# The Accuracy of Intra-Articular Needle Placements in Osteoarthritic Knee Patients: An Arthroscopic Assessment

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***Background:*** *The intra-articular of hyaluronic injection is widely used for osteoarthritic knee (knee OA). However, incorrect needle placement may cause discomfort and reduce effectiveness of the treatment.*
***Objective:*** *To assess the accuracy rates of needle placements into the intra-articular space of knee OA.*
***Material and Method:*** *This was a prospective study. Twenty-two patients with knee OA at Rajavithi Hospital received needle placement into intra-articular spaces using the three approaches, anteromedial (AM), anterolateral (AL), and lying lateral mid patella (LMP). The accuracy rates were confirmed by arthroscopy. Before and after injection of intra-articular hyaluronic acid at week 2, the visual analogue scale (VAS) was used to assess pain and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score was used in the evaluation of knee OA. The quality of life (QoL) was measured using the generic instrument Short Form-36 (SF-36).*
***Results:*** *The majority of the participants were female. Their mean age was 58.41±5.82 years old, and their mean (±SD) BMI was 25.07±2.47 kg/m$^2$. Their VAS and WOMAC scores improved significantly after injection compared to the baseline ($p<0.001$), but no significant differences in their QoL (SF-36) were observed after injection. The accuracy rate of intra-articular needle placement was highest (77.3%) using the LMP, followed by AL (63.6%) and lowest in the AM portal (31.8%). No significant difference was found between the accuracy rates of any of the needle placement groups based on KeL grade II. As for KeL stage III, the only significant difference between the accuracy rates was between those of the AM and the LMP approaches (23.1 vs. 76.9 accuracy rates, $p = 0.006$).*
***Conclusion:*** *The LMP approach had the highest accuracy rate and is recommended for the treatment of patients with mild to moderate knee OA.*

***Keywords:*** *Intra-articular, Knee osteoarthritis, Anteromedial, Anterolateral, Lying lateral mid patella*

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Knee osteoarthritis (knee OA) is one of the most common chronic diseases. It is a major source of pain, disability, socioeconomic cost, and decrease in life expectancy around the world, and several reports have shown that its prevalence and incidence will be even higher in the future. The epidemiology of knee OA is complex and multifactorial[1,2]. Epidemiological studies have reported that symptomatic radiographic knee osteoarthritis affects 10% of adults, especially those aged over 55 years. According to the World Health Organization (WHO), knee OA is likely to become a greater cause of concern amongst physicians due to the global trend of aging populations and increasing life expectancy[3]. Risk factors for knee OA are diabetes, cancer, and cardiovascular disease. Pain and related symptoms of knee OA can adversely affect the quality of life (QoL) of patients in either their physical or psychological functions. Primary care and community management are used to manage the symptoms[1,2], and the treatment of knee OA relies mainly on physical therapy, analgesics, nonsteroidal anti-inflammatory drugs (NSAIDs), and intra-articular injections of corticosteroids. However, the systemic side effects of NSAIDs and intra-articular steroid injections have been attracting increased interest[4] and caution must be taken when using NSAIDs especially with the elderly population, which accounts for the largest number of OA patients[5]. Some studies have suggested that a pure analgesic may be as effective as an NSAID in short-term symptomatic treatment of knee OA[6]. Currently, physicians recommend that orthopedic surgery consultants consider surgical management[1,7]; however, the cost of operations and lengthy recovery times are causes for concern.

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Intra-articular hyaluronic acid injections (IAHA) provide an additional non-operative strategy for knee OA management when non-pharmacologic and medical therapies do not relieve symptoms. Intra-articular corticosteroids and hyaluronic acids are recommended in the guidelines for the treatment of knee OA, though they are approved by the US Food and Drug Administration solely for knee OA[8-10]. It is known that an intra-articular injection of the knee is not a complicated procedure; however, assessment of whether the tip of the needle lies into the joint or soft tissue before administration of hyaluronic acid is crucial and must be performed carefully. Previous studies have reported the use of arthroscopic surgery for treatment of knee OA; however, its efficacy has been questioned. Although randomized controlled trials in the literature have reported that arthroscopic surgery was not effective for moderate to severe knee OA treatment, arthroscopy remains widely used[11,12]. The present study was designed to assess the accuracy rates of needle placement of intra-articular injections, using an arthroscope to confirm the results in outpatient practice. The approaches examined were the anteromedial (AM), anterolateral (AL), and lying lateral mid patella (LMP) techniques, and their accuracy rates were compared based on the Kellgren Lawrence Grading system (KeL grade II and III). The results were to be used in considering the treatment of knee osteoarthritis by injection into the knee.

## Material and Method

### *Patients*

The present study was accomplished through the prospective evaluation of patients with knee OA. Twenty-two new outpatients (3 males and 19 females) with knee pain related to OA seen in the orthopedic outpatient clinic of Rajavithi Hospital between January 2012 and December 2014 were recruited according to the criteria of the Royal College of Orthopedic Surgeons of Thailand. Inclusion criteria were symptomatic patients, with radiologically confirmed knee osteoarthritis (stage II-III according to Kellgren Lawrence Grading), had knee pain on the day of examination as well as at least three of the following five conditions: were over 50 years old, had lock knee presenting more than 30 minutes before moving, had a clicking sound or any other type of noise during knee movement, had large bone regenerated around the knee, and no sign of infection. Exclusion criteria were patients awaiting knee replacement surgery, taking medications associated with blood clotting, having underlying diseases such as heart and lung diseases, having had previous injections into the knee or body mass index (BMI) >30 kg/m$^2$. The Ethics Committee of Rajavithi Hospital reviewed and approved the present study (EC No.158/2554). All eligible participants signed consent forms.

### *Procedure*

Each patient was scheduled to receive all three needle placement approaches (AM, AL, LMP). A computer-generated block method with sealed envelopes was employed to randomize participants into each injection approach. This randomization was used to minimize the selection bias influencing the accuracy rates for the intra-articular injections in each approach. At the initial visit, once a patient had entered the study in the baseline assessment, the first envelope was opened and the patient was offered the first allocated needle placement approach. Before the needle placement was conducted, the landmarks for placement were outlined with a marking pen as required and the needle was positioned on the desired knee locations. A young orthopedic surgeon performed the first needle placement and the needle was maintained at a distance of one-third needle length, and this surgeon left an operative field. Following the first needle placement, another orthopedic surgeon with over 20 years' experience used an arthroscope to check whether the needle placement had reached the intra-articular space. Accuracy rates were confirmed with respect to intra-articular placement of the needle. Inaccuracies were identified as: 1) invisibility of needle in joint space, 2) needle in infrapatellar fat pad, 3) needle in synovium tissue, and 4) needle in meniscus ligament and articular cartilage. The arthroscope was then removed, and the second envelope was opened to allocate either the second or third needle placement approaches. When the next placement approach was randomly chosen, the same procedure for marking position, and needle placement was done by the same young surgeon. The aforementioned experienced orthopedic surgeon again used an arthroscope to evaluate the accuracy each time. Once the arthroscopic method was complete, the third placement method was used for that patient. After the completion of needle placement, arthroscopic irrigation, and debridement were performed on each participant followed by intra-articular injection of hyaluronic acid.

With respect to the study methodology, needle placement was performed using a 1.5-inch (3.81 cm) 18-gauge needle. A single orthopedic surgeon

performed the procedure, and the needle placement procedures were described below:

1. The lying AM approach involved the patients lying supine with the hip and knee flexed to approximately 90°. The needle placement site was selected at inferior to the patella, one finger breadth proximal to the tibial joint surface, and medial to the patella tendon. The needle was directed obliquely toward the intercondylar notch at a 45° angle.

2. The lying AL approach was used with the hip and knee flexed to about 90°. The needle placement site was selected at inferior to the patella, one finger breadth proximal to the tibial joint surface, and lateral to the patella tendon. The needle was directed obliquely toward the intercondylar notch at a 45° angle.

3. The LMP approach involved the insertion of a needle 1 cm above and 1 cm lateral to the superior lateral aspect to the patella at a 90° angle with the patient lying supine on the operating table.

The accuracy of needle placement for AM and LMP approaches were shown in Fig. 1.

At the baseline of the day of examination, all patients had clinical history and radiological evidence of osteoarthritis of the knee. Patients were asked about the total duration of pain in the knee and its current intensity both at rest and with movement. All patients had pain at the time of recruitment and this was assessed using the visual analogue scale (VAS). A self-administered questionnaire asked about patients' pain levels (on an 11-point numeric scale, ranging from 0 = no pain to 10 = maximal pain). The Western Ontario and McMaster Universities' Osteoarthritis Index (WOMAC) score was also used in the evaluation of Knee OA together with the patients' perceived disability (on a 6-point Likert scale, from no disability to unbearable), and functional status (function subscale modified WOMAC function subscale score for knee OA, from 0 = no disability to 100 = worst disability). To assess QoL in patients with knee OA, the Short Form-36 (SF-36) was used before needle placement and at the latest follow-up. The SF-36 scores can range from 0 to 100, with higher scores indicating better QoL. For the purposes of statistical analysis, the patients were stratified into two groups, I and II, on the basis of severity of radiological changes seen on radiographs taken before recruitment. Radiological evaluation was made using the criteria of Kellgren and Lawrence, which is a scoring tool used to assess the severity of knee osteoarthritis on a plain radiograph[13]. First proposed in 1957 by Kellgren and Lawrence, it uses a 5-point numeric scale, ranging from 0 = no radiographic feature of OA to 4 = severe sclerosis and definite bone deformity[14]. In the present study, grade II and III patients were assigned into the severity groups II and III.

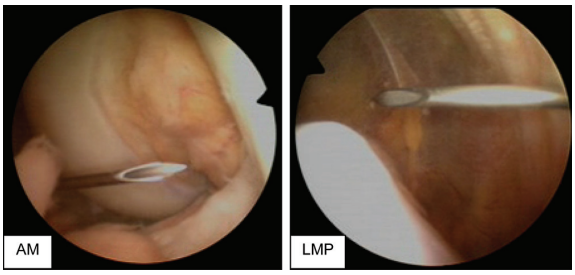


Fig. 1 The accuracy of needle placement into intra-articular for AM (left) and LMP (right).

***Statistical analysis***

Baseline characteristics were analyzed using descriptive statistics. For the primary analysis, the total VAS, WOMAC, and SF-36 scores were compared before and after needle placement using paired t-test. The Fisher's exact test was used to compare the accuracy rates of needle placement into intra-articular space among the three different approaches (AM, AL, and LMP). Statistical significance levels were set at $p<0.05$.

**Results**

Twenty-two patients were recruited, age between 47 and 71 years old, with a mean age (±SD) of 58.41±5.82 years old. The majority of the patients were female (86.4%), and their BMI ranged from 19.88 to 29.97 kg/m$^2$ (mean ± SD = 25.07±2.47 kg/m$^2$). Fifty percent of the patients were of normal weight while the rest were overweight. Regarding occupation, 16 (72.7%) were housewives, three (13.6%) were cooks, two (9.1%) were employees and one worked as a civil servant. Patients were asked about age at onset of pain and duration of pain. The mean age and range at the onset of pain were 53.32±5.24 and 43 to 62 years respectively. The mean duration and range of pain in the present study were 5.09±2.37 and 2 to 11 years respectively. Pain severity according to the Kellgren Lawrence grading was distributed and the results found that 59% and 41% were grade III and II respectively.

The patients' mean VAS scores, WOMAC score and SF-36 before (week 0) and after injection (week 2) of the study period are summarized in Table 1. The VAS scores showed a significant reduction after injection compared to before injection throughout the

whole treatment period ($p$<0.001). The WOMAC score significantly increased from baseline to after injection ($p$<0.001). However, no significant differences in the QoL (SF-36) were observed before and after injection.

The accuracy rates of each needle placement into the intra-articular knee OA were shown in Table 2. The accuracy rate though the LMP approach was 17 out of 22 needle placements confirmed to have been placed in the intra-articular space (77.3% accuracy rate). Fourteen of 22 needle placements (63.6% accuracy rate) performed though the AL approach were confirmed to have been placed in the intra-articular space while the accuracy rate for the AM was 7 out of 22 needle placements (31.8%). There were significant differences in the accuracy of the AM and AL ($p$ = 0.035) approaches, and the AM and the LMP ($p$ = 0.002) techniques. However, there was no significant difference in the accuracy rates of the AL and the LMP techniques.

The accuracy rates of needle placements based on the KeL grade for each approach were shown in Fig. 2. In the KeL grade stage II cases, the accuracy rates for AL and LMP were identical at 77.8% while the accuracy rate for the AM approach was 44.4%. No significant difference was found between the accuracy rates of any of the needle placement groups for KeL grade II. Regarding KeL grade III cases, there was a significant difference between the accuracy rates of the AM and the LMP approaches only (23.1 vs. 76.9 accuracy rates, $p$ = 0.006). No significant differences were detected between the accuracy rates for participants with a grade III ranking using the AM and the AL approaches (23.1 vs. 53.8 accuracy rate), and AL and LMP techniques (53.8 vs. 76.9 accuracy rate).

**Table 1.** VAS and WOMAC scores and SF-36 before and after injection at the first follow-up

| | Before injection | After injection | $p$-value |
|---|---|---|---|
| VAS score | 3.95±1.40<br>4 (2-7) | 2.82±0.80<br>3 (2-5) | <0.001 |
| WOMAC score | 72.23±7.26<br>74.5 (60-85) | 77.36±8.95<br>78 (62-90) | <0.001 |
| SF-36 | 86.95±3.63<br>88.0 (80-92) | 86.73±3.98<br>86.5 (80-92) | 0.590 |

Values were represented as mean ± SD and median (minimum-maximum)

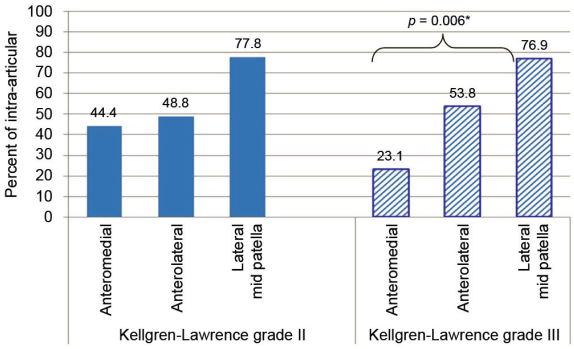


**Fig. 2** The accuracy rates based on the KeL grade II and III.

## Discussion

Knee OA is considered to be one of the most frequent chronic diseases of the whole joint, and it is a painful and disabling disease. The prevalence rate of knee OA was significantly higher among women than in men and increased significantly with age from 4% in 16- to 24-year-old patients up to 85% in 75- to 79-year-olds[15-17]. In the present study, the majority of the patients were women, which suggested that knee OA is most found often in females.

Knee injections are commonly used for both diagnostic and therapeutic purposes[1]. Hyaluronic acid injection is known as one of the treatments that may ease the pain and stiffness of osteoarthritis; however, the results from using hyaluronic acid injection for knee OA are controversial[8,19-21]. In many clinical trials, not only were the efficacy of intra-articular hyaluronic acid preparations tested[22], but appropriate techniques for injection were also assessed, as little is known about the accuracy of needle placement into the intra-articular space of the knee[18,23].

**Table 2.** The accuracy rates of needle placement into the intra-articular knee OA

| Injection approaches | Total No. of injections | Placement of needle (No. of injections) | | Accuracy rate (%) | $p$-value between injection approaches | | |
|---|---|---|---|---|---|---|---|
| | | Intra-articular | Extra-articular | | AM&AL | AM&LMP | AL&LMP |
| AM | 22 | 7 | 15 | 31.8 | 0.035 | 0.002 | 0.332 |
| AL | 22 | 14 | 8 | 63.6 | | | |
| LMP | 22 | 17 | 5 | 77.3 | | | |

AM = anteromedial; AL = anterolateral; LMP = lateral mid patella

The purpose of the present study was to evaluate the accuracy rates of needle placement into the intra-articular space using AM, AL, and LMP in knee OA patients. The highest accuracy rate (77.3%) was achieved with LMP, followed by AL (63.6%) and AM portal (lowest at 31.8%). These results are in agreement with the previous findings of Jackson et al (2002)[24]. That study evaluated the accuracy of needle placement, which was assessed in a prospective series of 240 consecutive injections in patients without clinical knee effusion. The needle placement was performed by one orthopedic surgeon using a 2.0-inch (5.1-cm) 21-gauge needle through three commonly employed knee joint portals, AM, AL, and LMP. Accuracy rates for needle placement were confirmed with fluoroscopic imaging to document the dispersion pattern of injected contrast material. Injections through the LMP approach had the highest accuracy of 93%, followed by AM (75%) and AL (71%). The present study highlighted the need to refine injection techniques for delivering intra-articular therapeutic substances that are intended to coat the articular surfaces of the knee joint[24]. On the other hand, Esenyel et al (2007)[18] evaluated a comparison of four different intra-articular injection sites using AM, AL, LMP, and medial mid patella portals in cadavers, and the present study showed slightly different results. AL injections had the highest accuracy rate (85%) followed by LMP (76%), AM (73%), and medial mid patella (56%) respectively[18]. Based on these studies and the literature, the accuracy obtained with the use of the LMP portal was significantly higher than that obtained with the use of the AM ($p<0.05$) portal. Normally, the lateral patella injection is used as the method for intra-articular hyaluronic acid injection, as this technique is more suitable than the anterior technique for extracting fluid when an effusion is present[25]. Although the AL injection approach resulted in good intra-articular delivery in many studies including the present one (63.6-85% accuracy rate), the results were not significantly different when compared to LMP portals in the present study. Therefore, either LMP or AL portals might be preferred depending on the experience of the orthopedic surgeons. Results from the present study are similar to one by Esenyel et al (2007)[18], which found that no statistically significant difference was observed between the accuracy rates of AL and LMP portals.

In knee OA patients with a KeL grade II, there was no significant difference ($p>0.05$) among the results obtained with placement through the AM, AL, and LMP approaches. The sample size may have been too small to detect a statistical difference when divided into a KeL grade II. In addition, the accuracy rate of AL and LMP approaches in grade II showed similar levels. This study revealed that the accuracy rate for intra-articular hyaluronic acid injections performed with the LMP approach was higher than those of both the AL and AM approaches in patients with a KeL grade III; however, a statistically significant difference was found only between the LMP and AM approaches. It is worth noting that the grade III knee OA responded extremely well to the intra-articular injections in the present study especially using the LMP approach and is in keeping with the generally-held view that intra-articular hyaluronic acid is effective in management of mild and moderate knee OA[5].

The primary outcome after placement of the needle was pain improvement in response to treatment, as defined by VAS and WOMAC scores including short form SF-36 QoL indices. The VAS and WOMAC scores significantly improved on those before needle placement indicating that most of the elicited responses were clinically significant. This finding is in agreement with the results of a meta-analysis of researchers at Tufts Medical Center that focused on a therapeutic trajectory of intra-articular hyaluronic acid for knee OA pain over six months post-intervention. It deduced that intra-articular hyaluronic acid is efficacious by four weeks, its effectiveness peaks at eight weeks, and it exerts a residual effect detectable at 24 weeks[26]. There was no significant difference in QoL after injection, and one possible explanation for this was the shortness of the assessment period (only two weeks).

The present study may be useful for clinicians. First, this study was conducted in knee OA patients as opposed to cadavers, as intra-articular hyaluronic acid injection is primarily used for therapeutic purposes. Few studies have reported on the accuracy of needle placement into the intra-articular space of the knee especially in knee OA patients, and little is known about appropriate techniques. Second, this is one of only a small number of studies focusing on needle placement into the intra-articular space of the knee using arthroscopy. It represents a better method than using X-ray-based imaging, which merely reflects contrast media during the procedure. The present study succeeded in showing the benefits of arthroscopic surgery for the treatment of knee OA patients.

## Conclusion

In conclusion, the accuracy obtained with use of the LMP approach was significantly higher than that

obtained with the use of either AM or AL approaches. An implication of these findings is that the LMP technique is suitable for use with the knee extended, as this technique is the most accurate in knee OA patients. Clinically significant outcomes are found up to a few weeks after placement of the needle. Further research should be carried out to assess other parameters and the accuracy rates of different techniques, and prolonged follow-up should be evaluated.

**What is already known on this topic?**

Cadavers were previously used to determine the accuracy rates of intra-articular injection in the knee. Different sites of the knee were assessed and chosen for injection depending on the experiences of the physicians. The needle placement was mainly determined using radiation, which found some differences in accuracy. Therefore, this study described the accuracy rates of needle placements into the intra-articular space of knee OA patients.

**What this study adds?**

This study uses arthroscopy. It is a better method than using X-ray-based imaging. The present study succeeded in showing the benefits of arthroscopic surgery for the treatment of knee OA patients. The accuracy rates of needle placements based on the severity of knee OA defined as KeL grade were only assessed in this study. Based on the results, LMP technique is suitable for use with the knee extended, as this technique is the most accurate in knee OA patients.

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**Potential conflicts of interest**

None.

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*ความถูกต้องของการแทงเข็มเข้าข้อในผู้ป่วยข้อเข่าเสื่อม: การประเมินโดยใช้กล้อง*

*สุกรม ชีเจริญ, กันตภณ เกษร*

***ภูมิหลัง:*** *การรักษาข้อเข่าเสื่อมด้วยการฉีดไฮยารูโลเนตเป็นที่แพร่หลาย แต่หากมีการฉีดในตำแหน่งที่ไม่เหมาะสม อาจมีผลต่อความไม่สะดวกสบายของผู้ป่วยและอาจมีผลต่อการรักษาได้*

***วัตถุประสงค์:*** *เพื่อประเมินความถูกต้องของการแทงเข็มภายในข้อในผู้ป่วยข้อเข่าเสื่อม*

***วัสดุและวิธีการ:*** *การศึกษาติดตามไปข้างหน้าในผู้ป่วยข้อเข่าเสื่อมที่โรงพยาบาลราชวิถี จำนวน 22 ราย ตำแหน่งการแทงเข็ม 3 ตำแหน่ง ได้แก่ anteromedial (AM), anterolateral (AL) และ lying lateral mid patella (LMP) ประเมินความถูกต้องของการแทงเข็มโดยใช้กล้องส่องข้อในวันแรกและหลังผ่าน 2 สัปดาห์ ของการฉีด hyaluronic acid อาสาสมัครถูกประเมินความปวดโดยใช้แบบประเมิน visual analogue scale (VAS) ประเมินอาการข้อเข่าเสื่อมโดยใช้ Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) และวัดคุณภาพชีวิต โดยใช้แบบประเมินคุณภาพชีวิต (SF-36)*

***ผลการศึกษา:*** *ผู้ป่วยส่วนใหญ่เป็นเพศหญิง อายุเฉลี่ย 58.41±5.82 ปี ค่า BMI เฉลี่ย 25.07±2.47 kg/m$^2$ หลังการฉีด hyaluronic acid ระดับความปวดวัดโดย VAS score และ WOMAC score ดีขึ้นกว่าก่อนการฉีดอย่างมีนัยสำคัญทางสถิติ แต่คะแนนคุณภาพชีวิตไม่แตกต่างกัน อัตราความถูกต้องของการแทงเข็มมากที่สุดคือที่ตำแหน่ง LMP (77.3%) รองลงมาได้แก่ AL (63.6%) และตำแหน่ง AM (31.8%) ตามลำดับ เมื่อแบ่งระดับของการแทงเข็ม โดยใช้เกรดของ KeL grade III พบความแตกต่างของความถูกต้องของการแทงเข็มระหว่างวิธี AM และ LMP (23.1% และ 76.9%, p = 0.006)*

***สรุป:*** *การแทงเข็มเข้าข้อเข่าในตำแหน่ง LMP มีความถูกต้องมากที่สุดและเหมาะสมในการรักษาผู้ป่วยข้อเข่าเสื่อมที่มีความรุนแรงระดับต้นและปานกลาง*