DUPLEX-ULTRASOUND ASSESSMENT OF THE SAPHENOFEMORAL JUNCTION

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ABSTRACT

Sonographic evaluation of the saphenofemoral junction is one of the most important examinations in the phlebological practice. It is indispensable for proper decision making in the management of varicose veins. This examination should primarily comprise the evaluation of competence of terminal and preterminal valves of the great saphenous vein and haemodynamic assessment of refluxes in the great saphenous vein and the anterior accessory saphenous vein. Since the anatomy of this junction is highly variable and reflux can originate not only in the common femoral vein, but also in the tributaries, they should also be thoroughly evaluated. In this paper we present the technique of sonographic examination of this area, with a description of reflux-provoking manoeuvres, interpretation of sonographic findings, and classification of venous refluxes. Phlebographic classification of pathological flows in the area of the saphenofemoral junction was first proposed by Hach and then revised together with Mendoza after the introduction of ultrasound. Subsequently a classification based on sonographic evaluation of the terminal and preterminal valves was published by Stücker. Here, in addition to the already described types of refluxes in the area of the saphenofemoral junction, we propose a new type, in which the reflux originates in a tributary and enters the anterior accessory saphenous vein, but both terminal and preterminal valves are competent.

Key words: duplex ultrasound, saphenofemoral junction, Stücker classification, terminal valve, great saphenous vein insufficiency.

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The majority of clinically relevant venous refluxes of the superficial veins requiring invasive treatment occur in the great saphenous vein (GSV) territory. The GSV runs from the inner part of the ankle, along the medial aspect of the leg, to the groin, where it drains into the common femoral vein (CFV) through the saphenofemoral junction (SFJ). Next to the SFJ, a bundle of tributaries coming from the pelvis and abdominal wall (the superficial epigastric vein and the external pudendal vein), lateral aspect of the hip (the superficial circumflex iliac vein), and the anterior (the anterior accessory saphenous vein) and posteromedial aspect of the thigh (the posterior accessory saphenous vein) drain into the GSV [1, 2]. The GSV, similarly to other veins, is equipped with valves that preclude venous reflux, i.e. a backward flow. In the area of the SFJ two valves are especially important: the terminal valve, which is located next to the junction with the femoral vein, at a mean distance of 0.4 cm from the junction, and the preterminal valve, which is located more distally from the SFJ, usually at a distance of several centimetres from the femoral vein and distally from the above-mentioned tributaries (Fig. 1) [3, 4]. It should also be emphasised that the anatomy of the SFJ is not constant and because of this high anatomical and functional variability there are many options of the flow and reflux in this area.

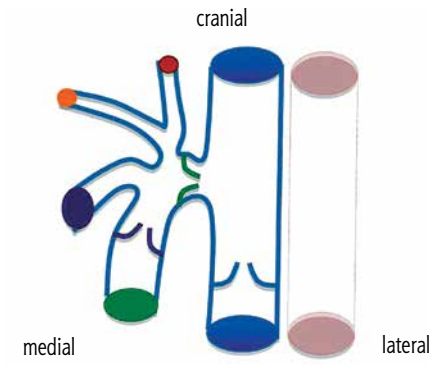
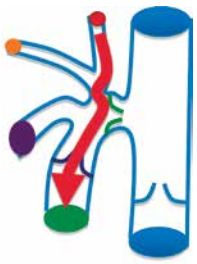
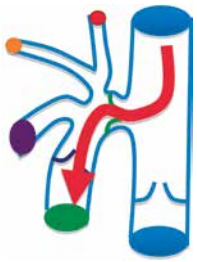


Fig. 1. Schematic representation of the SFJ (with kind permission of Schattauer from Mendoza E. The saphenofemoral junction in ultrasound. Phlebologie 2014; 43: 42-45

Red: common femoral artery; blue: common femoral vein (CVF); green: GSV; orange, yellow: tributaries; violet: AASV. Valves: blue: deep vein; green: terminal valve; dark blue: preterminal valve

Table 1. Different classifications of refluxes in the area of the saphenofemoral junction (with kind permission of Schattauer from: Mendoza E. The saphenofemoral junction in ultrasound. Phlebologie 2014; 43: 42-45)

Stücker's type	Terminal valve	Preterminal valve	Anterior accessory saphenous vein	Hach's type	Figure	Scheme
Type 1	incompetent ☹	competent ☺	with reflux ☹	"Komplett, Hach I"	8b	
Type 2	competent ☺	incompetent ☹	competent ☺	"Inkomplett, Hach II – IV"	9	
Type 3	incompetent ☹	incompetent ☹	competent ☺	"Komplett, Hach II – IV"	6	
Type 4 (not classified originally by Stücker)	competent ☺	competent ☺	with reflux ☹	not classified by Hach	10	

The first classification of these variabilities of the SFJ, which was based on venographic findings, was proposed by Hach [5]. Contrary to the venographic examination, duplex sonography is capable of independent assessment of the function of the terminal and preterminal valves. Based on such separate evaluations of these valves, Stücker *et al.* presented a new classification of venous flow abnormalities in the area of the SFJ [6]. This classification is summarised in Table 1. In addition to Stücker's types 1-3, we propose a new type 4: in which the reflux originates in a tributary and enters the anterior accessory saphenous vein with both terminal and preterminal valves being competent.

SONOGRAPHIC TECHNIQUE

Firstly, sonographic assessment of the area of the SFJ should exclude thrombosis of the femoral vein and the GSV, primarily using a compression test (the veins should be easily compressible with the sonographic probe). Then, venous anatomy of the region should be evaluated and several questions should be answered:

- are all veins visible?,
- is the SFJ at a typical location?,
- which tributaries are visible? (Fig. 1),
- are the valves of the GSV visible, and are their leaflets capable of moving during the blood flow (after throm-

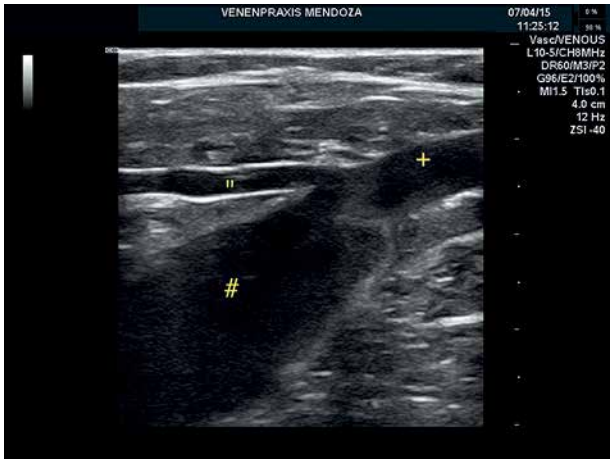


Fig. 2. Longitudinal view of the SFJ with CFV (#), GSV (+), epigastric vein (tributary of GSV) ('') and terminal valve (arrow)

bosis or severe inflammatory processes these leaflets may become thickened and immobile)? (Figs. 2, 3),
- is the GSV dilated? (Fig. 4),
- are there any pathological structures in the area of the SFJ, such as: enlarged lymph nodes, haematomas, etc.?

Assessment of venous flow in the area of the SFJ should preferentially be performed in the standing position [7, 8]. Some manoeuvres can be done in order to enhance the flow and to facilitate the investigation. In a standing patient a manual compression of the calf, or dynamic manoeuvres like forefoot elevation manoeuvre (the so-called Wunstorf's manoeuvre), are the most useful ones [9]. These manoeuvres elicit flow towards the heart in the veins during the so-called muscular systole, which is either artificially caused by the examiner through manual compression, or is evoked by contraction of patient's muscles during Wunstorf's manoeuvre or other similar manoeuvres. Following relaxation of muscle pump the muscular diastole begins. Competent veins present with an upward flow during muscular systole, which – during muscular diastole – is followed by a short period of backward flow, until the leaflets of the valves become closed. In a case of incompetent valves of the SFJ an upward flow during muscular systole and backward flow during diastole will be found, with duration of such a backward flow longer than one second. A permanent flow in the SFJ toward femoral vein, especially if such a flow is of high velocity and does not respond to the reflux-provoking

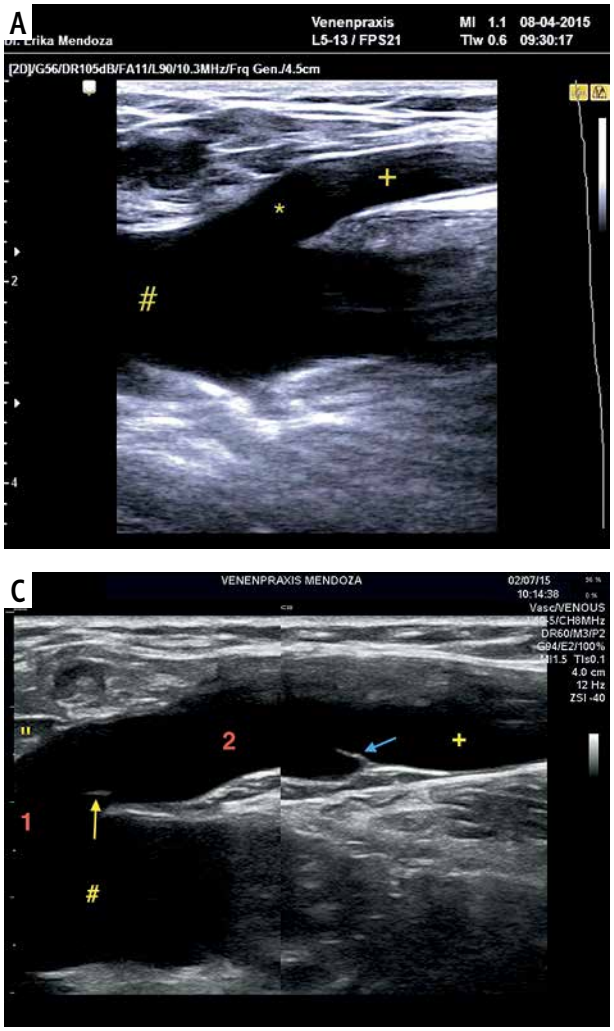


Fig. 3. Valves at the SFJ: **A**) sometimes no valves are visible at groin level and their existence and function can only be implied after investigation of blood flow; **B**) transverse scanning of the same area with visible terminal valve leaflets (arrows); **C**) longitudinal view of the SFJ with terminal (yellow arrow) and preterminal valve (blue arrow). '' Epigastric vein, + GSV, # common femoral vein. 1: Point to assess the competence of the terminal valve in PW, 2: Point to assess the competence of the preterminal valve in PW

Fig. 4. Diameter of GSV at the SFJ. The visualisation of the diameter of GSV just distal to the junction already gives an impression of the competence or not of the valves. Images in transverse scanning with measurement of CFV (#) distal to the junction and showing the GSV (+) at this level: **A**) left groin with competent GSV; **B**) right groin with incompetent and refluxive GSV (the calibre of GSV is much larger than in [A])

manoeuvres, suggests an occlusion (usually post-thrombotic) of the deep veins with the flow bypassing an obstacle through the GSV (Fig. 5).

Flow characteristics in the area of SFJ: in the CFV, and the GSV and its tributaries can either be assessed using colour Doppler mode (Fig. 6A, B), or pulsed wave mode (Fig. 6C and 10). While colour Doppler gives a better impression of the overall haemodynamic pattern, and pulsed wave mode allows the quantitative assessment of flow, especially duration of reflux, which is important to evaluate borderline cases. In the area of the SFJ we define reflux as pathological if backward flow after the above-mentioned manoeuvres is longer than one second (Fig. 10) [8]. Of note, using the above-mentioned reflux-provoking manoeuvres, for the assessment of competence of the terminal valve the Doppler gate should be positioned in the common femoral vein next to the SFJ, while for the assessment of preterminal valve this gate should be positioned between the terminal and preterminal valves.

Since venous anatomy in this area is highly variable, we suggest placing the sonographic probe transversely to the axis of the extremity. In this way it is easier to assess the anatomy. Nevertheless, in order to enable registration of venous flow with the probe placed transversely, it should not be positioned perpendicularly to the skin but rather slightly tilted, as shown in Fig. 7. Flow characteristics should be assessed in the CFV, and the SFJ and tributaries using colour Doppler mode (Figs. 5–10; Table 1). Sometimes, for better documentation of reflux in the tributaries, the probe should be positioned longitudinally.

Nowadays lots of treatment options are available. We can tailor treatment to the findings and dilatation of veins. Competence of the terminal valve with incompetent preterminal valve may lead to the choice of one or another tactical approach. It is important to have an exact

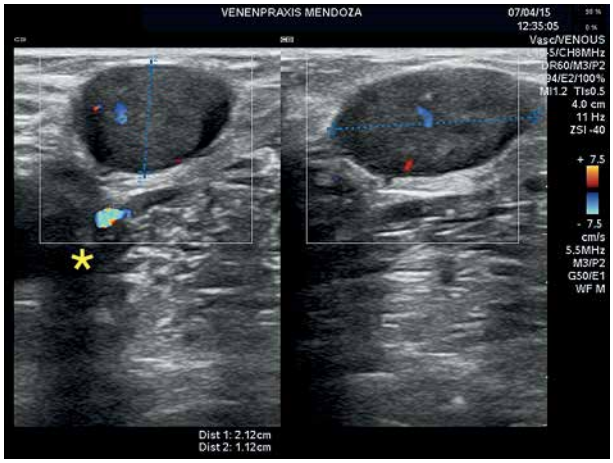


Fig. 5. Permanent orthograde flow from the GSV through SFJ into the deep vein: this finding makes it necessary to look after a deep vein obstruction. In this case an old thrombosis of the femoral vein with obstruction of deep veins was found with a bypass of venous outflow through GSV

documentation of the findings to allow trouble-shooting in the follow up if new refluxes appear. The exact preoperative documentation of the situation in the SFJ is of uttermost importance when driving surveys to compare different surgical treatment techniques.

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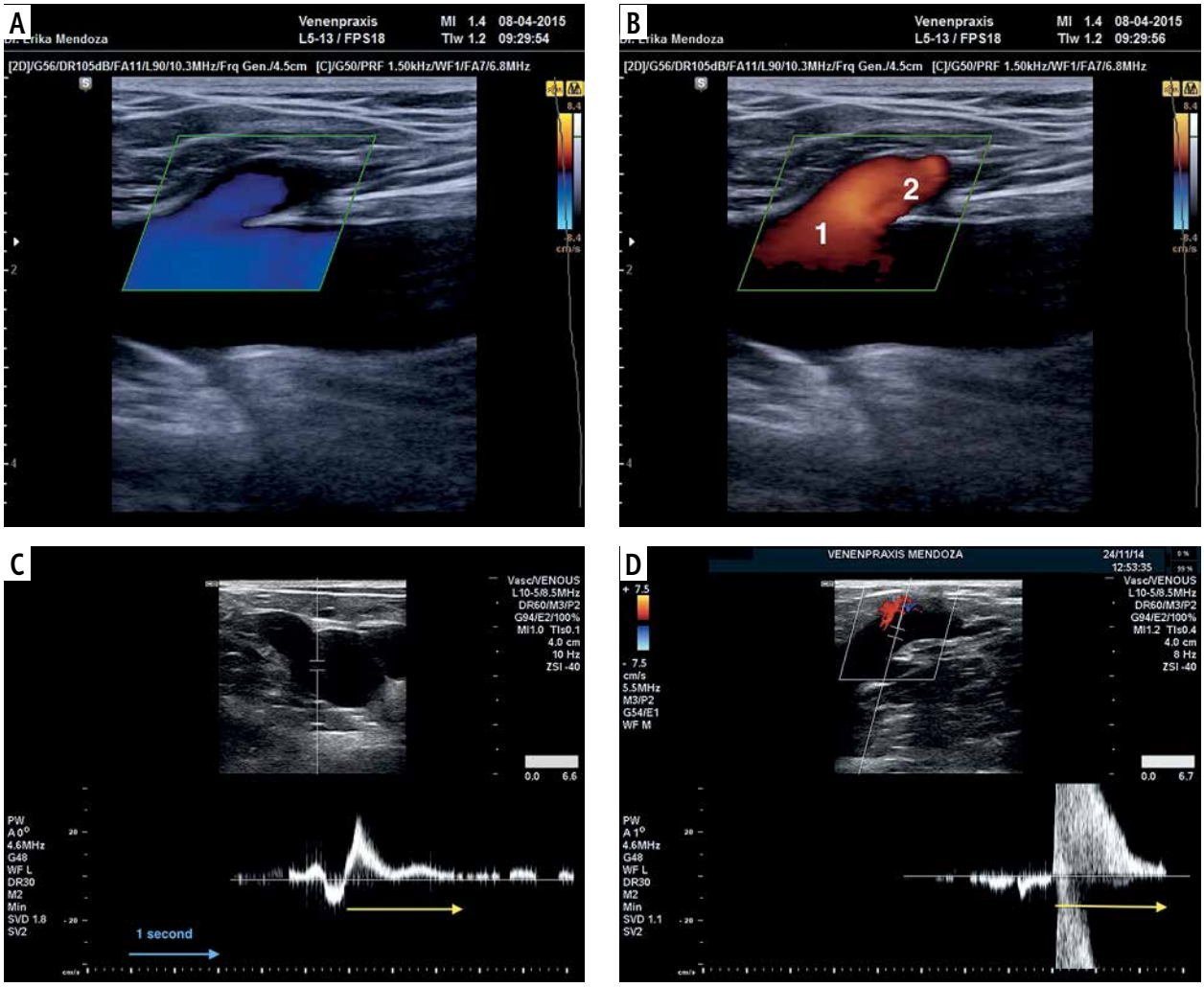

Fig. 6. Flow measurements in the SFJ, Stücker type 3: **A**) colour-coded duplex during systole, longitudinal scan of the groin. Blue flow image, representing orthograde flow from superficial to deep vein; **B**) colour-coded duplex during diastole, longitudinal scan of the groin. Red flow image, representing retrograde flow from deep to superficial vein. Note that you cannot say the time flow is lasting in the colour duplex image. The image suggests incompetent terminal and preterminal valve, Stücker 3. To assess and to prove this in the patient's register the flow has to be measured in PW at point 1 (TV) and 2 (PTV) in the image; **C**) transverse scan of the SFJ with assessment of the competence of the terminal valve during muscular systole and diastole, measuring in the common femoral vein in pulsed wave mode: obvious reflux lasting longer than one second (arrow); **D**) longitudinal view of SFJ with assessment of the saphenofemoral junction during muscular systole and diastole with use of the pulsed wave mode: reflux longer than one second (arrow) assessed between terminal and preterminal valve

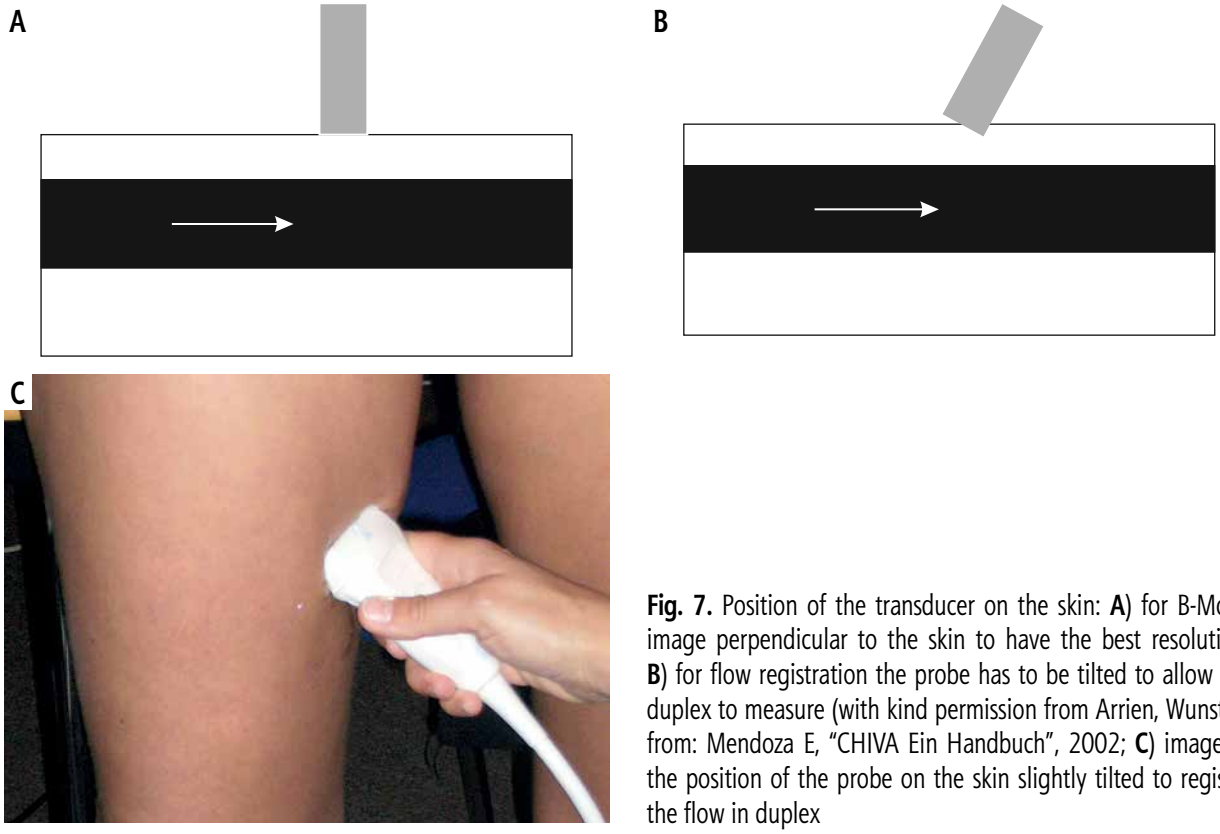

Fig. 7. Position of the transducer on the skin: **A**) for B-Mode image perpendicular to the skin to have the best resolution; **B**) for flow registration the probe has to be tilted to allow the duplex to measure (with kind permission from Arrien, Wunstorf from: Mendoza E, "CHIVA Ein Handbuch", 2002; **C**) image of the position of the probe on the skin slightly tilted to register the flow in duplex

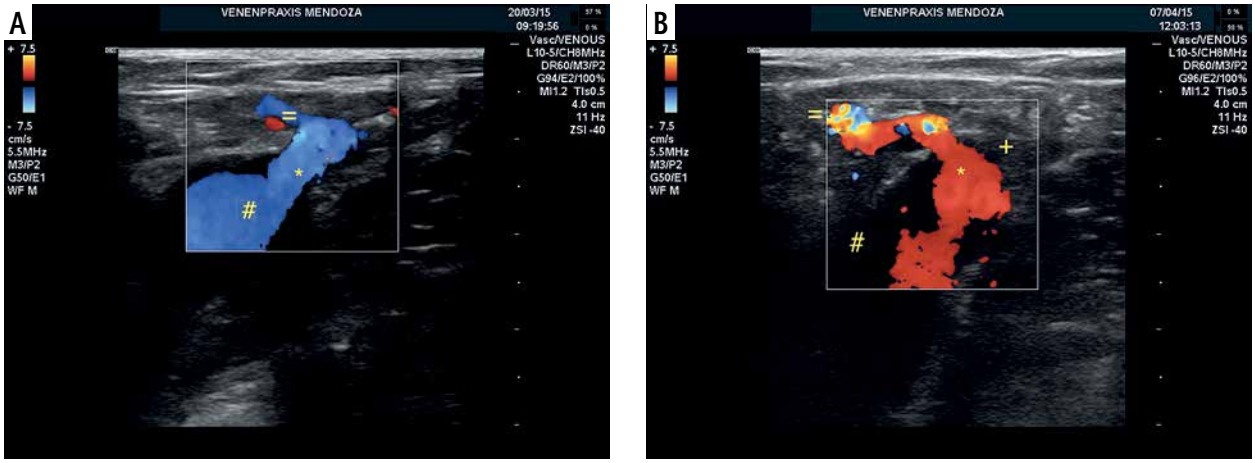

Fig. 8. Stücker type 1: **A**) flow assessment, transverse scan, in the saphenofemoral junction (*) and the anterior accessory saphenous vein (=) with the use of colour Doppler mode during the systole: orthograde flow in AASV (=) (CFV #); **B**) same as (A) in diastole suggesting incompetent terminal valve with competent preterminal valve (Stücker type 1): Reflux from deep vein (#) through SFJ (*) into the AASV (=) (Note: colour Doppler allows a didactical view of the flow in all three veins; to assess the flow at each valve PW should be used)

Fig. 9. Stücker type 2 with competent terminal valve (see Fig. 3D) and reflux emerging from tributaries. Typically the reflux is long lasting and not too quick. Flow assessment in the saphenofemoral junction with the use of pulsed wave Doppler between the terminal and preterminal valve in longitudinal view

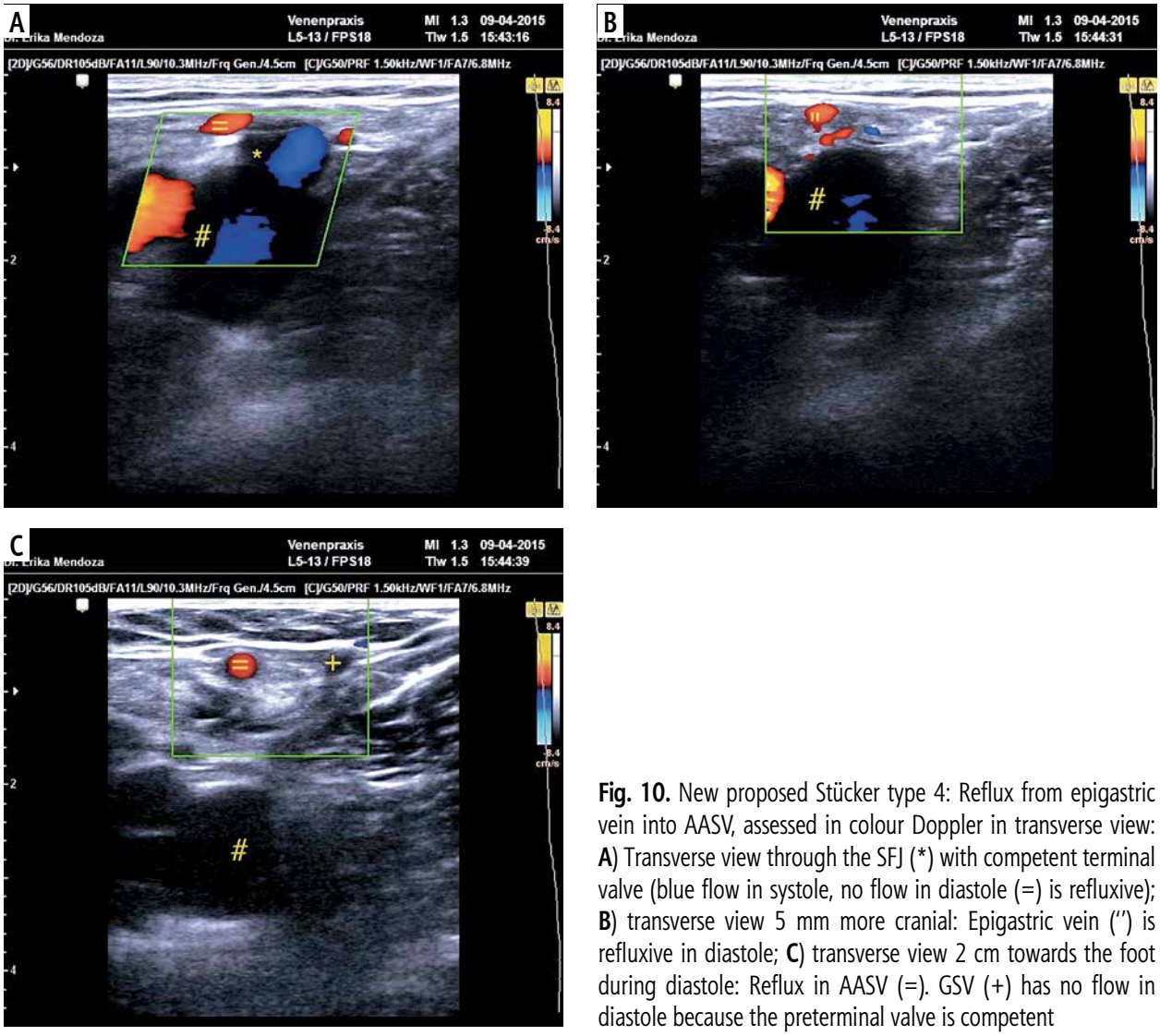

Fig. 10. New proposed Stücker type 4: Reflux from epigastric vein into AASV, assessed in colour Doppler in transverse view: **A**) Transverse view through the SFJ (*) with competent terminal valve (blue flow in systole, no flow in diastole (=) is refluxive); **B**) transverse view 5 mm more cranial: Epigastric vein ('') is refluxive in diastole; **C**) transverse view 2 cm towards the foot during diastole: Reflux in AASV (=). GSV (+) has no flow in diastole because the preterminal valve is competent

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