White Paper

iQ IOT342 Probe

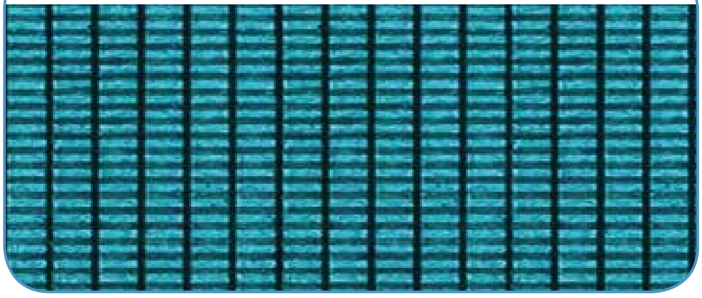
Advanced Surgical Liver Ultrasound

esaote
Creativity in Healthcare

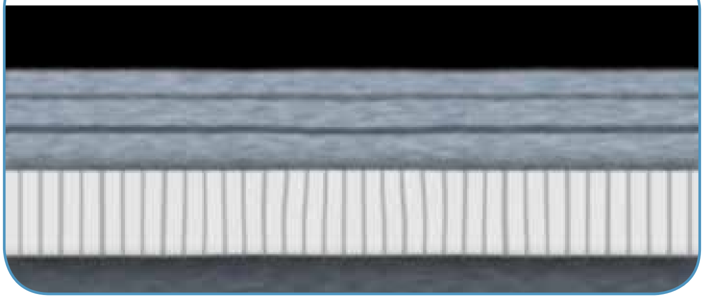
Background

Esaote has designed a new generation of ultrasound probes, the iQprobes, developed with new materials and methods to get the maximum spatial resolution and highest image depth. The new iQprobes's performances combined with the new appleprobe design concept, allow physicians to carry out extremely comfortable and ergonomic examinations.

Microscopic view of the Active Matrix Composite Material

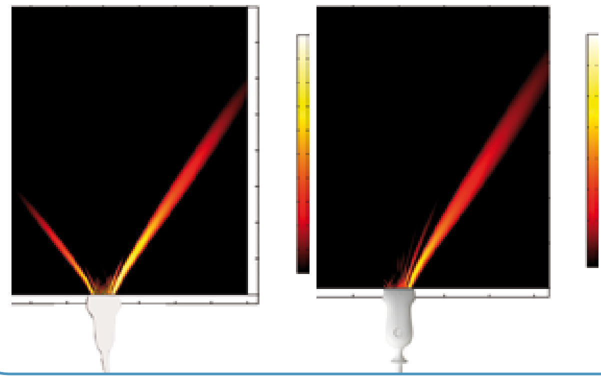


Microscopic view of the Multiple Adaptive Layers Technology



This technology and design concept has led Esaote to develop IOT342, a new intra-operative T probe featuring a Tp-View enlarged field of view, wider frequency range, compact profile and ergonomic grip, fit to perform compression maneuver.
A probe conceived for surgeons.

Comparison between iQProbe's 30° steered radiation lobe versus conventional one



Appleprobe concept

Three different ways to handle IOT342 according to requirements

PROBE HANDLING 1 PROBE HANDLING 2 PROBE HANDLING 3

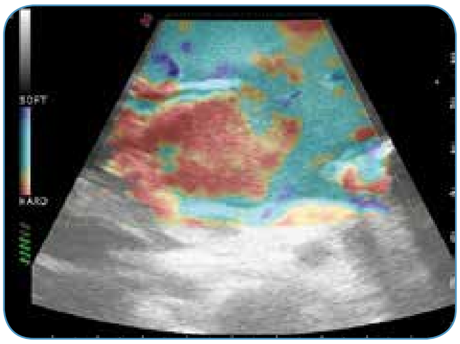
Target: Top performance in Surgical Liver Ultrasound

IOT342 is a new wide multi-band frequency probe that allows to explore every section of the liver, both superficial and deeper ones, while using advanced applications like CnTI (Esaote's Contrast Tuning Imaging) and ElaXto (Esaote's Elastosonography). IOT342 has an enhanced scanning plan compared to contact surface and is more stable than convex probes.

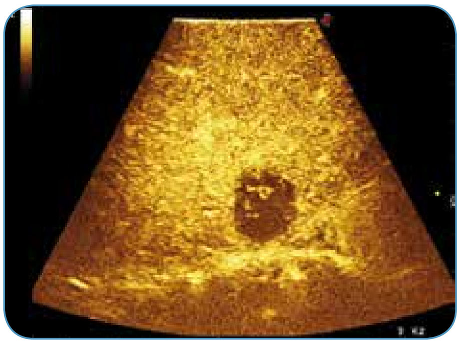
Its size and ergonomic design are suitable to perform compression maneuvers, offer different handing methods and allow to reach very narrow spaces.

Top performances in a surgical environment are now possible with IOT342:

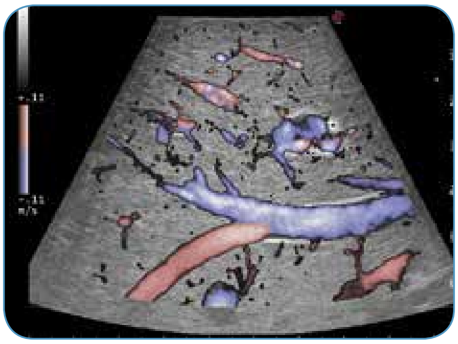
- Very high penetration and spatial resolutions
- Wide visual field
- High Contrast media sensibility (CnTI™)
- High sensibility in detecting slow flows (XFlow)
- Elastosonography (ElaXto)



ElaXto



CnTI™



XFlow

Clinical images Courtesy of Prof. G. Torzilli

IOT342: A probe designed by a surgeon for surgeons

Prof. G. Torzilli

Rationale of IOT342 design

High frequency echoprobes (7.5-11 MHz) are commonly recommended to perform IOUS since they supply a higher spatial resolution than those working at lower frequencies (3.5-5 MHz). The latter are however also useful, at least for the initial exploration, since they provide a better overview by compensating lower spatial resolution. A higher spatial resolution of the liver's superficial portion is, on the other hand, often less important than overall visibility of its deeper structures since most superficial portions can be detected by palpation.

The optimal solution is therefore to employ both lower and higher frequencies probes. IOT342 meets these expectations by covering a wider frequency range (3-11 MHz) with a single tool. A crucial point that should be evaluated when selecting a probe is its shape and volume. An optimal probe should indeed represent the best compromise between its size, its ultrasonographic scanning window and its adherence to organ's surface.

A smaller size allows to handle deep and narrow spaces, a larger windows allows to explore a wider area at a glance and a higher adherence enables suitable handling stability, avoids gas interposition and artefacts that could compromise results.

T-shaped, interdigital probes and micro-convex probes are the ones that are most frequently used. Micro-convex probes currently represent the best compromise between these features. Although T-shaped probes remain more stable and are associated with higher image resolutions, they offer lower lateral length and ultrasonographic scanning window ratios than microconvex probes.

While offering the best compromise between scanning window and volume, microconvex probes loose something in terms of stability, which could be crucial during guiding maneuvers i.e. such as when the electrocautery is positioned between the probe and the liver surface to delimitate resection area. IOT342 features Tp-View for enlarged field of view with linear probe stability, larger scanning windows and limited volume.

Another aspect that should be considered when evaluating probes, is the possibility to use them for surgical maneuvers such as vessels compression[1] as shown in Figure 1.

For this purpose probes should allow for optimal handling, stability, large scanning view and should supply a relatively small surface of contact in order to focus compression on organ's target section.

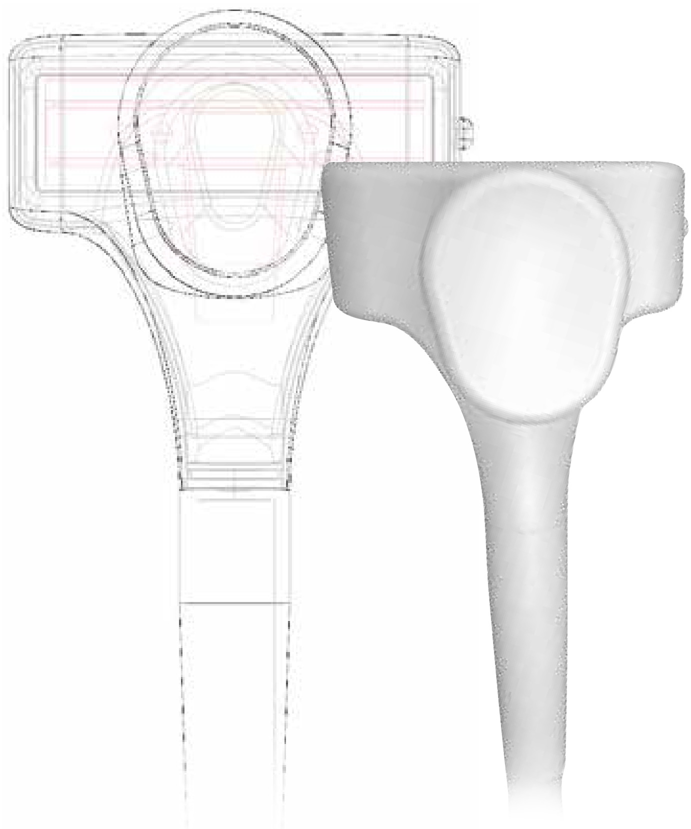
IOT342 was designed to combine all of these features and optimally sums up the concept of ultrasound being used not only as an imaging method but also as a tool to guide and assist surgeons during surgical maneuvers such as intrahepatic vessel compressions for bleeding control or to identify otherwise undetectable areas of the liver that need to be removed.

This probe's more sensitive color-flow modes should be viewed as useful tools to intraoperatively study the liver's inflow, outflow as well as its modifications during surgical maneuvers[2-3-4]: these data is crucial to allow otherwise unfeasible surgical strategies. IOT342 is equipped with Xflow in a directional mode which is able to meet also this requirement. Figure 2 shows a communicating vein depicted between middle and left hepatic vein, which allows to sacrifice one of the two vessels preserving the portion of the liver which should be drained by the removed vein itself.

Contrast-enhanced intraoperative ultrasound (CEIOUS) is one of the latest advancements in US intraoperative applications[5], there are few probes that are currently designed to carry out this diagnostic mode in direct contact with the target organ; CEIOUS furthermore requires fitted digital ultrasound machines which IOT342 also provides.

The features allow IOT342, which I am pleased to have contributed to design, to be the first probe substantiating the intraoperative ultrasound concept on its own both as an imaging provider as well as a surgical tool. This new concept is modifying the way we approach liver surgery and provides new possibilities to treat otherwise untreatable liver tumors.

Prof. G. Torzilli
Hepatic Surgeon and Co-Designer of IOT342 probe



Case Studies

Figure 1a

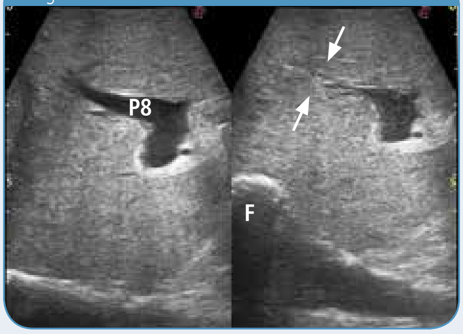


Figure 1b

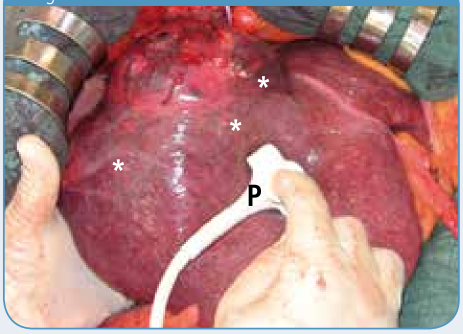


Figure 2

Figure 2: color-flow examination during surgery, a communicating vein (CV) between the middle and left hepatic vein is clearly shown

Figure 1c

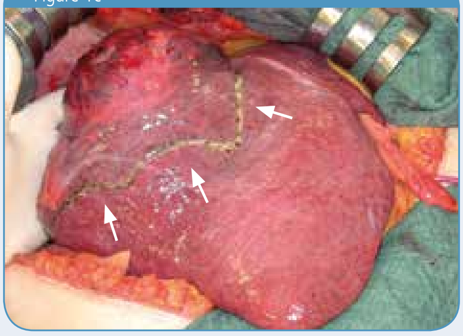


Figure 1d

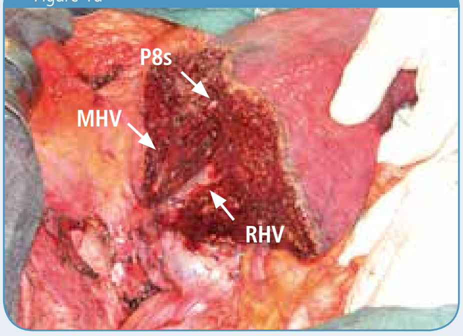


Figure 1: a – at IOUS, on the left, the portal branch to segment 8 (P8) is visualized; same image, on the right, the proper compression of P8 is verified in real time: arrows show the direction of the compression applied by the Probe (P) and the surgeon's fingers (F); **b** - the picture shows how the compression is carried out using the probe (P), and finger, with a bluish colour of segmental portion fed by compressed portal pedicle (*); **c** - resection area (arrows) is defined with electrocautery; **d** - liver surface cut after resection of segment 8 with portal branch stump (P8s), right (RHV) and middle (MHV) hepatic veins.

Case study courtesy of Prof. Guido Torzilli
Director Liver Surgery Unit, Department of Surgery
Humanitas Cancer Center
School of Medicine, University of Milan

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References

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