Percutaneous Cryotherapy of Facet Joint Syndrome under MRI Guidance: Technique and Results

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Purpose

The purpose of this pilot study was to demonstrate the feasibility of the percutaneous treatment of the lumbar facet joint syndrome under near-real-time MRI guidance using cryotherapy.

Introduction

The treatment of lumbar facet syndrome[1] is usually confirmed by single blind H_2O-, Xylocain- and Bupivacain-infiltration. R esponse to conservative treatment still remains a challenge. Direct cryoanalgesia by means of a cryogenic probe and direct MRI guidance may be an advantageous therapeutic alternative. Indeed, the possibility, with state-of-the-art open-field MRI systems, to guide the cryotherapy in near-real-time to the target lumbar facet joint and to further monitor the extent of the iceball volume and temperature, may significantly improve the clinical efficacy of the treatment as the effect on the surrounding tissue and the facet joint can be observed.

Methods

In this pilot study, we considered a group of 10 patients with confirmed lumbar facet syndromes. The technique exploits the unique features of a 0.5T SIGNA-SP open-field MRI unit from General Electric Medical Systems [2]. Using the near-real-time imaging mode of this open-field iMRI system, patients were subject to percutaneous cryoanalgesia. A Galil Medical's CRYO-HIT^{TM} cryosurgical system along with a Galil-E0^{TM} MR-workable cryoprobe of 3 mm in diameter was used to induce a cryogenic temperature onto the patient`s lumbar facet. Prior to the treatment, each patient was investigated according to a standardized motion and pain protocol to be systematically repeated 1 week, 1, 3 and 6 months after the cryoanalgesic treatment.

Patient selection: Patients more than 18 years old with low back pain for more than 3 month, which pain was unrelieved by analgesics, NAD, and physical therapy. Pain has to be graded higher than 30mm on a 100mm visual analog scale (VAS) and has to be present on the day of the facet injections.

Criteria of exclusion: LBP only on some occasions, prior to lumbar cryotherapy, LBP with true sciatica, pain originating from the upper lumbar column or sacroiliac joint, pregnancy, psychiatric disease that interfere with a patient's adequate response to the result of the injection, history of adverse reaction to lidocaine or bupivacaine.

Injection method: Lumbar facet joints are injected bilaterally or unilaterally when pain is distinctly localized. Injections are performed with the patient in prone position. The facet joints are approached through the postero-inferior recess with a 18gc needle under near-real-time MRI guidance. If an intra-articular placement is uncertain, patients are excluded from the study.

MRI Guidance: Details of the near-real-time imaging protocol include using: a fast 2D-Gradient Recalled Echo sequence with a TE/TR of 27.8/13.7 msec and a 80^{o} flip angle. Typically, a single 5 mm thick slice per image is acquired in the axial plane. The slice is spanning an FOV of 30X30 cm^2 sampled by a matrix of 256x128 pixels and 1 NEX. The resulting image refresh rate is of 4.0 sec/image.

Cryotherapy: The treatment is performed with the patient in prone position. Lumbar facet joints are treated unilaterally or bilaterally when pain is distinctly localized and matched with the facet infiltration result. The probe is inserted using a thermal shield to minimize soft tissue affection and is placed on top of the facet joint line. This shield is brought onto the target facet-joints under near-real-time MRI guidance. The cryogenic cycle consists of two sets of 7 minutes freeze to a target temperature of –180°C interleaved with two minutes of passive thawing. The iceball growth is then monitored under direct MRI vision. Percutaneous temperature measurements are also recorded using a thermosensor positionned within 5 mm from the cryoprobe shaft, 1 cm away from its tip.

Results

Figure 1(A) presents a typical MR axial image acquired in near-real-time mode during the course of a cryoanalgesia procedure. The situation is illustrated schematically in Figure 1(B).

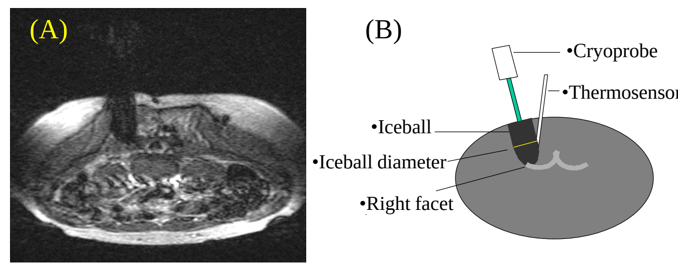

Figure 1

Figure 2 shows *in vivo* results collected during a bilateral cryotherapy case. For both facets treated, the probe internal cryogenic temperature is shown (dashed line) along with the reading of the external thermosensor (solid line). The figure also shows the post-operative evaluation of the 0 °C iceball diameter and of the temperature measured by the external thermosensor positioned roughly ~3 mm from the probes shaft. Measurements of the maximum extent of the induced iceball were taken as illustrated on Figure 1(B). The results allow for a quantitative understanding of the iceball's *in vivo* growth process. Temperatures at the external thermosensor are found to reach about –30 C. Maximum iceball diameter values, delimiting the 0 °C line, are found to be of order of 5 cm. In the second cryogenic treatment, one observes a direct correlation between tissue temperature, as sensed from the thermosensor, and the iceball diameter.

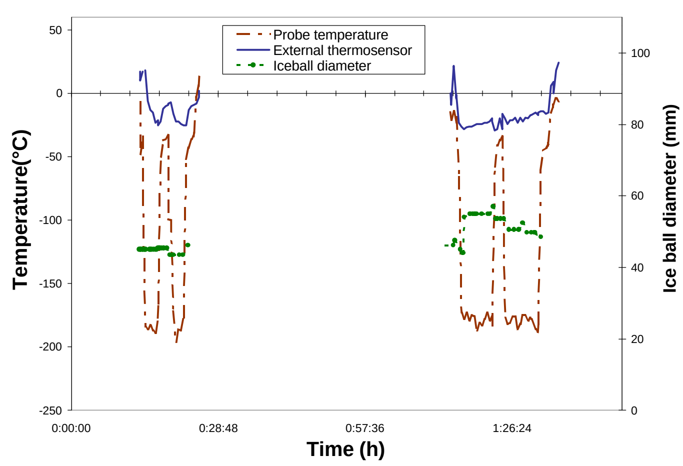

Figure 2

Conclusion

Results presented here demonstrate the feasibility of percutaneous treatment of the lumbar facet joint syndrome under near-real-time MRI guidance using cryotherapy. The iceball growth process in both the spatial and temperature domains of was further substantiated with direct quantitative analysis of data collected during human in vivo cases.

References

[1] J.M Cavanaugh *et al.*, "Lumbar Facet Pain: Biomechamnics, Neuroanatomy and Neuropysiology", J. of Biomechanics, 1996, 29(9): 1117.
[2] Shenk, J.F. *et al.*, Radiology, 1995, 195:805-814.