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A Preliminary Study of Needle Orientation and Injection Volume in Facet Intra-articular Injection under Computed Tomography-Guiding Technique for The Relief of Low Back Pain

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Lumbar facet joint injection has been a common technique for treatment of facet joint syndrome, but its therapeutic role depends on a reliable injection technique. In the standard fluoroscopy-guided method, an oblique placement of torso to the X-ray beam and confirmation of needle position by contrast-media arthrogram are necessary. However, we have shown that inward growth of osteophyte in degenerative facets often covered the inlet opening and obstructed the needle insertion into the capsule. We also demonstrated that small amount of air (0.5 ml), compared to the contrast medium, could better delineate the entire facet joint structures (joint space and capsule) under computed tomography (CT) and allowed repeated injections to the same joint for correct placement. This investigation indicated that intra-articular injection under CT guidance has the advantages over conventional fluoroscopic method in having better visualization of the articular planes, more accurate orientation of the needle pathway, the benefit of air arthrogram, and increased success rate.

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Lumbar facet joints (zygapophyseal joints) are a potential cause of back pain and sciatica firstly suggested by Goldthwait in 1911[1]. Morphologically, the joint capsule is well innervated, receiving nerve supply from the medial branches of the dorsal rami at the same vertebral level as well as the level above, and full of nociceptive fibers that penetrate the capsule and supplying synovial folds[2]. Therefore, there is rational basis in using facet block to treat lumbar facet pain based on the concept that the technique could desensitize and inhibit excitation of these sensory afferents within the joint. Intra-articular joint injection using analgesics with or without steroids has been presented as a common diagnostic tool as well as a modality of treatment[3-6] for "facet joint syndrome" [7]. Although early studies showed fairly high satisfactory results[8-11] , the diagnostic value and long-term effectiveness remains controversial[11-14]. It is presumed that part of the reasons for the conflicting results stem from lack of consistent and accurate execution of the facet block[12].

In the standard fluoroscopy-guided method, accurate introduction of needle into the capsule is not always attainable because inward growth of osteophyte in degenerative facets often covering the inlet[15]. Although computed tomography (CT) scan can serve as a better tool to delineate both the capsule and the bony structure of the facet joint[16] so that the inlet opening could be readily identified for correct needle insertion, very few study had been conducted to investigate the feasibility of CT guidance technique in facet joint block. In this study, we report our experiences of facet injection under computed tomographic (CT) guidance technique in carefully selected candidates in order to assess the utility of this technique. This trial was a preliminary design for our future large-scale study of facet block for seeking the possible predictive factors as a criterion for diagnosis of facet pain and standardizing our procedure to provide reliable and precise injection technique.

Method

Eight patients (6 males, 2 females) suffering from low back pain for more than 3 months were diagnosed as having facet joint syndrome by the same doctor (YRW) and were eligible for facet joint injection. All of them fulfilled the following criteria: (1) Chronic low back pain with or without radiating ache or soreness to either buttock, thigh, or leg. (2) No satisfactory long-term response to non-steroid anti-inflammation drug or physiotherapy after three months of treatment (3) No neurological deficit of lower extremities confirmed by nerve conduction test and electromyography. (4) Pain precipitated or provoked by either back hyperextension, back lateral tilt, lying flat on the bed, or back rotation. (5) Patient was able to self-locate the specific site(s) of pain or tenderness at paraspinal area nearing facet joints during rest or by provocation test. Informed consent was obtained from each patient after full explanation.
Four views of lumbar radiographic images (Anteroposterior , lateral, right and left oblique) were obtained to assist the diagnosis of facet disease. We also ruled out patients with back pain from spine pathology possibly other than facet joints, such as spinal stenosis, herniated nulceus polpsus, tumor destruction, or compression fracture. Patients with previous spine surgery were not excluded.

Facet injection was performed in a CT scan room. Each patient was asked to self-locate the most painful point(s), which were reconfirmed by movement provocation and was then marked, then lay on the examining table in the prone position with a rolls placed under the abdomen. An initial serial lumbar scans were obtained with 5-mm section thickness involving the injection vertebral levels intended for injection and one segment above and below the designated level. The entry point and needle trajectory were determined from scanning image showing articular depth and position, and localized with the aid of localizer light beam on skin surface. A 27 gauge spinal needle was inserted

vertically into the expected depth of the joint. Successful needle-tip localization was confirmed by the initial injection of 0.5 ml air followed by 0.3 ml iohexol (Omnipaque®) as contrast medium, both of which were visualized by a single scanning. One ml of 2% lidocaine and 20 mg triamcinolone (total 1.5 ml) was then injected. An average of 20 min was needed for one joint injection at each treatment.

Each patient was asked to grade his (her) usual pain and movement provoked pain on a 100 mm visual analog scale (from 0 = no pain to 100 = maximal intolerable pain) before injection and re-evaluated half an hour after the injection. Long-term follow-up was subsequently performed at 1 and 3 months. Although we continued regular anti-inflammatory drugs treatments in all of these patients, most subjects decreased the medication use markedly after the injections.

Results

Among 8 patients, 11 injections were successfully performed (Table 1). No injection complication such as headache, infection, paresthesia and no extracapsular extravasation of contrast medium were found. Because of the clear visualization of the gas image in the capsule, we omitted injecting contrast medium in the last 4 cases (Figure 1). One male patient (Patient 2), who had a previous failed facet arthrogram under fluoroscopy, did obtain a correct needle placement by the CT-guided technique. His severely degenerative joints, hindering the access of needle by traditional method, presented no barrier by CT scan (Figure 2). Another patient (Patient 7) received repeated air injections to a total volume of 2 ml due to initial uncertainty of air location. Her air arthrogram demonstrated an excessively distended capsule, which sharply reproduced her back pain (Figure 3). We withdrew the air then injected the drug, no air leakage from the capsule could be found from further CT image. All the patients showed moderate (more over 50%) or marked (more over 75%) improvement in back pain at rest and during back movement 30 min after injection, and such favorable response persisted in 6 patients at one month and in 3 patients at 3 month follow up (Table 2).

We observed some interesting phenomena in this study: Patients with reproduced pain or soreness as we injected air into the capsule had better pain relief score and this finding is consistent with that of Dory[17]. We also observed more immediate pain relief with the motion of back extension than in the standstill position. Without the use of contrast medium, reduced injection pressure of local anesthetics and steroid could be distinctly felt.

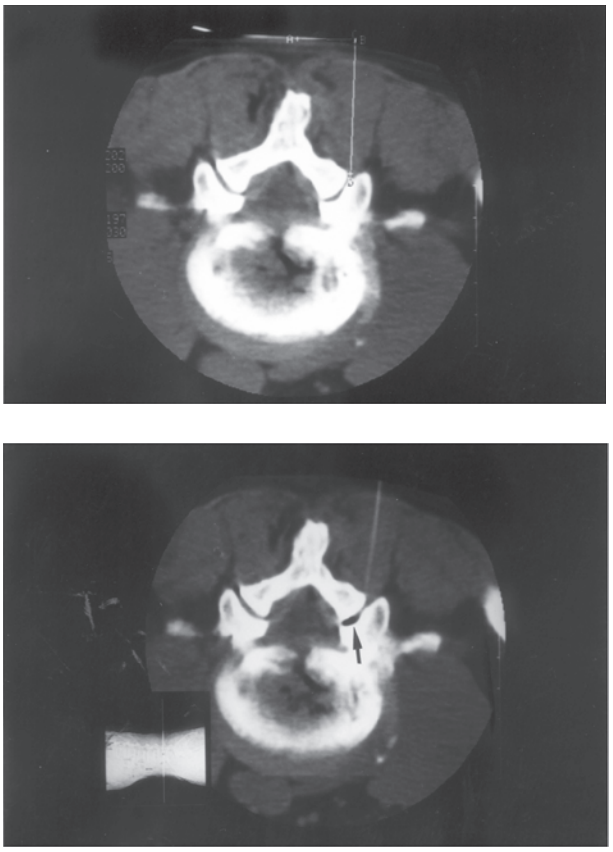

Fig. 1. The CT-guiding facet injection technique. First, measured the distance from a skin entry point to the mid-spinal line and to the joint (A). Inserted the needle to the desired depth then injected with 0.5 ml air, both were confirmed by single CT scanning. After identification of air in the joint (Arrow in B) by CT monitor, 1.5 ml of local anesthetic and steroid was slowly injected.

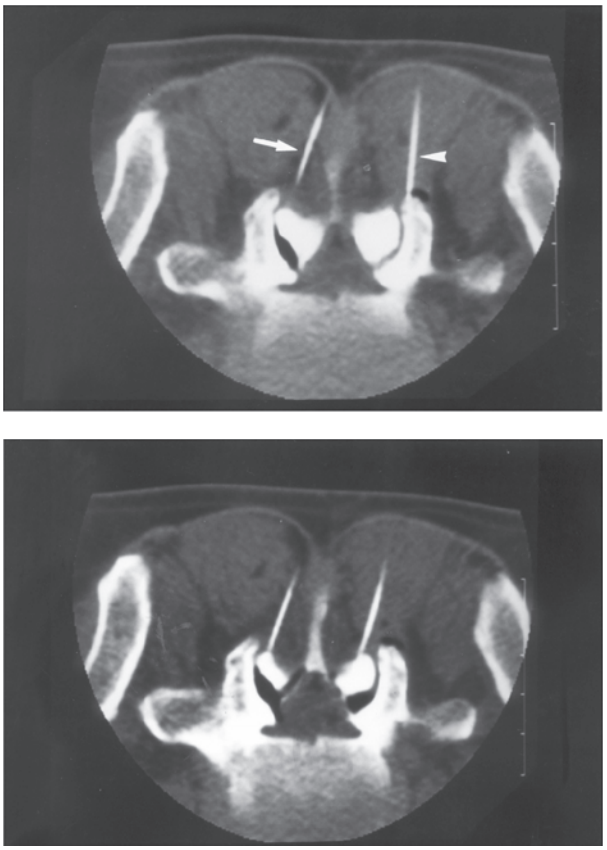

Fig. 2. Successful bilateral facet joints injection in patient 2 who had a previous failed injection under fluoroscopy. The needle trajectory at left joint (Arrow in A) is completely contrary to conventional approach to avoid the osteophyte covering the joint. Notified the first failed attempt of needle placement at right joint (Arrowhead in A), and the correct air image after we redirected the needle route (B).

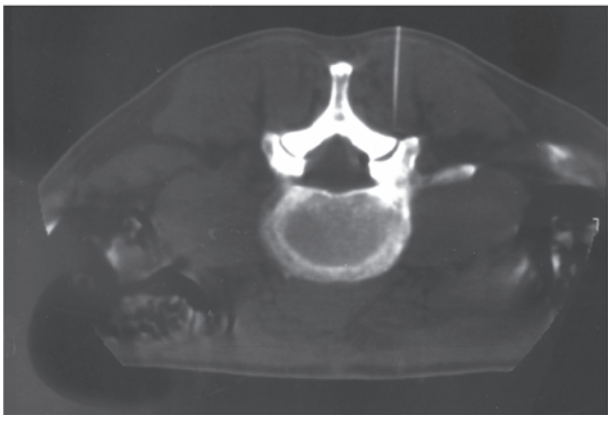

Fig. 3. Repeated injection of air to total volume of 2 ml caused the capsule distension. Patient complained of reproducing back pain as we injected the air.

Table 1. Table 1. Demographic data and pain characteristics of all patients

Patient	Age/Sex	Painjoint*	Symptoms
1	51/M	Left;L4/5	Extension pain**; Radiating to thigh
2	50/M	Bilateral;L5/S1	Bothlegssoreness; Pain in sitting, standing, and lying flat
3	25/F	Left;L4/5	Extension pain; Paraspinal spasm/tenderness; No radiation
4	28/M	Right;L4/5	Extension pain; no pain radiation
5	45/M	Bilateral;L5/S1	Post-laminectomy; radiating to thigh; Unable to lie flatly
6	59/M	Right;L3/4	Radiating to thigh, groin
7	48/F	Left;L4/5	Discnarrowing; Pain at night (lying pain)
8	34/M	Bilateral;L4/5, L5/S1***	Post-spine surgery (not specified); Extension pain; Pain mostly at night

Demographic data and pain characteristics of all patients* Also the injection joint, which was confirmed with both clinical and radiological evidences

**Pain evoked by back hyperextension ***Only bilateral facet joints at L4/5 were injected

Table 2. Pain intensity change after facet joint injection

Pain relief scale	Immediately after injection (No = 8)	Response at 1 month(No = 8)	Response at 3 month (No = 7*)
None (pain relief < 25%)	0	1 (12.5%)	1 (14.2%)
Mild (pain relief > 25%)	0	1 (12.5%)	3 (42.9%)
Moderate (pain relief > 50%)	5 (62.5%)	4 (50%)	2 (28.6%)
Marked (pain relief > 75%)	3 (37.5%)	2 (25%)	1 (14.2%)

Pain intensity change after facet joint injection * One patient was excluded due to loss of follow-up at 2-month post-injection period

Discussion

Our preliminary experience in a series of facet joint injections under CT-guidance demonstrated that this technique provided an accurate needle orientation and needle-tip placement in the articular capsule and proved to be a valuable therapeutic modality for chronic low back pain. In total 8 tested patients, intra-articular

injection with local anesthetic and corticosteroid in facet pain patients can induce moderate or marked pain relief in 6 patients at 1 month and 3 patients at 3-month intervals.

Fluoroscope-guiding technique has been the mainstay of facet joint injection in most clinical practices, and standard oblique placement of torso to the X-ray beam and confirmation of correct needle position by arthrogram with contrast media are necessary. Nevertheless, inaccurate localization of joint space leading to ineffective injection is always a possibility. Failure to enter the joint during attempted intraarticular injection has been reported in 16-38% of lumbar facet injections[11,15] and 44% of cervical facet injections[18]. Anatomically, lumbar facet joint is a curved joint with two different planes with anterior half of the joint lying obliquely to the sagittal plane and the posterior half in or near the sagittal plane. Inward growth of osteophyte in degenerative superior articular facet often covers the inlet opening and becomes the major obstacle that obstruct the needle insertion into the capsule, regardless of whether the needle is at a vertical or lateral approach. In most cases, these problems cannot be easily solved under the fluoroscopic guidance[15]. CT images, which yield precise structural change of the facet joint plane, can facilitate the choice of the best injection entry and trajectory, identify incorrect orientation, and consequently improved the successful rate of the injection. In our practice, we successfully introduced the needle into a severely degenerative joint space under CT in a direction completely contrary to conventional needle trajectory without repeated trial.

Air arthrogram is recommended in CT-guiding injection because we found very clear resolution of gas bubble under CT outlining the facet joint without having to use contrast material for arthrogram[16]. It not only saves much expense, but it also eliminates possible hypersensitivity reaction to contrast media. What is more important is the correct placement of local anesthetic at the target site, either the joint space or nerves to the joint. Its result predicts whether succeeding therapeutic block or radiofrequency rhizotomy would be effective[19,20]. Too much injection volume could rupture the articular capsule and penetrate into neighboring tissues such as muscle, periosteum, ligaments, epidural or subarachnoid space and thus decrease the specificity of the analgesic response to facet block. Capsular rupture had been identified after injection of more than 1 ml into cervical[17] and lumbar facets[21,22]. Without the use of the contrast medium, less injection pressure and more volume of local anesthetic and steroid could improve the analgesic effect without increasing the risk of inadvertent capsule rupture resulting in chemical irritation or infection[23,24]. Furthermore, repeated injection to the same joint is usually required in locating a difficult joint. While the contrast medium remaining in the joint could clearly obscure the subsequent injection, small amount of air rapidly would dissipate into the soft tissue thus repeated injection could be commenced immediately after wrong needle placement.

In our trial, excellent pain relief both at the immediate and 4 week follow-up was achieved, as compared with reported results that ranged from 18% to 63%[3,8,9,21,25]. This high success rate can probably be attributed to our strict diagnostic criteria and the use of the "self locating the pain site" method, which had not been described in previous reports. The characteristic self-sensed pain, either at rest or movement, enabled the clinician to more accurately identify the pain generating facet joint. Since much of the facet pain results from early-stage of articular inflammation with persistent nociceptive neurons sensitization, precise deposition of steroid would effectively inhibit peripheral inflammatory pain for a lasting period.

We are fully aware of the inherent flaws and limitations in this preliminary study; nevertheless, much valuable experience can be derived from this study as described above. When deciding the best imaging technique, such additional factors as radiation, costs and

time consumption must all be considered. Although the increase of time, cost, radiation exposure in patients when comparing with X-ray fluoroscopy, CT-guiding injections is, however, superior in demonstrating the articular orientation and anatomical relationship between the needle-tip and joint space. For cases with difficult approaching joint or history of failed injection, CT-assisted injection provides a technique of choice for this treatment modality.

In summary, our findings in this study encourage the use of CT-guide facet joint injection in patients with facet pain syndrome who have degenerative facet joints being not amenable to the conventional fluoroscopy-guide injection. However, careful study designs on controlled samples, various outcome measures, standardized injection technique and meticulous patients selection are still needed to clarify the role of facet

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以CT引導脊柱小面關節內注射時針刺定位及注射體積之初步研究

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腰椎小面關節注射是治療小面關節症候群的常見技術，但其治療效果決定於正確可靠的關節腔內注射。傳統的X光透視引導術需要側轉病患身體，以便利用顯影劑確定注射針尖的位置，然而，我們在電腦斷層檢視(CT)下，發現退化的小面關節長出的骨刺，常常會遮蓋關節入口並阻礙注射針刺入關節。我們同時證實關節腔內注射0.5 ml空氣，比起對比顯影劑有更好的顯影效果，同時可以增加注射藥物的劑量。本實驗證實了以CT輔助的小面關節內注射術比起傳統的X光透視引導術，可以有較優良的關節面顯影，正確的注射針定位，可避免對比顯影劑的副作用，及較高的成功比率。

關鍵字：小面關節注射、電腦斷層攝影，關節顯影。

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