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Usefulness of Fluoroscopy-Guided Intra-articular Injection of the Knee[1]

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Purpose: To determine the accuracy of the intra-articular location of hyaluroinc acid injection using a blind approach and to establish the usefulness of fluoroscopy-guided intra-articular injection.

Materials and Methods: A fluoroscopy unit was used for 368 intra-articular injections of hyaluronic acid to 93 knees in 65 patients. Initially, blind needle positioning was conducted on the fluoroscopy table. The failure rate of the blind approach among the 368 injections was evaluated, and a relationship between the Kellgren-Lawrence grade (K-L grade) and the incidence of repeated failures using the blind approach was determined for injections to 52 knees in 37 patients who received a complete cycle of injections (five consecutive injections with a one-week interval between injections).

Results: Using a blind approach, 298 of 368 trials (81.2%) resulted in a needle tip being placed in an intra-articular location, while 70 of 368 trials resulted in an extra-articular placement of the needle tip. Among 52 knees to which a complete cycle of injections (five consecutive injections with a one-week interval between injections) was administered, repeated failure of intra-articular placement using the blind approach was seen for 18 knees (34.6%); a more severe K-L grade assigned was associated with a higher rate of repeated failure. However, the trend was not statistically significant based on the Chi-squared test (p value = 0.14).

Conclusion: Fluoroscopy-guided needle placement may be helpful to ensure therapeutic intra-articular injection of the knee.

Index words : Fluoroscopy
Interventional procedures
Knee
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Recently, intra-articular injections of hyaluronic acid, known as viscosupplementation, have been used as an available option for the nonsurgical management of osteoarthritis of the knee. Hyaluronic acid is a major non-structural component of the synovial and cartilage extracellular matrix. The mechanism of viscosupplementation is related to the restoration of the elastoviscous properties of synovial fluid. Viscosupplementation has been postulated to exhibit an anti-inflammatory effect, an analgesic effect on intra-articular nociceptors, and has been shown to stimulate the in vivo synthesis of hyaluronic acid by exogenously injected hyaluronic acid (1, 2). Unlike steroid injection therapy, in which a re-

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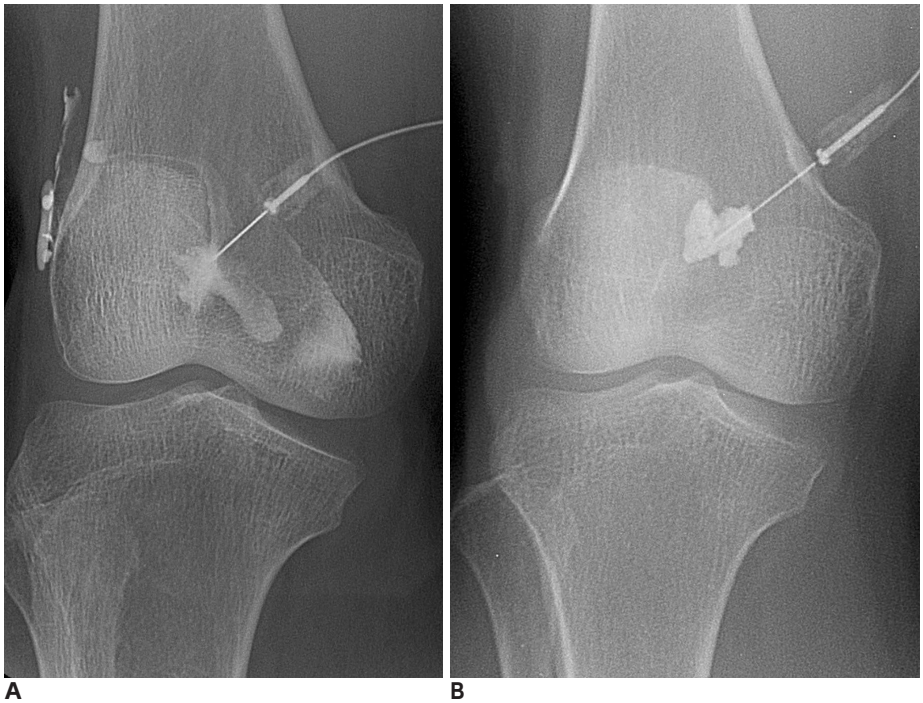
sponse was similar regardless of whether the injection was intra-articular or extra-articular, hyaluroinc acid derivatives should be delivered into the intra-articular space to achieve a maximal potential therapeutic benefit (3, 4).

Intra-articular knee injections are routinely performed in clinical practice, but optimum results are not guaranteed when the injections are given blindly. To improve the likelihood of success from intra-articular injection, several methods, such as air-arthrography, observation of audible squishing sounds after air-injection, and fluoroscopy have been utilized (5 - 7). Waddell et al (6) reported that viscosupplementation under fluoroscopic control was a precise and advantageous technique; the usefulness of fluoroscopy-guided intra-articular injections was emphasized. The purpose of this study is to determine the accuracy of intra-articular injection using a blind approach and to establish the usefulness of fluoroscopy-guided intra-articular injection.

Materials and Methods

From April 2005 to December 2005, the accuracy of intra-articular needle placement was assessed prospectively in 65 patients who were referred for intra-articular injection of Hyruan® (hyaluronic acid, LG Life science, Korea). Of the 65 patients treated, 13 were male, 52 were female, and the average age of the patients was 61.7 years. According to the protocol recommended by the manufacturer, treatment involved five consecutive intra-articular injections of Hyruan® with a one-week interval between each injection. Bilateral knee injections were administered to 28 patients and a total 93 knees received injections of hyaluroinc acid. A total of 368 injections were administered to affected knees through the medial portal by three radiologists who had four-years, two-years, and one-year of experience, respectively, in musculoskeletal intervention. Initially, the blind approach was performed while a patient was lying down on the fluoroscopy unit (Integris Allura, Phillips Medical Systems, Best, The Netherlands). Subsequently, 0.5 mL of the tentative nonionic contrast material, iohexol (Omnipaque™, Amersham Health, Carrigtohill, Ireland), was injected under fluoroscopy. A spot radiograph was taken and if the location was not intra-articular, reposition of the needle tip was conducted using fluoroscopic-guidance. The location of the needle tip was considered to be intra-articular if free dispersion of the contrast material was noted by fluoroscopy. After intra-articular confirmation of needle tip, 2 mL Hyruan® was injected.

The complete cycle of injections (five consecutive injections with a one-week interval between each injection) was executed in 37 patients with a total of 52 knees treated; 28 patients (41 knees) out of 65 patients (93 knees) failed to undergo the complete cycle of intra-ar-



A B

Fig.1. A 63-year-old woman with osteoarthritis of the knee (K-L grade 1).
A. A spot radiograph of the right knee revealed the intra-articular location confirmed by the free dispersion of contrast medium.
B. One week later, an injection was given to the same knee. The contrast material was loculated at the extra-articular space, suggestive of the anterior fat pad.

ticular injections. In 37 patients (52 knees) who received the complete cycle of injections, the association between repeated failure in the same knee joint and the Kellgren-Lawrence (K-L) grade was evaluated on plain knee anteroposterior and lateral radiographs by a radiologist who was unaware of any knowledge concerning intra-articular injection. On the basis of the presented radiographic features, the K-L grades were defined as follows: 0, no features of osteoarthritis; 1, doubtful osteoarthritis, with minute osteophytes of doubtful importance; 2, minimal osteoarthritis, with definite osteophytes but unimpaired joint space; 3, moderate osteoarthritis, with osteophytes and moderate diminution of joint space; 4, severe osteoarthritis, with greatly impaired joint space and subchondral sclerosis (8).

Results

Of the 368 trials given using the blind approach, 298 trials (81.2%) were determined as being placed in the intra-articular location while 70 trials (18.8%) were determined as being placed in an extra-articular location. For the trials determined to be located extra-articularly, the needle tip was repositioned using fluoroscopic guidance (Fig. 1, 2). Inadvertently, the location of the needle tip in extra-articular placement was the fat pad and, in the majority of instances, the needle tip was inserted into the intra-articular space by advancement into the lateral direction that traversed the fat pad (Fig. 2). Consequently, in all cases (100%), the intra-articular location was verified using fluoroscopic guidance. Therefore, an appropriate delivery of hyaluronic acid was given in all cases.

In the 52 knees in which a complete cycle of injections was administered, the repeated failure of intra-articular placement was observed in 18 knees (34.6%). The associated K-L grades were as follows: K-L grade 4; 3/6 (50%), K-L grade 3; 4/10 (40%), K-L grade 2; 9/25 (36%), K-L grade 1; 2/9 (22%), K-L grade 0, 0/2 (0%). The Chi-squared test for trend was 2.13 (1 degree of freedom) and the *p* value was 0.14. The results are summarized in Table 1. A more severe K-L grade assigned was associated with a higher rate of repeated failure. However, the trend was not statistically significant based on the chi-squared test (*p* value = 0.14).

Table 1. The Relationship of Repeated Injection Failure with the Kellgren-Lawrence Grade

	K-L Grade 0 (*n* = 2)	K-L Grade 1 (*n* = 9)	K-L Grade 2 (*n* = 25)	K-L Grade 3 (*n* = 10)	K-L Grade 4 (*n* = 6)
Repeated failure (+)	0	2	9	4	3
Repeated failure (-)	2	7	16	6	3

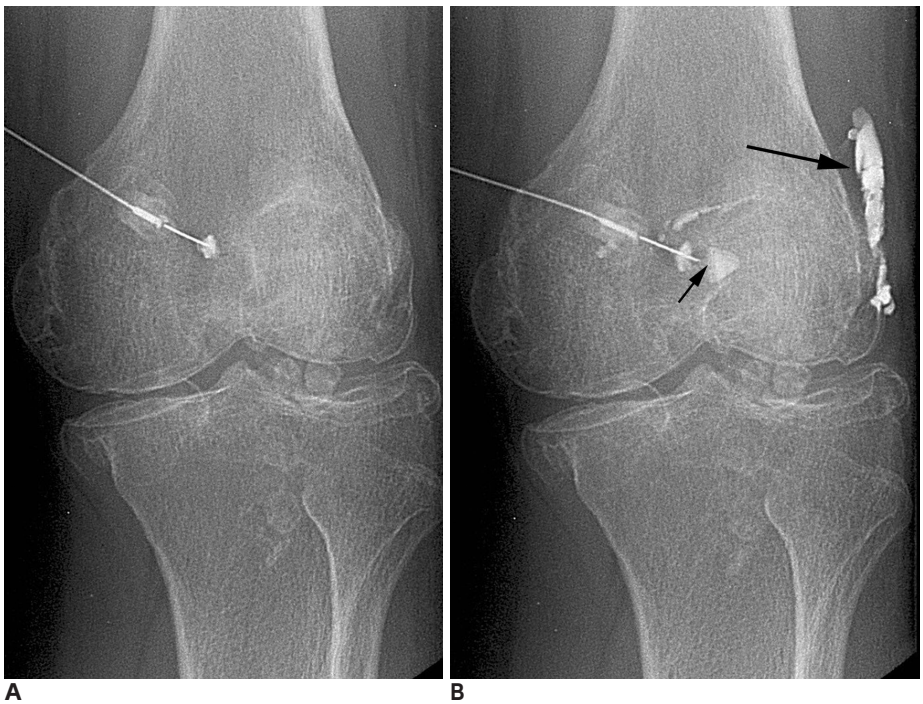


Fig. 2. A 51-year-old woman with severe osteoarthritis and osteophytes (K-L grade 4).
A. A spot radiograph revealed the loculated contrast agent, suggesting that the needle tip was located in the extra-articular space. Obliteration of the joint space at the medial compartment was not demonstrated in the supine position but it was demonstrated in a standing position.
B. The needle tip (small arrow) was advanced laterally and the intra-articular location was confirmed by the free dispersion of contrast medium. The contrast medium was observed at the lateral portion of the bursal space (large arrow)

Discussion

Because of the shock-absorbing and lubricating functions of the viscosupplement within the joint space, accurate intra-articular placement of the material was crucial. An advantage of use of fluoroscopic guidance was that the precise intra-articular location was determined prior to injection of the material, thereby preventing subsynovial or extra-articular placement (6).

According to our results, use of the blind approach failed to position correctly the intra-articular needle approximately 20% of the time. Jackson et al (9) reported that sixty of eighty injections (75%) performed via a medial portal using the blind approach were located correctly in the intra-articular position, a rate similar to the 81% accuracy rate determined in our study. In the instances in which the needle tip was localized in an extra-articular location, it was repositioned using fluoroscopic guidance. Subsequently, the contrast material was observed in the synovial space in 100% of the injections. In a clinical office setting, the use of blind approach is inevitable. However, the patient will benefit if facilities are equipped to perform the fluoroscopy- guided approach.

An orthopedic surgeon in an office setting, using superolateral injections with the knee flexed, performs the majority of Intra-articular injections of hyaluronic acid (5, 6). However, guided by fluoroscopy, the medial approach may be more useful because the patients are in a supine position with the knee fully extended. Certain technical tips should be mastered to achieve accurate placement into the intra-articular location through the medial portal. The injection site is chosen by moving medially from the region of the mid to upper patella to a point half way between the patella and the medial femoral condyle. Gentle rocking of the patella allows identification of its border thereby facilitating the injection (10, 11). The needle tip is directed laterally and slightly posteriorly while aiming to enter the area between the patella and the femur (12). In addition, the majority of patients who are referred to radiologists for intra-articular knee injection of hyaluronic acid have technical difficulties with the superolateral portal due to possible severe patellofemoral osteoarthritis. According to a report concerning the prevalence of osteoarthritis, patellofemoral osteoarthritis was relatively frequent; the prevalence rate was 64% (13). Using fluoroscopy-guided intra-articular procedures in a radiology department, placement in the medial portal may be useful. However, the needle tip may be unexpectedly placed in an extra-articular position, which is considered to be the anterior fat pad and, in the majority of cases, the needle tip can be inserted into the intra-articular space by advancement in the lateral direction by traversing the fat pad (Fig. 2).

The Kellgren-Lawrence grading scale appears to be associated with the accuracy and the causative factor of repeated failures of the same knee. Of the six knees assigned the K-L grade equal to 4, three knees (50%) were associated with repeated failures. With a more severe K-L grade, a higher the rate of repeated failure was likely to occur. Although there was no statistical significance because the population size was small (p value = 0.14), this results suggest that with more severe osteoarthritis, it is more difficult to ensure the acuurate intra-articular placement of needle tip using the blind approach. Therefore, fluoroscocopy- guided intra-articular injection may be useful especially in severe osteoarthritis patients.

We acknowledge that the accuracy using blind approach is influenced by the experience of the operator, but multiple operators with differing level of experience are a principl which is suitable to general elinical oractitioners.

The presence of joint effusion also could influence accuracy. In our study, there were nine knees that had effusion, but the presence of effusion was not included in the analysis because of the small number of cases.

Jackson et al (9) compared the accuracy rates of needle placement into three commonly used knee-injection portals and injection through the lateral midpatellar approach had an accuracy rate of 93%. The lateral midpatellar approach utilizes a portal that passes through a minimal amount of soft tissue to reach the intraarticular space. However, it is difficult to establish anatomical landmarks in obese patients. These patients have difficulty in statistic immobilization with the knee flexion. In patients whose knee joints were deformed by a degenerative process, intra-articular needle placement is difficult even with an accurate approach based on anatomical landmarks. Our study used a medial approach under fluoroscopic guidance.

This study focused on the technical points and the usefulness of the fluoroscopy-guided approach rather than on prognosis and clinical improvement. However, the technical guidelines and the demonstrated usefulness of fluoroscopy-guided intra-articular injection presented in

this report are applicable to clinical practice.

In conclusion, it is proposed that fluoroscopic-guidance may be beneficial for intra-articular injection of hyaluronic acid into the knee

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슬관절강 내 주사시 투시 유도의 유용성[1]

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목적: 투시 유도 없이 시행하는 슬관절강내 히알루론산 주사의 정확성을 조사하고 투시 유도의 유용성을 알아보고자 한다

대상과 방법: 퇴행성 관절염 진단하에 히알루론산 주사를 의뢰받은 65명 환자의 93 슬관절에 대해 368회의 관절강 내 주사를 시행하였다. 투시장치 계기대위에서 투시 유도 없이 천자를 하고 시험적 조영제(Omnipaque™, Amersham Health, Carrigtohill, Ireland)를 주입하여 천자 침 끝이 관절강 내 위치하는지를 확인하였다. 관절강 내 위치 후 2 mL의 히알루론산 주사를 시행하였다. 투시 유도 없이 시행한 관절강 내 주사의 실패율, 1주 간격으로 5회 주사를 시행 받은 37 환자의 52 슬관절에 대하여 Kellgren - Lawrence grade (K - L grade)와 2번 이상의 반복적인 실패확률의 상관관계를 비교하였다. 결과는 Chi - square 검사를 이용하여 통계 처리하였고, 유의 수준 p=0.05를 사용하였다.

결과: 투시 유도 없이 시행한 슬관절강 내 주사 368예 중 298예(81.2%)에서 성공하였고 70예에서 실패하였다. 1주 간격으로 5회 주사를 시행 받은 52 슬관절 중 18(34.6%) 슬관절이 2번 이상의 반복적인 실패를 보였다. K - L grade 가 높을수록 반복적 실패를 보이는 경향이 있었으나 통계적 유의성은 없었다(p value = 0.14).

결론: 슬관절강내 주사시 투시 유도는 치료 효과를 위한 위치 확보에 도움이 된다.