Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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EDUTORIAL

Teleproctoring in Vascular Surgery to Defy COVID-19 Travel Restrictions

Percutaneous ultrasound guided creation of an arteriovenous fistula (pAVF) for haemodialysis access is a relatively novel procedure with promising technical success and patency rates.[1] The vascular surgery departments of two collaborating Swiss hospitals decided to introduce the technique to their services. After visiting the surgeon (A.M.), who is highly experienced in pAVF, in Paris in October 2019, it was agreed that A.M. would act as a proctor for the first four cases in Switzerland, planned for March 2020. He was to be supported by an engineer from the firm (C.C.) supplying the anastomotic device (Ellipsys® Vascular Access System, Avenu Medical, Inc, San Juan Capistrano, CA, USA). Unfortunately, the outbreak of the SARS-CoV-2 pandemic and the consequent lockdown led to the closure of borders and made international travel impossible, so the visit and procedures had to be cancelled. At this point, it was evaluated whether it would be possible to teleproctor the procedures via a video conference system.

The set up relied on an all in one live video production device, video encoder, video streamer, and video recorder (Pearl-2, Epiphan), which made it possible to simultaneously transmit the live image from the ultrasound device (GE Logiq S8, linear probe 9L-D) and a live image from a video camera (JVC Camcorder G/-HM440E, Japan), both connected via HDMI (Fig. 1). The live stream was shared with the proctor in France and the device support team in the United States, using an encrypted Swiss video client (www.vitimway.ch). The set up was tested with all parties three days in advance. The resolution of the image transferred was excellent, but the data buffering in the video encoder resulted in an unavoidable delay in video transmission of approximately two seconds.

Pre-operatively, recorded video clips of each patient's ultrasound scan of the vascular anatomy in the cubital region, with detailed information regarding the diameter and quality of the vessel mapping, were shared by email with the proctor and the company representative. All the patients gave written consent to their procedures being recorded and used for educational purposes. Despite the good quality of the video, conference set up, and extensive preparation, performing the pAVF procedure for the first time as a teleproctored procedure was somewhat daunting, even for two experienced vascular surgeons and sonographers who use ultrasound routinely.

Each surgical procedure began with a verbal briefing of the planned procedure and a live ultrasound scan of the anatomy of the cephalic vein, the perforating vein of the elbow (PVE), and proximal radial artery (PRA). The detailed description of the technique for the creation of an Ellipsys® pAVF is available online.[2,3] All steps in the procedures were taken under the proctor's instruction and supervision. All four procedures necessitated several steps, for each of which the proctor's interpretation of the situation and his instructions for the consequent steps were crucial to the success of the pAVF creation. Details of the interaction between proctor and operator can be seen in the video clip (Video). The proctor gave on average 21 instructions per procedure. An average of four were device related but they became less frequent as time went on. The operators consulted the proctor, on average, five times per pAVF creation. The average duration of the procedure was 33.5 min. The pAVF creation was successful in all four patients, with an average fistula flow measured at the end of the procedure of 597 mL/min. There was only one interruption in the internet connection but video communication with all parties was re-established within four minutes and 24 s.

Supplementary video related to this article can be found at https://doi.org/10.1016/j.ejvs.2020.06.020

The quality of the proctor—surgeon interaction achieved during the interventions was impressive: live transmission of the ultrasound image and video image of the operator's hands provided the proctor with all the information necessary to guide the operator through the procedure. Because of challenging anatomy in two of the cases, important changes in strategy were suggested by the proctor and were applied successfully.

Teleproctoring (or telementoring) in surgery was first reported more than 20 years ago[4] and has been used predominately for laparoscopic surgery, with a wide range of complexity in infrastructure. In the majority of the published series, the operators had some experience in the procedures under direct tuition before performing with teleproctoring, but a few cases of procedures being performed with teleproctoring without previous experience have also been reported.[5] To the authors' knowledge, this is the first report on the use of teleproctoring for an ultrasound guided procedure.

It was the lockdown caused by the SARS-CoV-2 pandemic that prompted use of teleproctoring. Clearly, there is scope for improvement such as the reduction in the time delay and concerns regarding the reliability of transmission and data security which will need to be addressed. Nonetheless,

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Figure 1. Teleproctoring device setup with Pearl-2, Epiphan video encoder (a) connected to GE Logiq S8 ultrasound (b), and HD video camera (c) via HDMI for percutaneous ultrasound guided creation of an arteriovenous fistula for haemodialysis access.

the simplicity of the set up and the quality of proctor–operator interaction was such a positive experience that much wider use of teleproctoring can be envisaged in the future.

CONFLICTS OF INTEREST

A.M. is director of medical training and shareholder of Avenu Medical.

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AUTHOR CONTRIBUTIONS

A.I., T.W. performed the procedures tele-proctored by A.M.; T.W. and A.I. prepared the tele-proctoring set up; A.I., T.W., L.G., and A.M. drafted and revised the paper; all authors approved the final version of the manuscript.

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REFERENCES

1 Mallios A, Bourquelot P, Franco G, Hebibi H, Fonkoua H, Allouache M, et al. Mid-term results of percutaneous arteriovenous fistula creation with the Ellipsys vascular access system, technical recommendations and an algorithm for maintenance. *J Vasc Surg* 2020. https://doi.org/10.1016/j.jvs.2020.02.048 [Epub ahead of print].

2 Mallios A, Beathard GA, Jennings WC. Early cannulation of percutaneously created arteriovenous hemodialysis fistulae. *J Vasc Access* 2019. https://doi.org/10.1177/1129729819892796 [Epub ahead of print].

3 Mallios A. *CiDA live case*. https://www.youtube.com/watch?v=4yi5VMNjsG8. [Accessed 16 April 2020].

4 Erridge S, Yeung DKT, Patel HRH, Purkayastha S. Telementoring of surgeons: a systematic review. *Surg Innov* 2019;**26**:95–111.

5 Miller JA, Kwon DS, Dkeidek A, Yew M, Hisham Abdullah A, Walz MK, et al. Safe introduction of a new surgical technique: remote telementoring for posterior retroperitoneoscopic adrenalectomy. *ANZ J Surg* 2012;**82**:813–6.

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