Effect of local injection of 10% lidocaine hydrochloride on painful osteoarthritis of the knee joint

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Abstract
The aim of this study was to investigate whether local injection of high-dose lidocaine could attenuate tenderness and motion pain existing in the medial compartmental osteoarthritic knee. Seventeen patients who had tenderness and pain during walking at the medial compartment of degenerative femorotibial joint for more than 6 months were examined in this study. The knee pain during walking was assessed by the visual analog scale (VAS) score and pressure pain thresholds for tenderness at the site of the injection were evaluated by means of a hand-held pressure algometer. As for the treatment, 1 ml of 10% or 1% lidocaine was injected into the periarticular tissue of the most painful tenderness point of the medial femorotibial joint. These pain intensities were measured before (controls), 2 weeks and 4 weeks after the injection. Decreased VAS score ($p<0.007$) during walking and increased pressure pain thresholds ($p<0.004$) were observed 2 weeks after injection of 10% lidocaine and compared with respective controls. VAS score was significantly decreased throughout 4 weeks after the injection. At the same time, there was no significant difference before and after injection of 1% lidocaine. These results suggest that injection of 10% lidocaine may produce a more effective and long-term analgesia for pain following osteoarthritis of the knee, as compared with the injection of 1% lidocaine.

Key words: osteoarthritis, knee joint, lidocaine, visual analog scale, pressure pain threshold

INTRODUCTION
Osteoarthritis (OA) is known as the commonest rheumatological disease of the knee joint in the elderly $^6$. Most patients with OA of the knee joint suffer from chronic pain at the medial part of the knee joint. The mechanism by which OA causes pain is complicated. All causes of pain in the OA are associated with deformation of subchondral bone $^7$ or periarticular tissue $^1$, accompanied by destruction of articular cartilage $^{10,13}$. In general, patients with the knee OA are treated with regular use of non-steroidal anti-inflammatory drugs and intra-articular injection of hyaluronic acid $^{2,11}$. In some cases, however, the effect of conservative treatment is insufficient enough to relieve OA pain.

Since low concentration of local anesthetics has a relatively short period of action, we decided to use the trigger point injection $^{20}$ or intra-articular injection of local anesthetics $^4$ to abolish the OA pain.
more effectively and quickly. Lidocaine is a safe and effective anesthetic agent frequently used for local anesthesia. It should be mentioned that high concentration of lidocaine may produce neurological toxicity after spinal anesthesia (15,18,19) and irreversible neurological deficits on the peripheral nervous system (3,8,12,14). It is hypothesized that local neurological deficits may result in a long-term relieving effect of chronic OA pain at the medial compartment of the knee joint. However, high concentration of lidocaine has not been examined in the treatment for painful degenerative joint diseases yet.

Therefore, we conducted a double-blind study to reveal the effect of clinically used concentrations or higher concentrations of lidocaine hydrochloride solutions on the OA pain at the medial compartment of degenerative femorotibial joint.

MATERIALS AND METHODS

Seventeen patients, 13 females and 4 males, aged 81 years (range: 67 to 91 years), who had tenderness and pain during walking at the medial compartment of degenerative femorotibial joint for more than 6 months, were examined in this study. All patients were treated with regular use of non-steroidal anti-inflammatory drugs and intra-articular injection of hyaluronic acid for over 3 months. They had definite radiographic signs of osteoarthritic knee without previous injury. Radiographic features of the knees were assessed by the Kellgren-Lawrence grading scale (9), which were determined for medial femorotibial compartment of the knee joint on standing anteroposterior radiographs. Patients with clinically meaningful cardiopulmonary, hepatic, renal comorbidity or allergies against local anesthetics were excluded.

This study was conducted in accordance with the Declaration of Helsinki, approved by the local Ethics Committee. Informed consent was obtained from all participants enrolled in this study.

The most painful tender point of the medial compartment of the femorotibial joint was determined before the injection. One-milliliter volume of 1% or 10% lidocaine hydrochloride solution (Xylocaine®, Fujisawa pharmaceutical co., Osaka, Japan) was injected slowly into the periarticular tissue at the tender point with a 27-gage needle in a double-blind design. Pain intensity during walking and the following examinations were measured before (controls), 2 and 4 weeks after the injection. All patients were tested in the morning at the clinical visit to exclude the known circadian influence on the OA patients.

The pain intensity was scored on a 0–10 visual analog scale (VAS) where 0 cm indicated “no pain” and 10 cm indicated “the worse pain imaginable”. Pressure pain threshold for tenderness was measured at the injection site with a hand-held algometer (MICROFET2®, Hoggan Health Industries Inc., UT, USA) mounted on a 1 cm²-rubber pad. The pressure increased with approximately 2 N/s until the subject felt tenderness. The pressure pain threshold at the tender point was determined as the mean value of two trials with an interval of approximately 5 min. Active joint range of motion (ROM) of the treated knee was examined in the supine position. Maximal flexion and extension were assessed using a goniometer. Overall satisfaction with the injection (verbal rating scale VRS: 0 = unsatisfactory, 1 = satisfactory, 2 = excellent) was rated 4 weeks after the injection.

The results were expressed as means ± SD. The paired data were analyzed with the Friedman test (non-parametric repeated measures analysis of variance), and when it was found significant, it was followed by a Bonferroni’s multiple comparisons test for post-hoc analysis. The comparison of satisfaction between two groups was performed by Mann-Whitney U-test. The significant threshold was p<0.05 in all tests.

RESULTS

Ten knee joints were treated with 10% lidocaine (10% lidocaine group) and the others with 1% lidocaine (1% lidocaine group). The mean age of the patients was comparable between the two groups: 81 ± 5 vs 79 ± 8 in the 10% lidocaine and 1% lidocaine group, respectively. Of the 10 patients in the 10% lidocaine group, 2 (20%) were radiologically evaluated as grade
III, 4 (40%) as grade IV, whereas 1 (14%) was radiologically evaluated as grade II, 3 (43%) as grade III, 3 (43%) as grade IV in the 1% lidocaine group. No allergic complications occurred after the injection of lidocaine.

The average of VAS score during walking before the injection was 5.4 ± 2.2 in 10% lidocaine group and 5.0 ± 2.2 in the 1% lidocaine group. VAS scores were significantly decreased 2 and 4 weeks after the injection of 10% lidocaine, compared with controls (3.1 ± 1.4; \( p<0.007 \) and 3.5 ± 2.2; \( p<0.02 \), respectively). On the other hand, there was no significant difference between before and after the injection of 1% lidocaine (Fig. 1).

The average of pressure pain threshold for tenderness before the injection was 14.7 ± 5.3 N in 10% lidocaine group and 15.5 ± 6.3 N in the 1% lidocaine group. Pressure pain threshold significantly increased 2 weeks after the injection of 10% lidocaine, but not 4 weeks after the injection, compared with controls (26.7 ± 11.8 N; \( p<0.004 \) and 19.5 ± 8.7 N; \( p>0.18 \), respectively). There was no significant difference before and after the injection of 1% lidocaine (Fig. 2).

The average of active ROM before the injection was from 8.5 ± 6.2 to 129.2 ± 20.5 in 10% lidocaine group and 13.3 ± 8.7 to 127.3 ± 25.6 in the 1% lidocaine group. There was no significant difference before and after injection in each group (Fig. 3).

Overall satisfaction with the injection was significantly higher in the 10% lidocaine group than in the 1% lidocaine group (\( p<0.01 \)). Five patients in the 10% lidocaine group were relieved of chronic knee pain (Fig. 4).
DISCUSSION

The present study shows significant increased pressure pain threshold and decreased pain intensity during walking after the injection of 10% lidocaine, compared with controls. Patients in the 10% lidocaine group were satisfied with the injection at the tender point in spite of a little improvement of active ROM.

There is a possibility that high concentration of lidocaine might cause irreversible neurological alterations. Ready et al. reported that minimum irreversible concentration of intrathecal lidocaine in rabbits is 7.6–10.6% \(^{15}\). As to the effect of local anesthetics on peripheral nervous system, Baiton et al. reported that lidocaine-induced irreversible conduction loss in frog nerve is concentration-dependent \(^3\). Kalichman et al. showed that local anesthetics produced a concentration-dependent increase of specific morphological changes, such as formation of endoneurial edema and axonal degeneration, in the rat sciatic nerve \(^8\). Thus, increased pressure pain threshold 2 weeks after the injection of 10% lidocaine may be due to a degeneration of regional afferent fibers mediated tenderness, whereas no significant changes in pressure pain threshold after the injection of 1% lidocaine show a temporary anesthetic effect of lidocaine, such as reversible conduction block of the fibers. The gradual restoration to preinjection value 4 weeks after the injection of 10% lidocaine may indicate that the regeneration of afferent fibers at the injection site is the primary pathophysiological mechanism involved in this process.

A number of patients with the chronic knee OA usually complain on the well-localized pain and tenderness at the medial compartment of the femorotibial joint, which may represent osteophyte growth, degenerative meniscus or deformation of periarticular tissues. These degenerative changes, resulting in elevation and stretching of the richly innervated periosteum \(^7\) and periarticular tissues \(^1\), are probably major sources of pain in OA \(^10,13\). In addition, a large amount of neuropeptides was found in the synovium of osteoarthritic knee \(^16,21\). Moreover, a considerable number of afferent fibers in articular nerve, which consists of numerous unmyelinated fibers, is non-responsive under normal condition, but there is a potential for an acute injury or inflammation to sensitize these fibers or to awake the “silent nociceptor” \(^17\). Once peripheral sensitization occurred, these fibers might keep responding to the normal joint movement even when the original stimuli had been removed. Changes in the pain intensity may imply that periarticular injection of 10% lidocaine produced degeneration of pain-sensitive fibers responsible to the joint movement, and then reinnervated articular fibers at the injection site were likely non-responsive.

Active ROM remained limited after the injection regardless of the decreased pain intensity during walking. Negative correlation between joint range of motion and Kellgren-Lawrence scores in the patients with knee osteoarthritis has been reported \(^5\). Therefore, a slight improvement of active ROM may be attributed to the severe advanced deformation of the knee joint, as indicated by radiographic findings. In spite of that, however, patients in the 10% lidocaine group were satisfied with periarticular injection. These results may suggest that periarticular injection of 10% lidocaine was more efficient in relieving knee OA pain than intra-articular injection of hyaluronic acid as was the case with the periarticular injection of 1% lidocaine.

It should be noticed that limitations of the present study are small sample data, no observation period before injection, and a short period of follow-up. The treatment effect of lidocaine may be able to relieve some kinds of chronic pain following osteoarthritis of the knee joint. There is, however, a possibility for the repeated periarticular injection causing a regional neurological deficit and damaged periarticular tissue at the injection site. Further studies are therefore needed to clarify the efficacy and local histo-chemical and general cardio-vascular safeness of high concentration local anesthetics for the treatment of knee OA.

CONCLUSION

The periarticular injection of 10% lidocaine at
the medial compartment of the knee joint produces more effective and long-term analgesia for chronic pain associated with osteoarthritis of the knee compared with the injection of 1% lidocaine. In combination with previous treatment regimes, results of the present study may contribute to establishing new and more effective treatment strategies for painful OA.

References
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