CASE REPORT

Clinical usefulness of 3T UTE imaging on MSK
Comments from Dr. Xavier Alomar

“I would like to state that the Toshiba Medical’s magnetic resonance imaging (MRI) scanner contains a new package of sequence including a 3D FFE sequence which enables me to get high resolution isotropic images (e.g. 1 mm) with ultra-short TEs (e.g. 0.09 ms). This sequence is very robust, reproducible, stable and non-prone to artifacts; features which make it instrumental in clinical routine. I am very excited with this sequence because it will allow us to assess the structure of tissues with extremely short T2* value (e.g. tendons, ligaments, osteochondral joints, fibrosis) which cannot be evaluated with conventional sequences.

In addition to musculoskeletal studies, I foresee that this sequence will be also relevant in other clinical applications such as depicting lungs without radiation exposure.”

Dr. Alomar currently serves as Head of the Radiology Department and R&D at Medical Centers Creu Blanca. He holds a Doctor of Medicine degree with specialization in Radiology from Hospital de la Santa Creu i Sant Pau in Barcelona, Spain.

With over 27 years of experience in Diagnostic Imaging, particularly computer tomography and magnetic resonance, Dr. Alomar has contributed to a number of studies and papers in local and international scientific publications, to include AJR and RSNA. He has focused his clinical and research interests in orthopedic, angiography, cardiology, body imaging, women’s and men’s health.

Presentation of Group Creu Blanca

Creu Blanca is a family business with 67 years of experience in the healthcare sector. Currently we have over 350 health professionals who actively collaborate with us and a staff of 200 people.

The management of the group is completely centralized, which facilitates and streamlines the management of appointments, billing, and finally, the Customer Relations.

We attend more than 300,000 Customers annually, and make an average of 600,000 annual medical acts.

We are present in Barcelona and Zaragoza, we have:

In Barcelona:
- 2 Medical Centers (Creu Blanca Pelayo and Creu Blanca Tarradellas)
- 1 Polyclinic (Diagnosis Médica)
- 1 Hospital: Clínica Creu Blanca

In Zaragoza:
- 1 Polyclinic (Policlínica Sagasta)
- 1 Diagnostic Center (Paracelso Diagnóstico Médico)

We have a large variety of equipment that allows us to perform from the simplest to the most complex explorations:
- 13 MRI (3 of them of 3 Tesla)
- 3 CT Scanners
- 30 Ultrasound systems
- 30 XR systems
- 2 SPEC systems
- 1 Interventional XR Room
- 1 Digital Mammography systems with Tomosynthesis
- 150 Medical Offices
- Emergency Service
- 4 Surgery rooms, 4 Surgery rooms and 25 boxes for Outpatient
- 50 Hospital rooms
- 1 PET - CT
Patient History:
16 year-old male. Pain, swelling and instability after knee trauma.

Imaging Findings:
T2 FSE sequences show bone edema within the external femoral condyle, with a fracture line in the subcortical trabecular bone without delimiting discontinuity of the cortical bone or articular cartilage.

UTE (ultra-short TE) sequences allow for the visualization of low signal in the cartilage, as well as the cortical area of the bone previously identified on the T2 sequences. This area is divided in 2 layers, a superficial one of high signal in the UTE which corresponds to the osteochondral area or tidemark, and a deeper cortical bone area. At the level of the subchondral fracture, discontinuity of the double line in the cortical bone was not identified, which signifies its integrity.

The T2 sequences show thickening of the ACL fibers with signal abnormalities in their proximal area. The UTE sequences also display signal abnormalities.

Discussion:
UTE is a new sequencing option, characterized by the ability to acquire 3D gradient echo images with echo times (TE’s) of less than one millisecond. This allows us to evaluate structures with very short echo times such as connective tissue, fibrosis, and osteochondral unions. Previously these structures could not be evaluated with MR due to the low signal that results from their very short TE’s.

The process is simple: two UTE sequences are acquired with respective TE’s of 2 ms and 0.09 ms, an isotropic pixel resolution of 0.4 x 0.4 (matrix of 412 x 412), and a scan time of approximately 4 minutes per sequence. This is followed by a subtraction between the two different TE’s. The resulting images are used to evaluate connective tissues.

Conclusion:
Thanks to UTE sequencing, we are now able to evaluate a series of anatomical structures which have been previously overlooked due to their short relaxation times and low hydrogen content. Most important amongst these structures are connective tissues and their derivatives (such as tendons, ligaments, and osteochondral structures) and their many pathologies. In our case, UTE permitted us to rule out osteochondral pathology.
Patient History:
33 year-old male athlete. Presents with infrapatellar pain after exercise.

Imaging Findings:
T2 FSE and 3D gradient sequences display thickening with abnormal signal and edema of the patellar tendon on the patellar insertion, central fibers, without fibrillary discontinuity and with adjacent normal Hoffa fat. The UTE sequence demonstrates thickening with signal abnormality of the central patellar fibers along their insertion, while both the superficial and deeper tendon fibers show normal signal intensities.

An area of Grade 1 Chondropathia in the trochlear region, with areas of fibrocartilage, subchondral lesions and some areas of chondral delamination, is seen on both the T2 FSE and 3D gradient sequences.

In the UTE sequences, we did not observe the double line (black/white) in the cortical osseous trochlear region, as opposed to the patellar zone, where the line is clearly delimited, a sign of integrity of the osteochondral or tidemark zone.

Discussion:
With UTE sequences, we can evaluate different grades of intratendinous edema. While acute tendinopathy can be easily be seen on regular T2 FSE and 3D gradient sequences, as the pathology resolves, so does the edema, making it difficult to differentiate the grades of chronic tendinitis. Thanks to the new UTE technique, we can evaluate high signal regions, particularly in these areas where basic sequences could not routinely do so.

Conclusion:
It is probable that in the future, by utilizing this new sequencing technique, we will be able to better evaluate different grades of chronic tendinopathy and better understand the process of degenerative tendinopathy, as well as quantify the results of various treatments for these conditions.
**Patient History:**
75 year-old male. History of Achilles tendon rupture and post-surgical changes. 6 month follow-up showed good clinical evolution.

**Imaging Findings:**
Considerable thickening with signal abnormalities of the Achilles tendon on the T1 and T2 FSE sequences, as well as continuity of the tendon and some areas of internal myxoid degeneration, are seen. The UTE sequence identified the most extensive signal abnormality in the Achilles tendon in comparison to T2 and T1 sequences, corresponding to areas of tendinopathy and regeneration of subacute phases and delimiting the regenerative zones of healthy tendon. In the UTE sequences, we cannot identify the areas of myxoid degeneration or the areas of fibrillary discontinuity but we can see more clearly the surgical metallic artifacts and evaluate the areas that surround them.

**Discussion:**
By using UTE sequences, we can evaluate the different stages of chronic tendinopathy after surgery, allowing better delineation between healthy tendon and areas of regeneration, as well as the surgical zones, but we cannot differentiate areas of fibrillary discontinuity and myxoid degeneration from areas of tendinosis and regeneration.

**Conclusion:**
UTE permits a better evaluation of regenerative or discontinuous tendons and post-surgical tendons, as well as the evolution of final stages of chronic tendinopathies. However, UTE should not be used to assess the degree of fibrillary discontinuity in acute lesions, the degree of retraction in tendons, or areas of myxoid degeneration.

**UTE Sequence.** TE=0.09 ms
**UTE Sequence.** TE=2 ms. Post-surgical artifacts clearly depicted

**T2 FSE with Fat Saturation.**
Large chronic tendinosis area of low signal on T2 with an area of myxoid degeneration and fibrillary discontinuity. This area is not identified on the UTE images.

**T1 FSE.** Similar findings as in the T2 sequence.

**UTE Subtraction.**
Diffuse alteration in the Achilles tendon signal in the operative zone delimited at its ends with healthy tendons and interior fascicles.
Case 4

Patient History:
28 year-old male basketball player. Presents with increasing pain over the last two years in the inferior pole of the patella.

Imaging Findings:
Sub-acute tendinopathy with areas of chronic tendinopathy at the level of the proximal insertion of the patellar tendon, with focal tendon edema, osseous edema in the patella, and fibrillary discontinuity of deep fibers and edema in the Hoffa fat are all clearly observed in the FSE T2 sequences. UTE sequences show better depiction of the tendinous calcifications and the greater extension of the tendinopathy.

Discussion:
UTE sequences can be used to better determine the grade and extent of tendinous degeneration in the context of acute chronic tendinopathy in addition to intratendinous calcifications. At the same time, it is less sensitive in the assessment of fibrillary discontinuity in the cystic cavities, intra-tendinous myxoid degenerations, osseous edemas, and edemas in Hoffa fat.

Conclusion:
In the future, use of UTE as a complimentary technique may become essential for assessing the degree and extension of acute, subacute and chronic tendinopathy, as well as for follow-up. However, it will not replace routine FSE T2 and 3D gradient sequences as they provide better visualization of fibrillary discontinuity and involvement of adjacent structures.
All images shown in this document are acquired utilizing Vantage Titan™ 3T and the results are the findings of the author. Clinical outcomes may vary dependent upon clinical use and environment.