Construction of an Assessment Instrument for the Diagnostic Competence of Deep Vein Thrombosis Using Doppler Ultrasound

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Abstract
Deep Vein Thrombosis (DVT) is one of the leading causes of cardiovascular death. Doppler ultrasound is the gold standard for diagnosis, but it has limitations due to its dependence on the skills of the imaging specialist. Radiologists in training need to develop cognitive, procedural, and attitudinal competencies. Therefore, it is imperative to have an instrument that objectively assesses the degree of diagnostic competence according to skill development. This descriptive, observational, longitudinal study focused on constructing an ad hoc rubric through a literature review. A pilot study was conducted to assess apparent validity, content validity, and interobserver agreement. A judging round was carried out for data analysis, and the modified Hernández-Nieto test was applied for quantitative content validation. Interobserver agreement was performed using Fleiss's kappa with the statistical program DATAtab. A rubric consisting of seven dimensions and four levels of execution was designed to evaluate the diagnostic competence of DVT by Doppler ultrasound. Appearance validation was performed using the Delphi method until the construct was unified. According to Hernández-Nieto, the content validity is excellent at 0.94, and the inter-observer agreement is good at 0. The evaluation instrument for diagnosing deep vein thrombosis using Doppler ultrasound is valid enough to be used with physicians in training. This allows for routine use in imaging education.
Keywords: Diagnostic competence, assessment instrument, deep vein thrombosis, Doppler ultrasound.

INTRODUCTION

Formative evaluation is imperative in assessing the acquisition and development of psychomotor and attitudinal competencies by applying knowledge until the diagnostic competence is achieved. This endows the physician in training with autonomy in the specialty of diagnostic and therapeutic imaging. Therefore, the use of validated evaluation instruments that objectify the actions supporting the acquisition of skills by the resident to execute a quality study is essential (Cruzado, 2022). Competence is defined as the capacity to mobilize a repertoire of knowledge, skills, abilities, and attitudes, necessary for the execution of varied tasks with a certain degree of quality and effectiveness. (Moreno, 2016)

The capacity of residents to perform specific care activities is contingent upon their level of knowledge and experience, which is predominantly influenced by the year of residency. Consequently, it is imperative to employ an assessment instrument or rubric to evaluate the competencies and attitudes of resident doctors (Sanitas Group, 2020). This evaluation should be conducted in accordance with the degree of progress within their academic program, encompassing the anticipated learning and skills that accompany their progression from novice to expert status. Furthermore, it is essential to ascertain the timing for transitioning to independent study without the guidance of a tutor.

The use of instruments is imperative for the systematic evaluation of resident physicians. These instruments serve as the medium through which information is collected and the competencies of the resident physician are assessed. The instruments in question comprise a progressive scale of execution ranges, ensuring an adequate evaluation. As stated by Durante et al. (2012). However, for an instrument to be utilized in a systematized way in a formative assessment process, it must be both valid and reliable. Validation is defined as an evaluation that serves as the foundation for determining the significance of the empirical evidence and theoretical bases that support an instrument. It is understood as the degree to which an instrument measures what it intends to measure. Reliability, in turn, is defined as the ability of the instrument to yield a consistent result, that is, the reproducibility of the instrument. The determination of validity and reliability, certification of assessment processes, and assurance of student learning achievement are paramount. (Medina Díaz, 2020)

Content validity is a multifaceted concept that can be examined through two distinct phases. The initial phase is qualitative in nature and is referred to as appearance validity. This phase serves to shape the construct that is to be evaluated. The subsequent phase is quantitative in nature and serves to enhance the reliability of the instrument. Among the assessments that can be utilized to evaluate content validity are the content validity index of Lawshe (1975), the V of Aiken (1980), and the content validity coefficient of Hernández Nieto (2002), among others. (Pedrosa, 2014). In a similar vein, it is imperative to assess the inter-observer agreement, as it pertains to the consistency between two different observers when evaluating the same measure in a single individual. Conducting an analysis of this phenomenon is pertinent to evaluate its practical application. (Cerda, 2008)

The evaluation of diagnostic competence in imaging is linked to the issuance of reliable diagnoses that serve as a point of reference for clinicians and contribute to the quality of care, especially in cases of patients with life-threatening pathologies, such as deep vein thrombosis (DVT).

The incidence of deep vein thrombosis (DVT) is estimated to be approximately 1 to 2 per 1,000 inhabitants per year. Of those affected, 8% proceed to develop pulmonary embolism,

while approximately 4% ultimately progress to chronic thromboembolic pulmonary hypertension. (Arriaga-Caballero, 2019)

In Mexico, the estimated annual number of cases ranges from 400,000 to 500,000. According to Arriaga-Caballero et al., the preponderance of female subjects (61.5%) was observed in the left pelvic limb (76.9%), with a predominant involvement of the ilio-femoral sector (79.4%) and an incidence of complications that was recorded at 33.3%. (Parada-Guzmán, 2022)

The evaluation of the skills and competencies of DVT diagnosis by ultrasound has been obtained through studies carried out in non-radiologists who are trained to perform a technique known as point-of-care ultrasonography. A systematic review by Dickson et al. was conducted to assess the capacity of medical students to make ultrasound diagnoses following training courses. The review encompassed a total of 15 published papers, predominantly from the United States and pertaining to emergency medical programs. Among these studies, five utilized a standardized objective tool for evaluating skills and technique. However, these tools were not questionnaires or validated instruments, but rather exams developed for research purposes. This review found that the skills acquired after training exhibited acceptable sensitivity and specificity. However, research of this type that evaluates imaging residents is practically nonexistent. (Dickson, 2017)
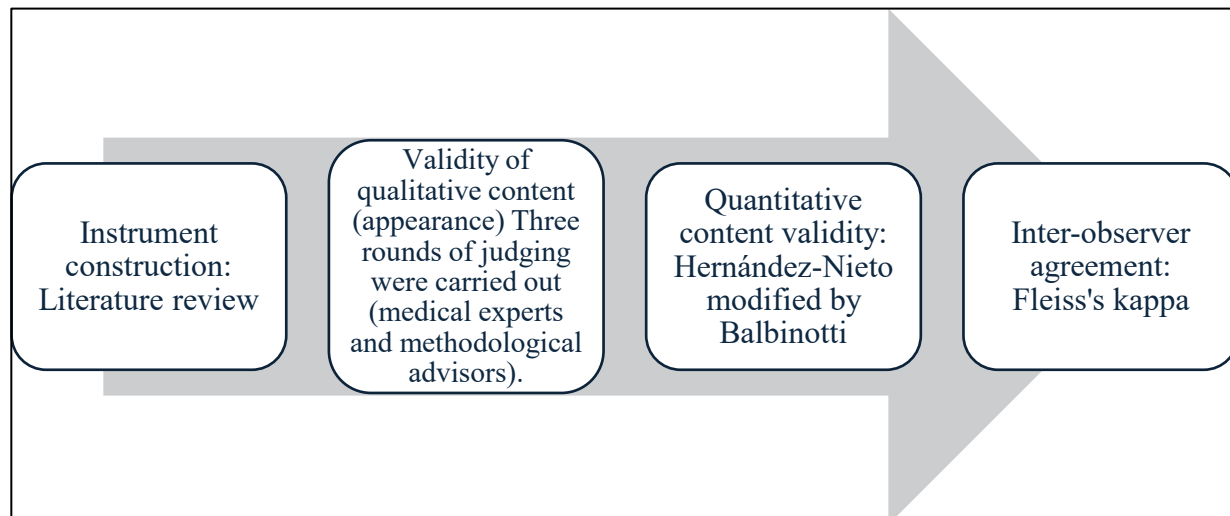
The objective of this work was to develop a tool for evaluating the diagnostic competence of students in the field of Doppler ultrasound-guided deep vein thrombosis imaging. This instrument was designed specifically for imaging residents.

METHODOLOGY

Qualitative study with a descriptive, observational, and longitudinal approach. It was submitted for evaluation and approved by the research ethics committee with registration number R-20022-2103-020. It focused on the construction of a purpose-built rubric through a review of the literature, applying a pilot study for apparent validity, content validity, and interobserver agreement.

Convenience sampling was used, and medical experts in Doppler ultrasound and methodological advisors with master's or doctoral degrees were contacted. The study was conducted in four phases presented in Figure 1.

Figure 1 The four phases of the study

A comprehensive review of the extant literature was conducted to inform the creation of the instrument. Search engines such as PubMed, EMBASE, and Google Scholar were utilized in this endeavor. The implementation of mesh terminology involved the use of specific terms such as "Doppler ultrasound," "deep vein thrombosis," "validation of an instrument," and "reliability." To ensure a comprehensive review, all published articles related to the topic were included. A comprehensive review of extant literature was conducted, encompassing articles published since 2020. Theoretical validation was carried out in accordance with the consensus of expert physicians to determine the key points in the evaluation of a Doppler ultrasound study with a protocol for deep vein thrombosis. The initial step in the process was to establish the initial dimensions from which various descriptors would be initiated. To that end, the AIUM guidelines (The Association for Medical Ultrasound) were examined, and a number of articles were reviewed that included the description of the protocol, as well as books on Doppler ultrasound.

Table 1 Scientific basis for the construction of the instrument

DIMENSIONS	DESCRIPTION	BIBLIOGRAPHY
DIMENSION 1: Initial assessment of the study.	It adheres to the Official Normal 004 of the Clinical File, the requests must have the clinical problem under study, as well as the name and signature of the doctor requesting the study.	DOF 2012 - Official Gazette of the Federation. (n.d.). Official Mexican Standard 004.
DIMENSION 2: Scientific Foundations	Knowledge of the anatomy of the pelvic limb, anatomical variants, pathophysiology of DVT and technique for the execution of the protocol.	Moore, Keith l. Agur, Anne m. r. Dailey, Arthur f. Zwiebel J. Williams.
DIMENSION 3: Employs the appropriate DVT protocol technique	The technique for the execution of the study was documented, according to the most prominent exponents of radiology.	Krebs. Color Doppler. (2004) Laurence Needleman. AIUM Guides.
DIMENSION 4: Make an appropriate choice of images representative of the disease, as well as the appropriate quality of the images acquired.	Study quality requires the selection of significant, high-quality images that support the imaging diagnosis	García Fajardo, J. D., Bolaño Vaillant, S., (2020).
DIMENSION 5: Make a clear and precise description of the pathology according to the results of the study.	The report associated with the images that are structured, clear and accurate	Martí-Bonmatí, L., Alberich-Bayarri, Á., & Torregrosa, A. (2022).

DIMENSION 6: Identifies the disease according to ultrasonographic criteria	Diagnostic competence requires adequate knowledge of radiological criteria	Chama-Naranjo, A., Becerra-Bello, J., Sánchez, R. A. V., & Huerta-Huerta, H. (2021). Caronia J, Sarzynski A, Tofighi B, Mahdavi R (2014)
DIMENSION 7: Message shared clearly so that it is properly understood	Every doctor must have an adequate doctor-patient relationship since it is the fundamental core of the practice of medicine, it has a universal scope and seeks to improve the health and well-being of the person.	López Gabeiras, M. del P. (2023). The importance of doctor-patient communication.

Subsequent to the delineation of the dimensions and descriptors for each component, the evaluation points that would comprise each dimension were drafted. For the subsequent three rounds of evaluation, the validation of the appearance and content of the rubric was conducted. Each round comprised three medical experts and four methodological experts. This configuration was implemented to ascertain evidence of content validity and determine the relevance of the reagents to the construct to be measured. The Delphi method was utilized as an approach to validation, as it is both feasible and capable of avoiding bias due to contact between observers. The Delphi method is a social research technique that aims to obtain a reliable group opinion from a group of experts. It is a method of structuring communication between a group of people who can make valuable contributions to the resolution of a complex problem.

The initiation of the process involved the contact of experts via email, extending an invitation to participate in the study. The instrument was transmitted to them, accompanied by a database that encompassed an appearance validation table. This table evaluated several criteria, including appearance validity, content, linguistic readability, weight of components, format, comprehensibility, transparency, ease of use, and conceptual, procedural, attitudinal, and diagnostic competence. These criteria were assessed as adequate or inadequate. Following a three-week period, evaluations were collected, and the pertinent changes were implemented in the initial instrument. A subsequent validation round was conducted, focusing on content. In this round, a database was disseminated to evaluate the coherence, clarity, scale, and relevance of each item. A score of 1 was assigned if an item was deemed unacceptable, 2 if it was deficient, 3 if it was regular, 4 if it was good, and 5 if it was excellent. Over the course of a three-week period, evaluations were collected, and pertinent changes to the instrument were made. Consequently, a third round was conducted to evaluate the instrument's objectives in a generalized way.

The final step in the validation process for the instrument was pilot testing. This stage was evaluated by a group of five radiologists. The Fleiss Kappa statistics were then calculated to assess the concordance. This calculation was performed using the statistical program DATAtab.

RESULTS

Consequently, a holistic evaluation rubric was developed following a documentary review in accordance with the prevailing health standards in Mexico and the diagnostic criteria for Doppler ultrasound studies focusing on the anatomical region corresponding to the venous circulation of the pelvic limbs. This rubric was designed to encompass the identification of conceptual competencies, procedural competencies, and attitudinal competencies. The instrument is composed of seven dimensions, which are as follows: initial assessment of the study, effective communication, knowledge of the study, execution of the study, assessment of the study, interpretation of the study, and diagnosis. The latter includes evaluation indicators that are qualified in four levels of execution according to the competencies or indicators carried out. A score of 90 to 100 on the rubric indicates "excellent"; a score of 80 to 90 indicates "good" if one of the actions is not performed; a score of 60 to 79 indicates "average"; and a score of less than 59 indicates "deficient."

Table 2 Final Doppler Ultrasound Protocol Assessment Instrument for Deep Vein Thrombosis

DIMENSIONS		LEVEL OF EXECUTION			
Compete	Dimension	Excellent	Well	Regular	Deficient
C O N C E P T U A L A T T I T U D I N A L	**DIMENSION 1:** **Initial assessment of the study** Criteria necessary for the correct identification and justification in the conduct of the study **DIMENSION RATING:** _____	a. Ratify the patient's name and social security number. b. Identifies the clinical summary of shipment, with the laboratory studies. c. Determine if the requested study is appropriate with the clinic. **20 points**	a. Ratify the patient's name and social security number. b. Identifies the clinical summary of shipment, with the laboratory studies. c. Determine if the requested study is appropriate with the clinic. **15 points**	a. Ratify the patient's name and social security number. b. Identifies the clinical summary of shipment, with the laboratory studies. c. Determine if the requested study is appropriate with the clinic. **10 points**	a. Ratify the patient's name and social security number. b. Identifies the clinical summary of shipment, with the laboratory studies. c Determines whether the requested study is appropriate for the clinic. **0 points**

C O N C E P T U A L	**DIMENSION 2:** **Study Knowledge** Reasoning of the study and its execution. **DIMENSION RATING:** _____	a. Know the venous irrigation of the lower limb. b. Learn about the study protocol c. Identifies the transducer to use d. Meet B-mode, Doppler mode and spectral. **20 points**	a. Know the venous irrigation of the lower limb. b. Learn about the study protocol c. Identifies the transducer to use d. Get to know the B mode, Doppler mode and spectral mode. **15 points**	a. Know the venous irrigation of the lower limb. b. Learn about the study protocol. c. Identify the transducer to use. d. Get to know the B mode, Doppler mode and spectral mode. **10 points**	to. Know the venous irrigation of the lower limb. b. Learn about the study protocol. c. Identify the transducer to be used. d. Know the B-mode, Doppler mode and spectral mode. **0 points**
P R O C E D U R A L	**DIMENSION 3:** **Execution of the study** Use the necessary actions for the proper conduct of the study. **DIMENSION RATING:** _____	a. Position the patient properly and apply enough gel. b. Select the right program for the pelvic limb venous system. c. Position the transducer properly. d. Assesses the adequate echogenicity of the vessel and the application of Color Doppler.	a. Position the patient properly and apply enough gel. b. Select the right program for the pelvic limb venous system. c. Position the transducer properly. d. Assesses the adequate echogenicity of the vessel and the application of Color Doppler.	a. Properly position the patient and apply enough gel. b. Select the right program for the pelvic limb venous system. c. Position the transducer properly. d. Assesses the adequate echogenicity of the vessel and the application of Color Doppler. e. Compress every 1.5 cm.	a. Position the patient properly and apply enough gel. b. Select the right program for the pelvic limb venous system. c. Position the transducer properly. d. Assesses the adequate echogenicity of the vessel and the application of Color Doppler.

		e. Compress every 1.5 cm. f.Makes transverse and longitudinal cuts of the deep venous system g. It uses B, color and spectral Doppler mode. **20 points**	e. Compress every 1.5 cm. f.It makes transverse and longitudinal cuts of the deep venous system. g. It uses B, color and spectral Doppler mode. **15 points**	f.It makes transverse and longitudinal cuts of the deep venous system. g. It uses B, color and spectral Doppler mode. **10 points**	e. Compress every 1.5 cm. f.It makes transverse and longitudinal cuts of the deep venous system. g. It uses B, color and spectral Doppler mode. **0 points**
P R O C E D U R A L	**DIMENSION 4:** **Study Quality** Make an appropriate choice of images representative of the disease, as well as the appropriate quality of the images acquired. **10 points** **DIMENSION RATING:**	a. Assess the quality of the image. b. Identifies structures, with the right name. c. Placed Representative images of the thrombus. d. Placed Representative Images of Compressible Veins e. Properly capture images with Doppler mode and spectral. f. Properly recognizes ultrasound	a. Assess the quality of the image. b. Identifies structures, with the right name. c. Placed Representative images of the thrombus. d. Placed Representative images of compressible veins. e. Properly capture images with Doppler mode and spectral. f. Properly recognizes ultrasound signs of deep vein	a. Assess the quality of the image. b. Identifies structures, with the right name. c. Placed Representative images of the thrombus. d. Placed Representative images of compressible veins. e. Properly capture images with Doppler and spectral mode. f. Properly recognizes ultrasound signs of deep vein thrombosis.	a. Assess the quality of the image. b. Identifies structures, with the right name. c. Placed Representative images of the thrombus. d. Placed Representative images of compressible veins. e. Properly capture images with Doppler and spectral mode. f. Properly recognizes ultrasound signs of deep vein thrombosis.

		signs of deep vein thrombosis. **10 points**	thrombosis. **7.5 points**	**5 points**	**0 points**
C O N C E P T U A L	**DIMENSION 5:** **Interpretation of the study** Make a clear and precise description of the pathology according to the results of the study. **10 points** **DIMENSION RATING:** _____	a. Makes a systematized description of the study: Expressing in writing the main normal ultrasound findings of vascular structures, anatomical variants and abnormalities caused by B-mode DVT. b. Describes changes in color Doppler, and spectral Doppler flowmetry. c. Describe the artifacts that can occur in the diagnosis of this pathology. **10 points**	a. Makes a systematized description of the study: Expressing in writing the main normal ultrasound findings of vascular structures, anatomical variants and abnormalities caused by B-mode DVT. b. Describes changes in color Doppler, and spectral Doppler flowmetry. c. Describe the artifacts that can occur in the diagnosis of this pathology. **7.5 points**	a. Makes a systematized description of the study: Expressing in writing the main normal ultrasound findings of vascular structures, anatomical variants and abnormalities caused by B-mode DVT. b. Describes changes in color Doppler, and spectral Doppler flowmetry. c. Describe the artifacts that can occur in the diagnosis of this pathology. **5 points**	a. Makes a systematized description of the study: Expressing in writing the main normal ultrasound findings of vascular structures, anatomical variants and abnormalities caused by B-mode DVT. b. Describes changes in color Doppler, and spectral Doppler flowmetry. c. Describe the artifacts that can occur in the diagnosis of this pathology. **0 points**
C O N C E	**DIMENSION 6:** **Diagnosis**	a. He is assertive in the diagnosis and enumeration of differential	a. He is assertive in the diagnosis and enumeration of differential	a. He is assertive in the diagnosis and enumeration of differential diagnoses	a. He is assertive in the diagnosis and enumeration of differential diagnoses

P T U A L	Identifies the disease according to ultrasonographic criteria **10 points** **DIMENSION RATING:** _____	diagnoses between patients with acute and chronic diseases. b. It correlates the clinical and the radiological. c. Clinical and ultrasound reassessment was suggested due to probable sequelae of post-thrombotic syndrome. **10 points**	diagnoses between patients with acute and chronic diseases. b. It correlates the clinical with the radiological. c. Clinical and ultrasound reassessment was suggested due to probable sequelae of post-thrombotic syndrome. **7.5 point**	among patients with acute diseases and chronicles. b. Correlates the clinical radiological. c. Clinical and ultrasound reassessment was suggested due to probable sequelae of post-thrombotic syndrome. **5 points**	between patients with acute and chronic diseases. b. It correlates the clinical with the radiological. c. Clinical and ultrasound reassessment was suggested due to probable sequelae of post-thrombotic syndrome. **0 points**
A T T I T U D I N A L	**DIMENSION 7:** **Effective communication** Message shared clearly so that it is properly understood **10 points** **DIMENSION RATING:**	a. Patient care: Deals with the patient. b. Patient care: Adequately explains the procedure to the patient and verifies that the patient understood the procedure. c. Ethics: It has the ability to protect privacy and patient	a. It deals with the patient. b. Properly explain the procedure to the patient and verify that the patient understood the procedure. c. It has the ability to protect privacy and patient confidentiality. d. Establishes understanda	a. It deals with the patient. b. Explain the procedure to the patient and verify that the patient understood the procedure. c. It has the ability to protect the privacy and confidentiality of patients. d. Establishes understandable communication with interconsulting physicians in	a. It deals with the patient. b. Explain the procedure to the patient and verify that the patient understood the procedure. c. It has the ability to protect the privacy and confidentiality of patients. d. Establishes understandable communication with interconsulting physicians in

_____	confidentiality. d. Ethics: Establishes understandable communication with interconsulting physicians in special situations. e. Self-regulation: Has the ability to ethically accept one's own error. **10 points**	ble communication with interconsulting physicians in special situations. e. He has the ability to ethically accept his own error. **7.5 points**	special situations. e. He has the ability to ethically handle his own error. **5 points**	special situations. e. He has the ability to ethically handle his own error. 0 points

Instrument indicators:

Excellent: It is the total capacity of skill of the resident doctor in the preparation of the study, complying with a score of 90 to 100 in the rubric.

Good: It is the average capacity of skill of the resident doctor in the preparation of the study, complying with a score of 80-90 in the rubric.

Regular: It is the poor skill capacity of the resident physician in the preparation of the study, complying with a score of 60-79 in the rubric.

Deficient: It is the null capacity of skill of the resident doctor in the preparation of the study, fulfilling a non-passing score of less than 59 points in the rubric.

FINAL GRADE:

FEEDBACK:

NAME AND SIGNATURE OF THE EVALUATOR:

The Hernández-Nieto Content Validity Coefficient (CVC), as modified by Balbinotti (2007), is a statistical method that allows for the assessment of the degree of agreement among experts regarding each item and the instrument in general. The analysis yielded an overall average of 0.94, indicating excellent validity and agreement. The evaluation of each item resulted in a CVC of 0.72 in 9% of cases and a CVC of 0.96 in 91% of cases. Consequently, no item was eliminated, as it is recommended to retain items with a CVC greater than 0.70.

Table 4 Content validity coefficient of each item and overall

ITEM	EXPERT 1	EXPERT 2	EXPERT 3	Sx1	Mx	CVCi	Pe	CVC

1	20	20	20	60	3	1	0.037	0.962
2	20	20	20	60	3	1	0.037	0.962
3	13	20	13	46	2.3	0.7666	0.037	0.729
4	20	20	20	60	3	1	0.037	0.962
5	20	20	20	60	3	1	0.037	0.962
6	13	20	13	46	2.3	0.7666	0.037	0.729
7	20	20	20	60	3	1	0.037	0.962
8	13	20	13	46	2.3	0.7666	0.037	0.729
9	20	20	20	60	3	1	0.037	0.962
10	20	20	20	60	3	1	0.037	0.962
11	20	20	20	60	3	1	0.037	0.962
12	20	20	20	60	3	1	0.037	0.962
13	20	20	20	60	3	1	0.037	0.962
14	20	20	20	60	3	1	0.037	0.962
15	20	20	20	60	3	1	0.037	0.962
16	20	20	20	60	3	1	0.037	0.962
17	20	20	20	60	3	1	0.037	0.962
18	20	20	20	60	3	1	0.037	0.962
19	20	20	20	60	3	1	0.037	0.962
20	20	20	20	60	3	1	0.037	0.962
21	20	20	20	60	3	1	0.037	0.962
22	20	20	20	60	3	1	0.037	0.962
23	20	20	20	60	3	1	0.037	0.962
24	20	20	20	60	3	1	0.037	0.962
25	20	20	20	60	3	1	0.037	0.962
26	20	20	20	60	3	1	0.037	0.962
27	20	20	20	60	3	1	0.037	0.962
28	20	20	20	60	3	1	0.037	0.962
29	20	20	20	60	3	1	0.037	0.962
30	20	20	20	60	3	1	0.037	0.962
31	20	20	20	60	3	1	0.037	0.962
				AVERAGE 0.940				

Finally, the inter-observer agreement of the instrument was determined through a pilot test, the results of which were calculated using the Fleiss Kappa method, yielding a value of 0.63. This finding indicates that the rubric is deemed acceptable for the purpose of assessing the diagnostic capacity of resident physicians in performing Doppler ultrasound studies for the identification of deep vein thrombosis, in accordance with a specified protocol.

Table 5 Inter-observer agreement validation

Fleiss Kappa	Standard Error	Lower 95% CI	Upper 95% IQ	p
0.63	0.08	0.47	0.78	<.001

Conclusions

The instrument was deemed optimal for the evaluation of diagnostic competencies among imaging specialists. It is regarded as an appropriate rubric due to its versatile design, which enables the assessment of competencies as students develop proficiency in performing studies for the diagnosis of DVT with UD, eventually attaining autonomy and efficiency. As Huamán et al. (2021) assert, holistic rubrics are considered a potent instrument for the evaluation of authentic real-life tasks. This instrument is particularly well-suited for the assessment of competencies, as it facilitates the decomposition of complex tasks into more manageable, incremental, and operational components.

The pedagogical advantages of the rubric are manifold. Primarily, it serves as an efficient method of collecting information regarding students' competencies, thereby enabling the formulation of concrete pedagogical decisions. These decisions encompass the content to be reinforced, the amount of exercise to be administered, the type of activities to be implemented, and the areas to be continued, among others. Secondly, the provision of feedback is facilitated, which in turn allows for the facilitation of reflection on what is being learned (metacognition). This is achieved by clearly delineating the levels, dimensions, and correction criteria, which in turn allows for more effective thinking about learning.   For this reason, they are considered useful tools for the promotion of self-evaluation and peer correction. Consequently, it is considered important and relevant to establish improvements in the academic training of the resident physician. Such improvements can promote the resident physician's problem-solving capacity (diagnostic attitude) and offer a comprehensive approach to patients.

The results of the appearance validation process, which was executed through the Delphi method, served to refine the instrument until it met the expectations of the experts and there was homogeneity of criteria.

In the quantitative content validation by Hernández Nieto, the modified content validity coefficient was determined to be 0.94, indicating excellent validity. This result is analogous to the instrument developed by Leyva et al. in 2022 to assess the environmental performance of restaurants, which exhibited a higher coefficient of 0.8 out of 0.953. This finding substantiates the instrument's suitability for use within the designated unit of analysis. Finally, the instrument was submitted to interobserver agreement by Kappa de Fleiss with a score of .63, which is considered substantial or good agreement. This differs from the rubric developed by Bernal et al. (2018) to measure physical-emotional perceptions in the practice of anatomical dissection, which achieved a score of .84, indicating almost perfect agreement. This discrepancy may be attributed to the fact that the rubric of the study encompasses multiple dimensions that value attitudinal competencies, in addition to the conceptual and procedural competencies assessed by Bernal et al.

In the Mexican educational system, the cultivation of competence in its professionals stands as a pivotal challenge. The medical field, in particular, bears a significant responsibility to nurture adept professionals, thereby effectuating an enhancement in the health status of the population. The prevailing pedagogical paradigm in medical education places considerable emphasis on participatory education, wherein students are accorded a pivotal role as autonomous learners. Competence is defined as the set of knowledge, abilities, skills, and attitudes necessary to carry out various activities with a certain level of quality and efficiency. Therefore, the radiology resident must demonstrate certain competencies to carry out various studies according to their knowledge and experiences. The evaluation of this diagnostic competence with a suitable instrument enables an objective assessment of the knowledge and experience accumulated during an individual's medical training. It encompasses not only the

evaluation of knowledge regarding a condition but also the capacity to conduct the pertinent study for the patient, thereby fostering problem-solving skills in diverse scenarios.

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Data availability: The data supporting the findings of this study are available from the corresponding author, upon reasonable request.

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