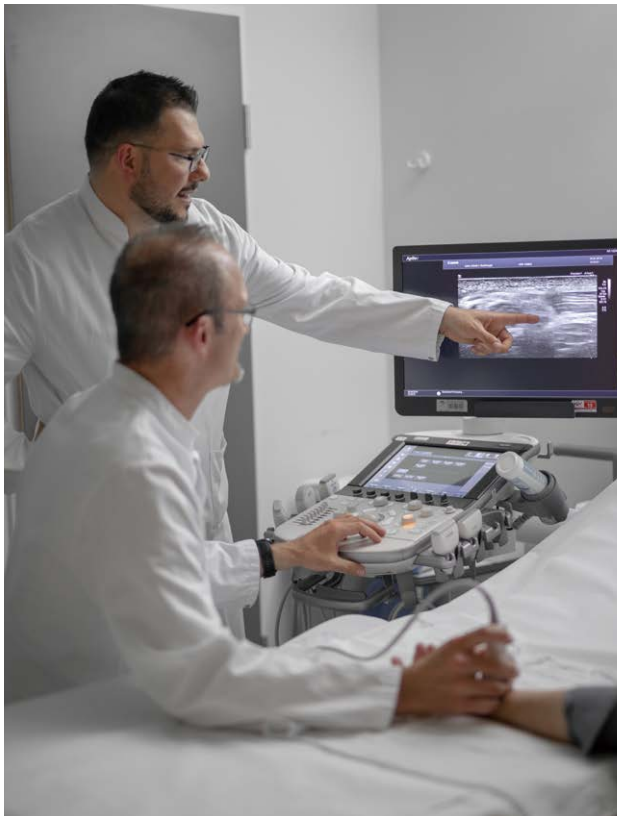
INTERVIEW REPORT

The WOW-Effect in Sonography

Introduction

In the center of Tyrol and thus also situated in the middle of the Alps, the Medical University Innsbruck (Medizinische Universität Innsbruck) offers ideal conditions for successful research, studies and teaching at an attractive location. Its core tasks include teaching and education as well as research at the highest level and the continuous improvement of state-of-the-art medicine.

The Medical University Innsbruck is a research center with a long tradition. In 2004, it was founded as an independent university. However, its roots date back much further than that: in 1562, the Jesuits built a high school in Innsbruck.



PD Dr Hannes Gruber (in the front) and PD Dr Alexander Loizides (in the back) from the Medical University Innsbruck.

Building on this school, Emperor Leopold I founded a university of which evolved into four founding medical faculties including the Medical University Innsbruck. In its 350 year history, it has always been one of the most important flagships of the university. Three of the four Nobel Prize winners worked at the Medical University Innsbruck at the 'Institute für Medizinische Chemie' (Institute for Medical Chemistry), for instance. Today, the Medical University Innsbruck with a total of approx. 3,000 students and approx. 2,000 employees is the most important medical research and education institution in Austria.

Research, diagnostics and treatment are among the core tasks of the Medical University Innsbruck. The Innsbruck physicians gain international recognition with new therapy methods and research findings. One locational advantage is the close structural and spatial proximity of theory and practice. Patients from all over the world come to Innsbruck for treatment.

As is well known, four eyes see more than two. This particularly applies to the senior consultants PD Dr Hannes Gruber, head of the Department of Interventional and Diagnostic sonography of Radiology of the Medical University Innsbruck/Tirol Kliniken and "ÖGUM Working Committee Nerve Sonography " and PD Dr Alexander Loizides, head of the " ÖGUM Working Committee Musculoskeletal Sonography and Interventional Sonography" and vice-head of the Department of Interventional and Diagnostic sonography of Radiology of the Medical University Innsbruck/Tirol Kliniken.

Due to their know-how and competence in diagnostic ultrasound, the two radiologists see what many physicians can often only dream of, like the tiniest of nerves and their pathologies. The application of high-frequency ultrasound allows them to make medical diagnoses and carry out pain therapies which turns out to be a win-win situation both for the attending physician and the patient.

You are running a state-of-the-art center for sonography and also do scientific work in ultrasound research; how did this come about?

PD Dr Gruber: Already as a young medical student at the anatomic institute, I was interested in musculoskeletal issues. When I joined the University Hospital here and met two colleagues who had begun to understand nerve sonography in detail, so I found an opportunity to intensively study in this direction myself. Already at that time, we were able to identify nerve pathologies and anomalies of which others could only dream of and thus became pioneers in the sonographic acquisition of such details.

Can you give us an example what it was about?

PD Dr Gruber: At the beginning, we were even happy when we were able to differentiate between tendons and nerves which could not be taken for granted given the sonographic and resolution qualities of the ultrasound devices in the nineties. We then started from the "big" pathologies, like the carpal tunnel syndrome or the cubital tunnel syndrome, continued via traumatology and ended up at more complex nerve pathologies and nerve topographies. At that time we could not have believed that today we would depict and diagnose such tiny structures with up to 33 MHz probes. In addition to these morphological diagnoses, the treatment of pain by using ultrasound guidance showed an astonishing development. This was not only interesting from a scientific standpoint but allowed for bridging the gap between the diagnosis at the peripheral nervous system and targeted and image-guided pain therapy.

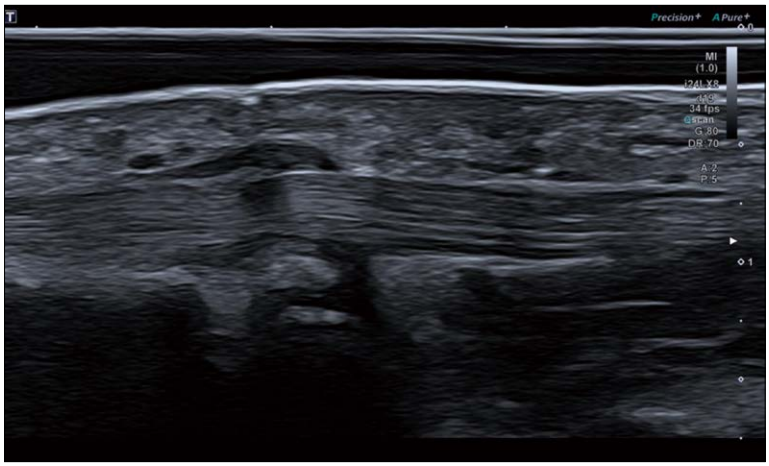


Figure 1 Massive thickening of the A1-Pulley in a 53-year-old patient with tendovaginitis stenosans.

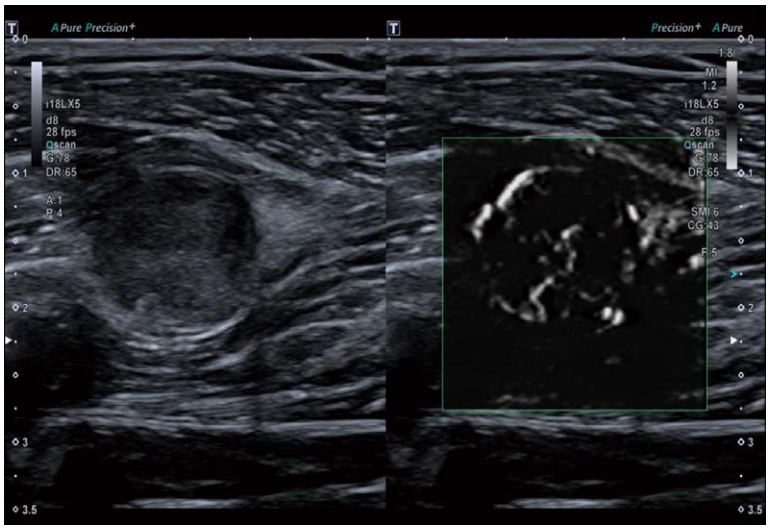


Figure 2 Grey scale US and SMI of a typical Schwannoma of a muscular branch of the soleus muscle.

Did you cooperate with other disciplines when you started to develop this image guided pain therapy?

PD Dr Gruber: Until then, neurosurgeons had been used to perform pain therapy intraoperatively by means of fluoroscopy. Both involve considerable time and effort. When we then started to use sonography at confined precision, we were not taken seriously in the initial stages. Today, we are able to perform even targeted pain therapy of the peripheral nerve system including the entire spine using sonographic image control. The only cases where we cannot offer those interventions are patients with e.g. significant scar tissue or with a body mass index of over 45 - which affects at most 10% to 15% of all patients.

Why has nerve imaging experienced such a boom recently?

PD Dr Loizides: In times of 10 MHz probes, we could mainly display and assess large nerves: Thanks to technical advances in hardware and software, optimized post processing and especially due to the development of ultra-high frequency probes with frequencies of up to 33 MHz, even tiniest nerves and nerve branches with diameters markedly below one millimeter may be imaged in detail and assessed with high accuracy. This is a groundbreaking development in nerve sonography and this detailed imaging elicits a "wow" from us and our colleagues time and again.

What are further important applications of the high-frequency probes?

PD Dr Loizides: Besides imaging of the peripheral nervous system, high-frequency ultrasound is also used widely in the evaluation of soft tissues and in particular in musculoskeletal tumor diagnostics. As a radiological reference center with an orthopedic department, we have raised the tumor diagnosis to a new level. Using a standardized examination algorithm, we can create an overall image of the tumor by evaluating the lesion sonographically and obtaining precise biopsies from sonographically predefined areas. Before applying our optimized diagnostic algorithm, the inconclusive histologies were at around 20%; by integrating the contrast-enhanced sonography into our examination algorithm in a standardized way, we were able to reduce such inconclusive histology practically to zero. In this way, we can image vital tumor parts for the subsequent ultrasound navigated biopsy next to assessing the vascularization of a lesion which is fundamentally different between benign and malignant tumors.

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What are the concrete advantages of high-frequency sonography in radiological imaging?

PD Dr Gruber: The technical progress made in probe design has enabled the development and construction of new ultrasound probes, able to generate much higher frequencies. Which significantly and in some constellations also dramatically improved the spatial resolution. There is no other modality offering a comparable win-win situation for patients and attending physicians alike due to low costs and zero radiation dose.

Do patients know about these advantages?

PD Dr Gruber: Patients today have very good knowledge and often come to us for a second opinion. Frequently, they endured extended periods of suffering with many imaging studies and several unsuccessful therapies. So the benefit to the patient is tremendous if the examination including an eventual therapy takes a maximum 15 minutes, with a clear positive clinical result.

What makes the Innsbruck Sonography internationally so well known, successful and unique?

PD Dr Loizides: We are one of the leading centers that has already been dealing with nerve sonography and pain therapy for a long time and therefore has gained an enormous amount of experience and expertise. The ultrasound navigated pain therapy in the spine has mostly been developed and was first published in Innsbruck. These infiltrations were of course evaluated in prospective randomized studies as valid results and the scientific evidence are an important concern to us. In the meantime, these infiltrations have been standardized and are offered as a routine procedure in our department as an alternative modality to time-consuming procedures and above all to methods prone to radiation exposure like fluoroscopy and computer tomography. Due to these publications and the acquired technical know-how and competence, we have become an international training center over the past few years visited by colleagues from all over the world to learn about ultrasound guided infiltrations in the spine.

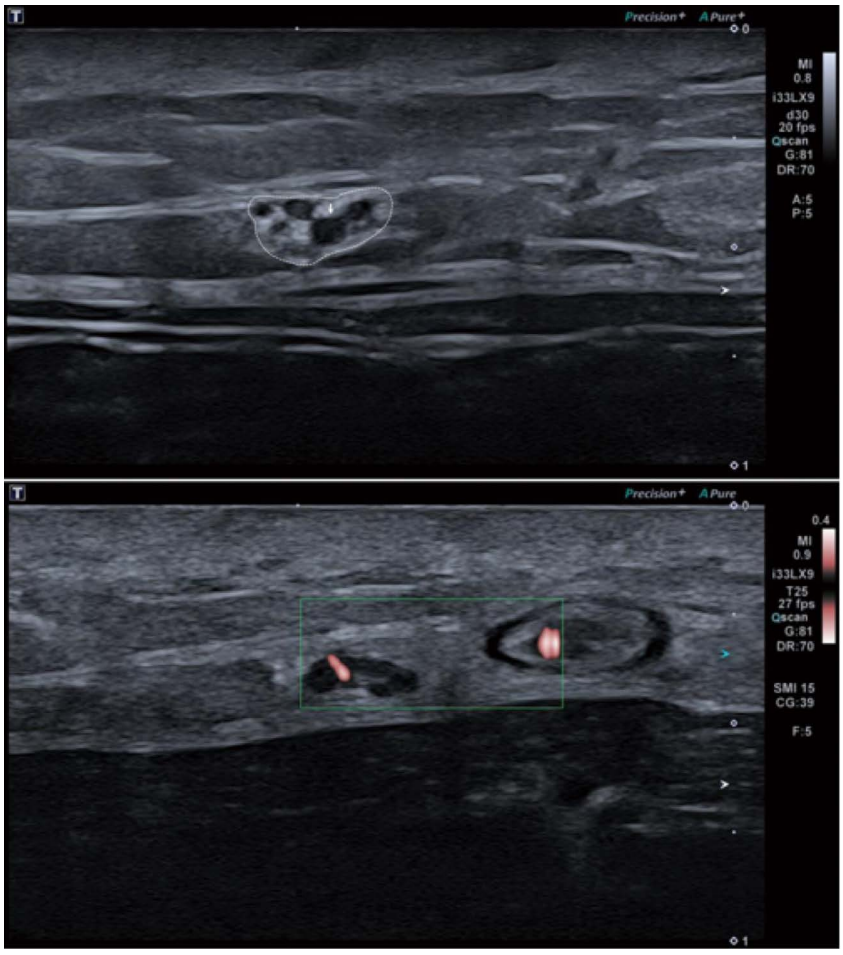

Figure 3 Depiction of the sural nerve (dotted line) with illustration of more than 7 nerve fascicles (arrow) including even an intraneural vessel using a 33 MHz probe.

You rank worldwide among the leading physicians who have clinically used the latest 33 MHz Active Matrix Transducer of the Aplio i800. What was your first impression?

PD Dr Loizides: We were already using the 24 MHz probe, when we were among the first to be given the opportunity to use the 33 MHz probe in our daily routine. When talking about a highlight at that time, we are talking about THE ultimate 33 MHz probe now. This redefines the entire collected knowledge in nerve sonography: so far it had been general knowledge that tiny nerves/nerve branches are monofascicular. Now, we know that this is not true: by using the 33 MHz probe, we could show that these smallest branches consist of several fascicles after all. This insight leads to entirely new approaches in the diagnosis and therapy of nerve pathologies.

Ultrasound provides both anatomical as well as tissue perfusion information. Can you give examples where you implement this state of the art ultrasound flow imaging in your work?

PD Dr Gruber: From neurosurgery we know that nerves appear reddened and swollen during operations in case of compression syndromes. However, we never had a correlated image to prove it to visualize preoperatively this pathological vascularity of compressed nerves and our current data makes us confident that this will be a big step forward in diagnostics: we might come closer to finding a possible "vascular" cause of compression neuropathy.
The innovative Superb Micro-vascular Imaging (SMI) ultrasound technology means a big step forward in the duplex sonography and thus in the diagnostic accuracy. We are nowadays able to diagnose pathologies of patients not only based on questionable reliable surrogate markers but rather directly and thus more in detail. This is reflected in the distinct efficiency of our work, but also leads to the conclusion that radiologists and sonographers must update their knowledge as new findings become routine in this environment. A big challenge is that we need and want to bring on board colleagues from other medical disciplines.

What special challenges do these new findings bring along?

PD Dr Gruber: In the first place, not so much in medicine but rather due to the fact that we have to bring colleagues from many medical disciplines on board. It will be crucial to convince neurosurgeons, trauma surgeons, orthopedists and especially radiologists that we specialists in ultrasound diagnostics are able to provide a faster, more accurate diagnose than traditionally used modalities, ultimately that will lead to better patient outcomes. So we must work together to find concrete solutions for the correct treatment of patients and the related correct procedures based on these technologies.

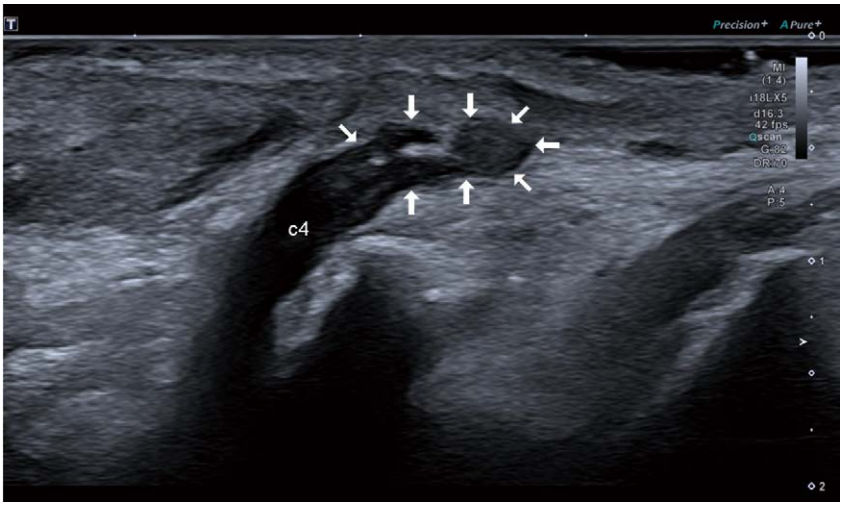

Figure 4 Neurotmesis of the C4 nerve root in a patient after sharp neck-injury.

In recent years, you have held numerous ultrasound courses together with your team: Why do you think it so important to pass on your ultrasound expertise?

PD Dr Gruber: What was the stethoscope in earlier times is more and more replaced by ultrasound today. In nearly every medical discipline, ultrasound is part of the training schedule as the diagnosis is fast, simple and comprehensible. However, it is not enough to be a fan of ultrasound, what counts is the professional practice which definitely requires training. I am honestly glad to share my know-how as I also see it as part of my physician's responsibility in the sense of the Hippocratic Oath.
We are holding workshops for around 15 years - from all sub disciplines of diagnostic sonography, especially on nerve sonography, musculoskeletal sonography and courses about sonographically targeted pain therapies - and I see active practice as central part of these courses; only those who make and learn from their mistakes improve their skills under the guidance of experts. They will then be able to successfully work at the patient using ultrasound in daily practice. The high demand confirms that we are walking in the right direction.

How do you see the role of sonography as a diagnostic instrument in medicine in the future?

PD Dr Loizides: Sonography is and will continue to be an indispensable instrument for every physician and I assume that further developments and progress in this field will let us see even more, depending however on the work of the device manufacturers. Of course, we will also have to report back our new findings to the companies as this is the only way to set further milestones in sonography.
In our latest book release "Sonographic Peripheral Nerve Topography – A Landmark-based Algorithm", we have tried to put the specific value of sonography for the clinical user in perspective. This book presents for the first time the topographic anatomy of almost all peripheral nerves using ultrasound focusing on special landmarks. The German version of the book has been downloaded more than 7,000 times in just nine months - which has exceeded our expectations by far and proves the high clinical need for this knowledge. Now, many are under pressure to take action because the knowledge is there which obliges the colleagues to also acquire that know-how to be able to treat patients appropriately - what was intended. Sonography is more than just a radiological modality!

Selection of publications:

Nerve

1. Sonographic Peripheral Nerve Topography - A Landmark-based Algorithm.
Gruber H, Loizides A, Moriggl B.
2019, Springer Verlag.

Spine

1. A new simplified sonographic approach for pararadicular injections in the lumbar spine: a CT-controlled cadaver study. Loizides A, Gruber H, Peer S, Brenner E, Galiano K, Obernauer J. AJNR Am J Neuroradiol. 2011 May;32(5):828-31. doi: 10.3174/ajnr.A2389. Epub 2011 Feb 24.
2. Ultrasound guided versus CT-controlled pararadicular injections in the lumbar spine: a prospective randomized clinical trial. Loizides A, Gruber H, Peer S, Galiano K, Bale R, Obernauer J. AJNR Am J Neuroradiol. 2013 Feb;34(2):466-70. doi: 10.3174/ajnr.A3206. Epub 2012 Jul 19.
3. Ultrasound-guided versus computed tomography-controlled periradicular injections in the middle and lower cervical spine: a prospective randomized clinical trial. Obernauer J, Galiano K, Gruber H, Bale R, Obwegeser AA, Schatzer R, Loizides A. Eur Spine J. 2013 Nov;22(11):2532-7. doi: 10.1007/s00586-013-2916-0. Epub 2013 Jul 23.

Tumors

1. Optimizing ultrasound-guided biopsy of musculoskeletal masses by application of an ultrasound contrast agent. Loizides A, Widmann G, Freuis T, Peer S, Gruber H. Ultraschall Med. 2011 Jun;32(3):307-10. doi: 10.1055/s-0029-1245713. Epub 2010 Oct 11.
2. Perfusion pattern of musculoskeletal masses using contrast-enhanced ultrasound: a helpful tool for characterisation? Loizides A, Peer S, Plaikner M, Djurdjevic T, Gruber H. Eur Radiol. 2012 Aug;22(8):1803-11. doi: 10.1007/s00330-012-2407-4. Epub 2012 Mar 13.
3. Soft-Tissue Tumor Contrast Enhancement Patterns: Diagnostic Value and Comparison Between Ultrasound and MRI. Gruber L, Loizides A, Luger AK, Glodny B, Moser P, Henninger B, Gruber H. AJR Am J Roentgenol. 2017 Feb;208(2):393-401. doi: 10.2214/AJR.16.16859. Epub 2016 Dec 13.

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