

# Synovitis quantification

Consideration of the QPack application from MyLab™ 9



# “The Q-Pack tool developed by Esaote could help clinicians to objectively power doppler measurement. Thanks to this method, which until now was



Philippe Gaudin, Professor of Centre Hospitalier Universitaire de Grenoble, France

## Background

Doppler US allows detection of the perfusion of synovial tissue in inflammatory rheumatic diseases. It has become an important tool for determining inflammatory activity in Rheumatoid Arthritis and other rheumatic diseases. The presence of Doppler signals represents a prognostic criterion for developing erosive disease in RA.

“Ultrasound quantification based on Doppler signals of synovitis in inflammatory rheumatism is currently semi-quantitative with 4 stages (0-3)<sup>[1-3]</sup>.” This classification was introduced by Szkudlarek et al.<sup>[4]</sup> in 2003 and suggested the semi-quantitative grading system described in the table below:

Grade	Recommendation
0	No flow in the synovium
1	Single vessel signals (up to 3)
2	Confluent vessel signals in less than half of the area of the synovium
3	Vessel signals in more than half of the area of the synovium

“For clinical studies and in order to refine the data, more precise quantification may be useful. Indeed, grade 2 using power Doppler corresponds to a synovitis representing the range between more than 3 spots and 49% of the synovitis area. And the same happens with grade 3, which includes all the percentages of the synovitis area in the range between 51% and 100%. The current classification leaves a certain amount of subjectivity”.

Furthermore, many studies have shown that most of the cases are classified as grade 2 according to the Szkudlarek score while scores 1 and 3 are rare<sup>[5,6]</sup>.

“Measuring part of the surface of the synovitis in B-mode and quantifying the vascularization with power or energy Doppler in cm<sup>2</sup> and in % of the latter represents an interesting refinement”.

The QPack tool developed by Esaote S.p.A. could help clinicians to objectively define the score of the evaluated joint since it is based on a cumulative power Doppler measurement. Thanks to this method, which until now was more oriented toward clinical research, it is possible to classify the joints, whether those evaluated with DAS28 or with simplified scores such as Naredo<sup>[7]</sup> or Bakhau<sup>[8]</sup>.

## Technology

Quantification Curves Environment (QPack) is an Esaote S.p.A. application where the color Doppler US information coming from a generic sequence of frames (clip) or from a single frame are automatically displayed on the monitor in terms of % of colored pixels with respect the total amount of pixels included in a ROI defined by the end user.

Doppler quantification is available in all Doppler Color-based Modalities (CFM – Esaote Color Doppler-, PWRD – Esaote Power Doppler-, XFlow – Esaote microflow-, microV – Esaote micro vascularization-) and it extracts different statistics measurements of the Doppler signal to perform a semi-quantitative assessment of joint inflammations.

QPack application can be used both on a single frame and on an acquired clip. In the image below, the output in both cases is shown (Figure 1a, 1b). The calculated measures are shown at the top left of the echoimage and in the case of a clip (Figure 1b) all quantified values per frame are displayed in a dedicated Graph Area. In order to perform the correct measurement and to remove the information coming from the blood dynamics the end user should select a frame corresponding to the diastolic phase (Figure 1b).

Figure 1a - QPack environment when it is activated on a single frame.

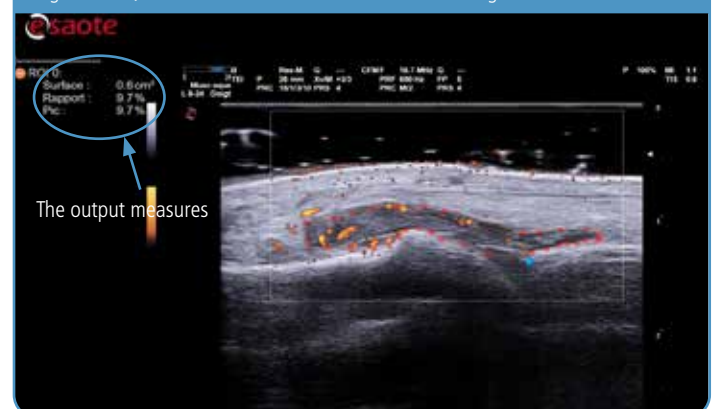
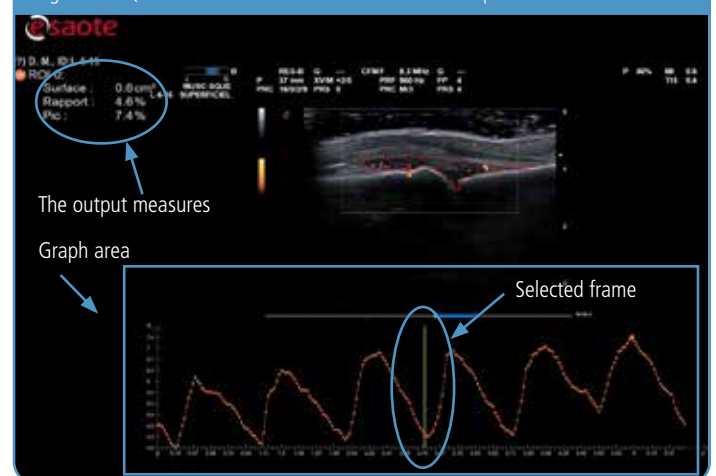


Figure 1b - QPack environment when it is activated on a clip.



define the score of the evaluated joint since it is based on a cumulative more oriented toward clinical research, it is possible to classify the joint.”

The end user can acquire a single frame/clip and can select the QPack tool in Freeze by using the control panel and the touch screen when one of the compatible modalities has been activated; lastly, in order to perform the calculation, the end user should select the specific type of ROI among several options (ellipse, trace, vertex, manual shape).

The QPack can be applied both on live US acquisition and off-line by selecting a clip/frame already saved into the archive.

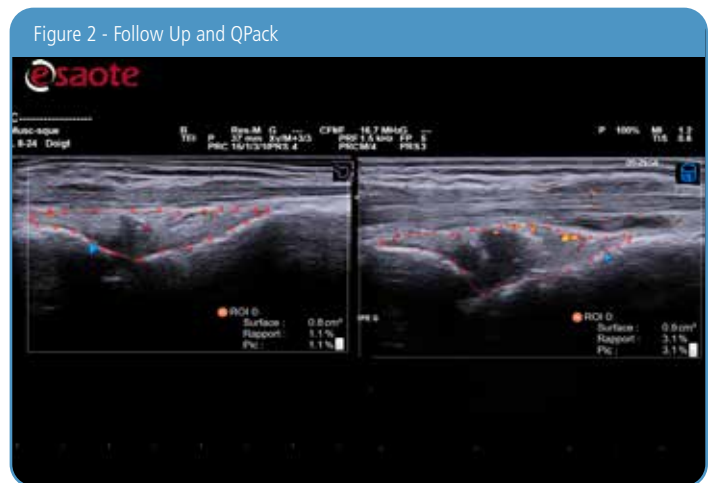
The output measures, displayed on the top left of the Echoimage, are the following:

- **Surface:** area inside the region of interest [cm<sup>2</sup>]
- **RATIO** =  $\Sigma$  Color Doppler pixels /  $\Sigma$  Pixels included in the total ROI area \* 100. Values are included in the range [0;100%]
- **PIC** = maximum value (RATIOS)

where:

- **Pixels included in the total ROI area:** number of pixels included in the area shape (does not depend to Gray/Color levels)
- **Color Doppler pixels:** are intended to be the ones really displayed on the main screen.

Follow-up modality could be used QPack, and plays a fundamental role here since it represents the possibility to assess and quantify over different examinations the level of flows in the same target areas:

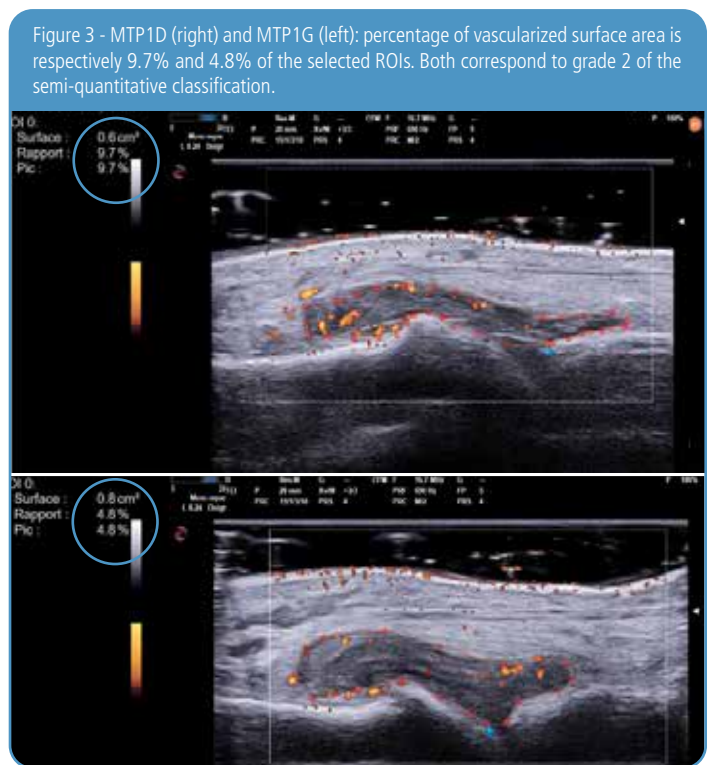


## Clinical cases

Using the QPack application, it takes only a few minutes to outline the synovitis and quantify the percentage of vascularized synovial surface area. Standardization of slices is essential so that successive measurements will be reproducible.

To better understand the clinical value of QPack, some clinical cases are described below.

a) MTP1D and MTP1G with QPack quantification applied (Figure 3):



b) MCP3D (right) and MCP3G (left) before (figure 4) and one week after (figure 5) synoviorthesis (which is a commonly utilized procedure employed in the management of recurrent intra-articular bleeds and secondary chronic synovitis in haemophilic patients) with triamcinolone hexacetonide:

c) Two measurements performed on the same joint one hour apart show the high level of QPack reproducibility (figure 6):

Figure 4 - MCP3D (right) and MCP3G (left) before synoviorthesis: percentage of vascularized surface area is respectively 28.7% and 57.3% of the selected synovial surface area.

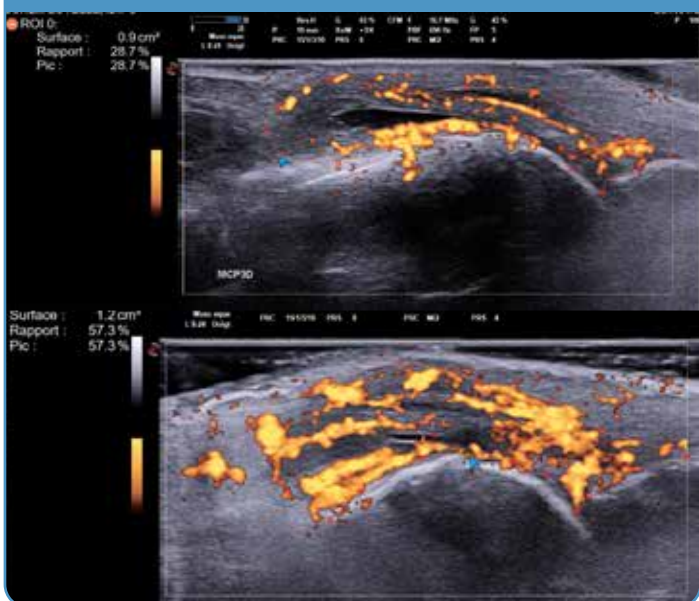


Figure 5 - MCP3D (right) and MCP3G (left) after one week of synoviorthesis: vascularized surface area drops to 0.3% and 0.7% of the selected synovial surface area respectively.

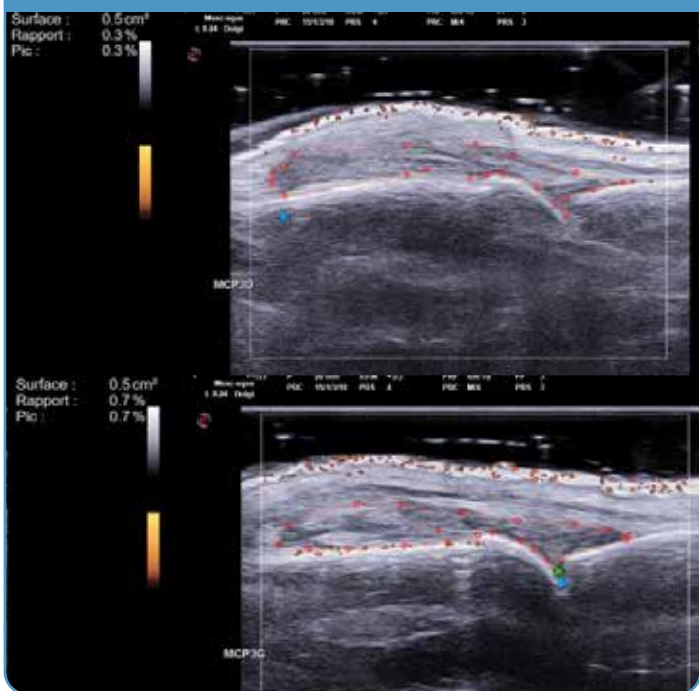
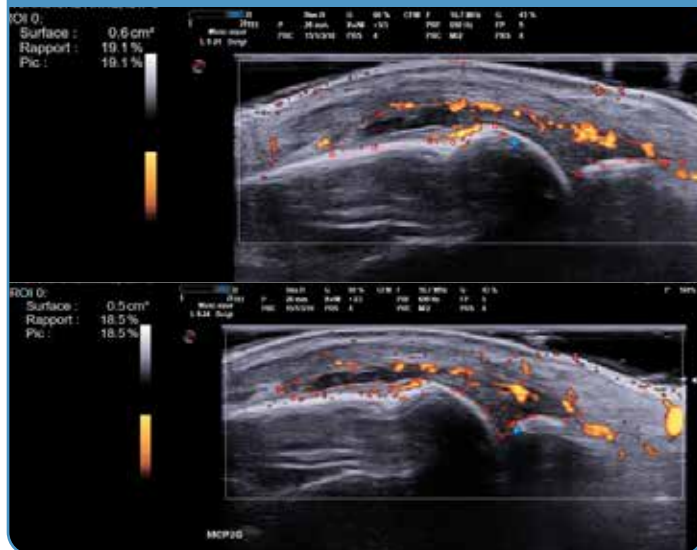


Figure 6 - The percentages of vascularized surface on the same joint one hour apart are 19.1% and 18.5% of the selected synovial surface respectively.



## Conclusion

The QPack application is easy to use and it allows quantification to the nearest percentage of the vascularized synovial surface and could help clinicians in their daily routine, especially for the follow-up of the inflammatory process, while also opening the door for a multi-site score to be approved.

## References

1. D'Agostino MA, Terslev L, Aegerter P, Backhaus M, Balint P, Bruyn GA, Filipucci E, Grassi W, Iagnocco A, Jousse-Joulin S, Kan D, Naredo E, Schmidt W, Szkudlarek M, Conaghan PG, Wakefield RJ, D'Agostino MA, et al. Among authors: Naredo E. RMD Open. 2017 Jul 11;3(1):e000428. doi: 10.1136/rmdopen-2016-000428.
2. Terslev L, Naredo E, Aegerter P, Wakefield RJ, Backhaus M, Balint P, Bruyn GAW, Iagnocco A, Jousse-Joulin S, Schmidt WA, Szkudlarek M, Conaghan PG, Filipucci E, D'Agostino MA, Terslev L, et al. Among authors: Naredo E. RMD Open. 2017 Jul 11;3(1):e000427. doi: 10.1136/rmdopen-2016-000427.
3. Hammer HB, Kvien TK, Hammer HB, et al. Arthritis Res Ther. 2011 May 27;13(3):R78. doi: 10.1186/ar3341.
4. Szkudlarek M, Court-Payen M, Jacobsen S et al. Interobserver agreement in ultrasonography of the finger and toe joints in rheumatoid arthritis. Arthritis Rheum 2003;48:955-62.
5. Terslev L, Ellegaard K, Christensen R et al. Head-to-head comparison of quantitative and semi-quantitative ultrasound scoring systems for rheumatoid arthritis: reliability, agreement and construct validity. Rheumatology 2012;51:2034-8.
6. Ohrndorf S, Halbauer B, Martus P et al. Detailed joint region analysis of the 7-joint ultrasound score: evaluation of an arthritis patient cohort over one year. Int J Rheumatol 2013;2013:493848.
7. Naredo E, Valor L, De la Torre I, Martínez-Barrio J, Hinojosa M, Aramburu F, Ovalles-Bonilla JG, Hernández D, Montoro M, González CM, López-Longo J, Monteagudo I, Carreño L. Arthritis Care Res (Hoboken). 2013 Apr;65(4):512-7. doi: 10.1002/acr.21869.
8. Backhaus M, Ohrndorf S, Kellner H, Strunk J, Backhaus TM, Hartung W, Sattler H, Albrecht K, Kaufmann J, Becker K, Sörensen H, Meier L, Burmester GR, Schmidt WA, Backhaus M, et al. Among authors: Backhaus TM. Arthritis Rheum. 2009 Sep 15;61(9):1194-201. doi: 10.1002/art.24646.

Esaote S.p.A. - sole-shareholder company

Via Enrico Meloni 77, 16152 Genova, ITALY, Tel. +39 010 6547 1, Fax +39 010 6547 275, info@esaote.com

MyLab is a trademark of Esaote spa. Technology and features are system/configuration dependent. Specifications subject to change without notice. Information might refer to products or modalities not yet approved in all countries. Product images are for illustrative purposes only. For further details, please contact your Esaote sales representative.