year, or injection of corticosteroid or hyaluronic acid, contraindication to injection including thrombocytopenia, or bleeding diathesis, severe effusion of knee, and infection of local skin.

## Hyaluronic acid

Hyaluronic acid was injected into the knee intra-articular joint. It is a mixture Glucuronic acid and N-acetyl-glucosamin with a molecular weight of 500-750 KD. It provides visco elasticity of articular fluid and also triggers endogenous hyaluronic production.

## Supralateral blind approach

This technique was performed with the patient supine and the knee extended. This technique aims for the suprapatellar pouch, and allows the needle to pass underneath the articular surface of the patella.

## Ultrasound guided injection

In ultrasound group, all intra-articular injections were performed under ultrasound guide. Ultrasound approach was performed via transverse image and out-of-plane to the knee.

## Fluoroscopy

The accuracy of success or failed intra-articular injection was confirmed by fluoroscopy. After needle insertion, 1 ml of contrast media was injected and then after fluoroscopy and if place of needle was confirmed then hyaluronic acid (4ml) was also used to inject. Patients underwent fluoroscopy at the same time of injection.

## Results

Total of 220 patients with knee osteoarthritis were enrolled from which 100 patients were in injected under ultrasound guided and 123 patients injected blindly by supralateral approach. Age, sex and BMI of patients were not significantly different between two groups of study (Table 1). Grade of osteoarthritis was not also significantly different between two groups of study.

## Expert vs. inexperienced physician

Patients were divided into two groups, group A, who were injected by an expert pain physician and group B injected by an inexperienced physician. In group A, from 97 patients, 50 patients (51.5%) were injected under ultrasound guide and 47 (48.5%) had blind injection. 29 patients were male, and 68 (70%) were female. Sixty one patients

had OA grade 2 and 36 (37%) had grade 3 OA. Mean age was 63.2±7.48 years old.

**Table 1** Demographic variables of patients in ultrasound and blind group

	Ultrasound (100)	Blind (123)	p-Value
Age	64.46±7.16	63.68±7.54	0.13
Sex (male/female)	27/73	33/90	0.55
BMI	26.67±3.06	26.88±2.64	0.58
Grade of Osteoarthritis			
Grade 2	46	58	0.48
Grade 3	54	65	
Symptom duration	6.03±2.44	6.51±3.19	0.2

## Group A (highly expert)

In group A, 50 patients had ultrasound guided injections, 14 male and 36 female, 28 had grade 2 and 22 had grade 3 OA. Duration of symptoms was 6.4±2.23 and BMI was 27.3±3.38. In group A, 47 patients had blind injection by an expert, 15 were male (31.9%) and 32 were female (68.1%), 33 patients (70.3%) had grade 2 and 14 patients (29.7%) had grade 3 OA. There were no significant differences in age, symptom duration, and BMI of patients who were injected by highly expert clinician (group A) using ultrasound or blind approach (Table 2). There were no significant differences in sex and grade of OA of patients who were injected by highly expert clinician (group A) using ultrasound or blind approach (Table 2). In group A, failed intra-articular injection was confirmed by fluoroscopy in 1 (2%) from 50 patient in ultrasound guided injection and 2 (4.26%) from 47 patients in blind injection; and there was no significant difference between blind and ultrasound injection when it was performed by highly expert clinician (p=0.61). All three failed cases were female and grade 2 which were not significantly different between two groups.

**Table 2** Age, symptom duration, BMI, and grade of OA of patients who were injected by highly expert clinicians (group A) using ultrasound or blind approach

Variables	Ultrasound (50)	Blind (47)	p-Value
Age	65.5±7.25	63.6±7.6	0.2
Symptom duration	6.04±2.33	6.85±3.92	0.22
BMI	27.48±3.38	27.31±2.55	0.78
Grade 2 (male/female)	18-Oct	21-Dec	0.2
Grade 3 (male/female)	18-Apr	11-Mar	0.12

**Table 3** Age, symptom duration, BMI, and grade of OA of patients who were injected by inexperienced clinicians (group B) using ultrasound or blind approach

Variables	Ultrasound (50)	Blind (76)	p-Value
Age	63.36±6.94	63.72±7.52	0.78
Symptom Duration	6.02±2.58	6.30±2.65	0.56
BMI	25.86±2.50	26.62±2.65	0.11
Grade 2 (Male/Female)	12-Jun	18-Jul	0.18
Grade 3 (Male/Female)	25-Jul	Nov-40	0.15

## Group B (inexpert)

In group B who were injected by inexperienced clinician, 126 patients were enrolled with mean age of 63.58±7.27 years old, BMI of 26.32±2.62, mean symptom duration of 6.19±2.62. From 126 patients, 31 (24.6%) were male and 95 (75.4%) were female, and 43 (34.1%) were grade 2 and 83 (65.9%) were grade 3 OA. In this group 50 patients were injected under ultrasound guide and 76 were injected blindly. There were no significant differences in age, symptom duration, and BMI, and grade of OA of patients who were injected by inexperienced clinician (group B) using ultrasound or blind approach (Table 3). In group B (inexpert), failure in intra-articular injection was confirmed by

fluoroscopy in 3 (6%) from 50 patient in ultrasound guided injections and 16 (21%) from 76 patients in blind injections; and there was significant difference between blind and ultrasound guided injection when it was performed by inexperienced clinician ( $p=0.02$ ). In group B, from 19 failed cases, 15 cases were female and 4 were male; 4 cases were grade 2 and 15 cases were grade 3 which were not significantly different between two groups.

In this study we demonstrated the role of ultrasound in improving success rate of knee intra-articular injection even in hand of inexperienced clinician. Several studies have used various materials and compared their effect in healing signs and symptoms of knee OA but it seems that technique of intra-articular injection is also of importance. Various blind techniques have been attempted in recent years with different success rates. Hermans et al.<sup>9</sup> determined that the superolateral approach results in the highest pooled accuracy rate of 91% (95% CI 84%-99%), although this approach still results in a substantial amount of extra-articular needle placements.<sup>9</sup> Recently, researches have focused on various equipments and approaches for improvement of knee intra-articular injection. Ultrasound has been applied in recent years to determine the anatomy of articular spaces and increasing the success rate of injections. Other applied equipments such as fluoroscopy or MRI have limitations which makes ultrasound a better choice for knee intra-articular injections. Ultrasound is a safe equipment but its ability to improve success rate has not been studied, and besides many clinician may find themselves of no need to ultrasound assistant. Here we demonstrated how ultrasound improved intra-articular technique success rate even in the hands of inexperienced clinician. Ultrasound is a safe procedure with very few side effects. In articular joint with no effusion, differentiation of intra-articular from soft tissue injections is difficult. On the other hand, due to variability in pain tolerance and inability to proper positioning of some patients due to severe pain, ultrasound could increase success rate significantly in these situations.

Some previous researches have used clinical improvements as a sign for accuracy of intra-articular injections. In this study, we used fluoroscopy to determine the accuracy of intra-articular injection. It has been shown that several factors have effect on success rate of intra-articular injections in blind approach, such as obesity, BMI, grade of osteoarthritis, needle, expertise of clinician, patient's tolerance to pain and approach to injection. However, when ultrasound is applied success rate would be independent of these factors and this is an advantage to the procedure. Our results showed that blind approach could have a failure rate of 4% when performed by highly expert clinician close to ultrasound guided injection; however, in hands of inexperienced clinician the failure rate could rise sharply to more than 20% while ultrasound guided failure was not significantly lower than expert clinician. In a study by Sibbitt et al.<sup>11</sup> they showed that Relative to blind methods, ultrasound guidance resulted in significant (43%) reduction in procedural pain, improved arthrocentesis success and improved clinical outcomes.<sup>10,11</sup> Jang et al.<sup>12</sup> showed that ultrasound-guided intra-articular injections both in-plain and out-of-plain method (97% success rate) showed significantly higher accuracy rate than injections in the blind injection (78% success rate).<sup>12</sup> Park et al.<sup>13</sup> showed that ultrasound-guided intra-articular injections by long axis in plane approach has a 95% success rate in consistent with our study.<sup>13</sup> In another study,<sup>14</sup> authors showed that US-guided HA injection exhibited a significantly greater accuracy (96.0%) than blind injection (83.7%) very close to our numbers. In addition to these results, our study showed that unlike blind approach ultrasound has a consistent high success rate independent of the level of expertise of

clinician or approach. In a very interesting systematic review,<sup>15</sup> they showed that ultrasound-guided intra-articular knee injections are more accurate than blinded ones. Blinded injections at SLP site had good accuracy (87%) especially if performed by experienced injectors. A systematic review confirmed that accuracy is improved with the use of ultrasound-guided intra-articular injection.<sup>16</sup>

## Conclusion

In conclusion, ultrasound improves accuracy of knee intra-articular injection independent of clinician level of expertise. Blind approaches compose a high failure rate particularly when performed by inexperienced clinicians.

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None.

## Conflicts of interest

The authors declare there is no conflict of interests.

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