Ultrasound(US)-guided Fusion Imaging-assisted Facet Joint Injections: A Didactical Approach

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**BACKGROUND**

*Facet joints (FJs) or zygoapophysial joints (Z-joints)* are one of the most ignored joints in the body, but they play a key role in allowing for smooth spine motion.

Located posterior to the vertebral body, FJs are *synovial diarthrosis* on the side of the vertebral column nearest from the surface of the skin.

FJs allow the spine considerable variety of movement and flexibility, but they also prevent excessive or extreme movement, such as hyperextension, hyperflexion, and work against such injuries as whiplash (*Fig 1*).

*Fig. 1. Facet Joints in Motion*
Each spine vertebra communicates with each other with four small arm-like extensions or articulating processes: two pointing up (superior process) and two down (inferior process); the inferior process of the vertebra communicates with the superior process of the vertebra below and the superior process communicates with the vertebra above.

Together with a disc that sits between the bodies of the two vertebra they form a *three joint complex*, that consist of vertebral body-disc-vertebral body joint and two facet joints *(Fig. 2).*

The inner surface of the facet joint serves as an outer wall of an opening or a foramen for a spinal nerve, through which it exits.

The disc and the junction of the two vertebral bodies serve as an inner wall of this foramen.

*Fig. 2. The Three Joint Complex*
BACKGROUND

- FJ patologic changes can be responsible of 15-40% of Low Back Pain.

- A correct diagnosis can be made with TC or MRI demonstrating inflammation, irritation, swelling, or degenerative changes of facet joints (Fig 3).

- In such cases, FJ intra-articular injections with local anesthetics or anti-inflammatory drugs can be made with diagnostic or therapeutic purpose.

US-TC or US-MR fusion imaging allows the use of a recent diagnostic examination of the spine thus reducing the radiation dose comparing to procedures performed under the guidance of fluoroscopy or CT.

Fig. 3. Axial CT scan showing reduction of articular space and pseudocystic degenerative changes of the IV lumbar facet joint.
Currently, facet joint injections are usually performed using CT guidance or fluoroscopy (Fig. 4).

The use of a GPS enhanced fusion system allows to combine the precision and panoramic view of these imaging modalities with the US dynamic imaging.

This setting may also shorten the time of the procedure and reduce the radiation dose.

The aim of our educational exhibit is to illustrate the performing of such procedure using a GPS-driven US with CT or MRI fusion system.
PROCEDURE DETAILS - MATERIALS

- ✔ 20G spinal needle (Fig. 5a)
- ✔ 3 ml syringe
- ✔ Steroid (triamcinolone acetonide, 0.5 cc)
- ✔ Local anesthetic (lidocaine, 0.5 cc)
- ✔ US equipment with fusion-imaging dedicated software
- ✔ Position Sensing Unit (PSU) (Fig. 5b and 5c)
- ✔ Bracket fitting the position sensors on the US probe (Fig. 5d and 5e)
- ✔ One recent diagnostic TC or MR examination of the affected spine level
Plug in the Position Sensing Unit connector and load on the US equipment the CT volume or MRI scan (Fig. 6a and 6b).

In the case a MRI examination is used, a volumetric, 3D-sequence is needed to reconstruct in real-time the scanning plane without loss of quality of the images.

In the case a CT examination is used, a thin slice (0.625-1.25 mm) dataset is needed.
PROCEDURE DETAILS – STEP 2 (Patient)

Place the patient in prone position.

Perform a 2-step disinfection of the area to be treated:

- first, use a brown water-based povidone-iodine solution to mark the treated area and leave for 3–5 min;
- second, use a transparent solution of 70% isopropyl alcohol and 2% chlorhexidine to disinfect by denaturing proteins and disrupting the cell wall of microorganisms in addition to being bactericidal and long-acting.

Delimitation of the area to be operated on is performed by the operator using sterile technique, including adhesive sterile towels (Fig.7).
PROCEDURE DETAILS – STEP 3 (Probe)

- We used a standard US device (GE, Logiq E9) equipped with a convex transducer (1.5-5 MHz) and with Vnav and Fusion Imaging dedicated softwares.

- Place the bracket and position sensors on the probe together with abundant amount of US standard gel (Fig.8).
A sterile cover is placed on the probe and fixed with a rubber band by the operator with a sterile technique and a disposable biopsy guide of the adequate size is attached on the outside (Fig.9).

Sterile gel is then applied on the cover.
PROCEDURE DETAILS – STEP 4
(Localization of the posterior spinous processes)

- A posterior parasagittal scan is obtained to identify the correct level to treat, starting from the sacrum and proceeding cranially *(Fig.10a, 10b).*

- If difficulty is encountered, note that the posterior spinous process of the first sacral vertebra (S1) is solidal to the sacrum when the Patient is asked to perform slight movements of flexo-extension, while a slight movement of the last lumbar vertebrae (L5, L4, L3) is clearly appreciable.

*Fig.10a and 10b.* Posterior parasagittal US scan (10a) and corresponding parasagittal MRI scan (10b), obtained to identify the sacrum (S1) and the spinous processes of L5 and L4.
Once the level of the L5 spinous process is localized, an axial scan is performed to count the spinous processes above and reach the level of the pathologic facet joint.

The CT/MR corresponding level is consequently set by the operator.

The calibration of the system consists in selecting and coupling at least two points on the US image (apex of the spinous process and joint space) and on the corresponding CT/MR section at the same level. (Fig. 11a, 11b).
Once calibrated, the system shows the CT/MR image corresponding to the current US scanning plane (Fig. 12a, 12b).

Reference points are graphically visualized with crosses if they lie in the scanning plane, as squares if on another plane (see also Fig. 13a-d).
The corresponding reconstructed image can be also superimposed on the US scan as a shadow, in order to improve the operator confidence (Fig.13a,13b and Fig.13c,13d).

The biopsy line with a proper angle is superimposed on the US scan to visualize the path the needle will follow once inserted and it is then aligned with the joint space to be treated.

*Fig.13a, 13b and Fig.13c, 13d. Superimposition of the corresponding reconstructed CT (13a,13b) or MRI (13c,13d) image on the US scan together with the biopsy line with a proper angle.*
The spinal needle is inserted in the bioptic guide and its progress through the soft tissues is visualized on the US scan.

Once the needle tip reaches the joint space, the syringe is applied on the needle and the intra-articular injection is performed.

At the end of the injection, the needle is extracted and a sterile plaster is applied.

The movie shows the Ultrasound(US)-guided Fusion Imaging-assisted Facet Joint Injections; it is possible to recognize the 20G needle as a weak hyperechogenicity that reaches the FJ to treat along the biopsy line.
CONCLUSIONS

After a short learning curve, US needle guidance with MR or CT fusion assistance allows for a quick, safe and effective injection of degenerative facet joint disease without the use of ionizing radiations.

In case of “difficult” target joints with the presence of osteophytes along the path of the needle, a solution could be the use of a virtually tracked needle to perform a free-hand, out-of-plane injection that, however, requires a longer learning curve.
SUGGESTED READINGS


