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CJMS

Canadian Journal of Medical Sonography

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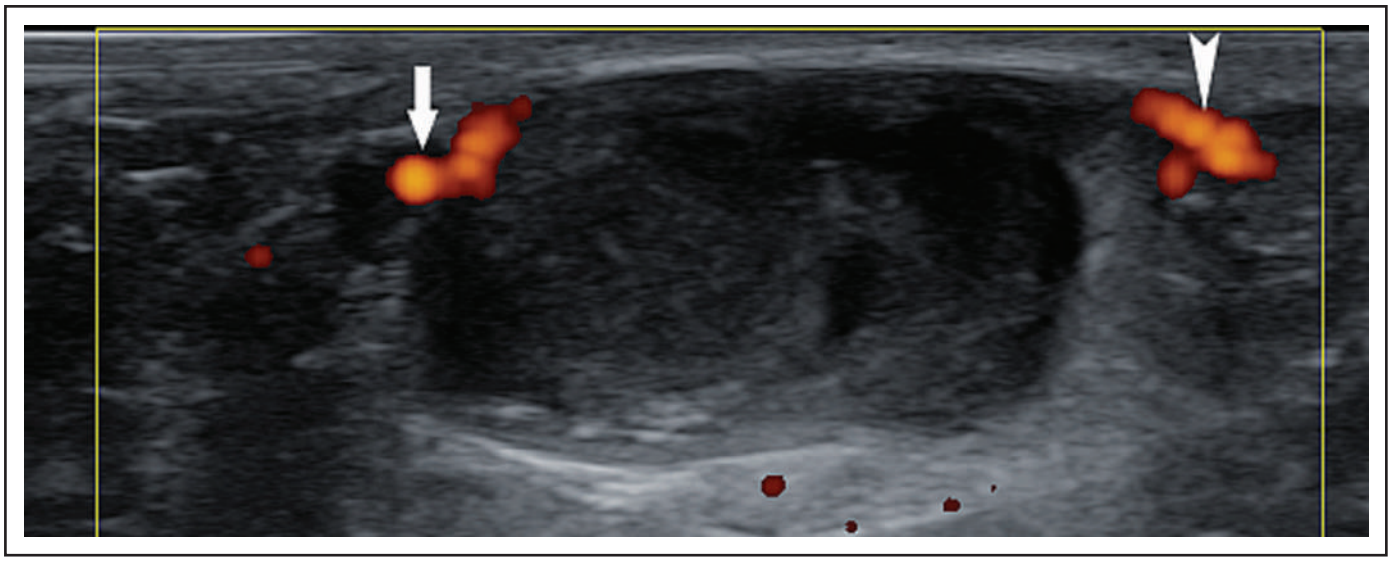

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About the Cover

This image is Figure 3B from Tony Li's article "Traumatic Superficial Venous Aneurysm with Thrombosis"

Ed - In issue1, Lori Arndt was under Editor in Chief but should have been under reviewers.

Message from the Editor-in-Chief

Welcome to issue 2 of 2021 which focuses on progress and achievement.

This issue celebrates Sonography Canada award winners. These are individuals who have made significant contributions to the profession of sonography or to the association. These awards acknowledge the various roles and accomplishments sonographers can have in their careers starting as students, then as mentors, educators or colleagues.

This issue also highlights the results of a survey done by Sonography Canada to report on the status of COVID-19 vaccination for Canadian sonographers and opportunities offered at their different work sites. I applaud this research project designed to help support the association's advocacy efforts with federal and provincial health officials to place sonographers on the priority list for vaccination.

This issue of the CJMS also features two case reports and two literature reviews. Once again, manuscripts were submitted by both Canadian and American authors. Tony Li, one of our new reviewers who has published previously with the CJMS, reports on a rare case of a patient with blunt trauma diagnosed with a superficial vein aneurysm with thrombosis. This article will be of interest to all generalist as well as vascular sonographers. Jody Chantler reports on a tricuspid valve fibroelastoma in a patient with non-specific cardiac symptoms, reminding us that every symptom may not directly relate to the pathologies that we find. Lacey Fischer & Brandon Hirsch present a robust literature review on the chronology of utilizing diagnostic medical imaging in the diagnosis of appendicitis. And finally, we have a report from Grace Park, Fatima Tul Zahra and Nicole Marley on infection control and safety protocols to protect sonographers and patients during the COVID-19 pandemic. This article is an evidence-based report that is applicable to all sonographers at this time.

Throughout the COVID-19 pandemic, sonographers have demonstrated ongoing innovation, commitment, and resilience during what is arguably one of the most demanding and challenging times for healthcare professionals. This issue is published in honour of all those on the frontline who have gone to work, day after day, to support their communities and help keep us safe this past year.

Sheena Bhimji-Hewitt

Broadening Horizons & Pushing Boundaries

*The opinion in this editorial is that of the Editor-in-Chief and not that of Sonography Canada or the Sonography Board of Directors.

Message du rédactrice en chef

Bienvenue au numéro 2 de 2021 qui met l'accent sur les progrès et les réalisations.

Ce numéro rend hommage aux lauréats des prix de Sonographie Canada. Il s'agit de personnes qui ont apporté une contribution importante à la profession d'échographiste ou à l'association. Ces prix reconnaissent les divers rôles et réalisations que les échographistes peuvent avoir dans leur carrière, d'abord comme étudiants, puis comme mentors, éducateurs ou collègues.

Ce numéro met également en lumière les résultats d'une enquête menée par Sonographie Canada pour faire le point sur l'état de la vaccination COVID-19 des échographistes canadiens et sur les possibilités offertes dans leurs différents lieux de travail. J'applaudis ce projet de recherche conçu pour aider à soutenir les efforts de plaidoyer de l'association auprès des responsables de la santé fédéraux et provinciaux afin de placer les échographistes sur la liste des priorités en matière de vaccination.

Ce numéro de la CJMS présente également deux rapports de cas et deux revues de la littérature. Une fois de plus, les manuscrits ont été soumis par des auteurs canadiens et américains. Tony Li, l'un de nos nouveaux réviseurs qui a déjà publié des articles pour la CJMS, rapporte le cas rare d'un patient souffrant d'un traumatisme contondant chez qui on a diagnostiqué un anévrisme de la veine superficielle avec thrombose. Cet article intéressera tous les échographistes généralistes ainsi que les échographistes vasculaires. Jody Chantler rapporte un fibroélastome de la valve tricuspide chez un patient présentant des symptômes cardiaques non spécifiques, nous rappelant que chaque symptôme peut ne pas être directement lié aux pathologies que nous trouvons. Lacey Fischer et Brandon Hirsch présentent une solide analyse documentaire sur la chronologie de l'utilisation de l'imagerie médicale diagnostique dans le diagnostic de l'appendicite. Et enfin, nous avons un rapport de Grace Park, Fatima Tul Zahra et Nicole Marley sur le contrôle de l'infection et les protocoles de sécurité pour protéger les échographistes et les patients pendant la pandémie de COVID-19. Cet article est un rapport fondé sur des preuves qui s'applique à tous les échographistes à l'heure actuelle.

Tout au long de la pandémie de COVID-19, les échographistes ont fait preuve d'innovation, d'engagement et de résilience pendant ce qui est sans doute l'une des périodes les plus exigeantes et difficiles pour les professionnels de la santé. Ce numéro est publié en l'honneur de tous ceux qui, en première ligne, se sont mis au travail, jour après jour, pour soutenir leurs communautés et contribuer à notre sécurité au cours de l'année écoulée.

Sheena Bhimji-Hewitt

Élargir les horizons et repousser les frontières

*L'opinion exprimée dans cet éditorial est celle du rédacteur en chef et non celle de Sonographie Canada ou du conseil d'administration de Sonography.

Case Report

Tony Y. Li, RDMS, RVT, RMSK, CRGS, CRVS

Traumatic Superficial Venous Aneurysm with Thrombosis

About the Author

Tony Li is with the Albany Medical Clinic, Department of Diagnostic Imaging, Toronto, ON, Canada

ABSTRACT

Venous aneurysm (VA) is a focal dilation of a vein. A superficial VA is rare. In this case study, an extremely rare superficial VA with thrombosis caused by blunt injury is reported. The patient presented with a painless soft mass in the medial aspect of the right distal leg with previous history of local blunt injury. The mass was partially compressible and had no significant change with the leg in dependent or elevated position. Duplex ultrasonography revealed a focal dilation of a vein segment with hypoechoic content inside, which is consistent with a superficial VA with thrombosis. The possible pathogenesis may be that the local injury causes degenerative changes leading to the weak vein wall, while more static pressure and less emptying power in the vein of distal leg results in the local vein dilatation and thrombus formation.

Introduction

Venous aneurysm (VA) can be defined as a focal dilation of a vein. It has no direct relationship with varicose veins' arteriovenous fistulas, or pseudoaneurysms.[1] VAs have been reported in most major veins, but more frequently in the deep venous system, especially the popliteal vein.[2–4] Thus far no quantified definition of a VA with regard to the diameter size has been documented.[5] VA is classified as superficial or deep according to the location in the venous system.[2] Findings from a retrospective study in a vascular center indicated that superficial venous aneurysms are rare, and occur in approximately 1.5% of the vascular patients.[1] Both deep and superficial VA's have the possibility of thrombus formation, but the superficial VA has a lesser risk.[3] VA can be primary, which means the pathogenesis is associated with congenital weakness of the vein wall or if associated with trauma, inflammation, degenerative changes in the wall, or increased pressure in the vein is referred to as secondary.[5] A venous aneurysm secondary to mechanical trauma is very rare, and only a few cases have been reported, among which most were caused by penetrating or surgery-related injury.[4,6] This case report discusses the findings from a blunt injury to the distal lower extremity and its diagnosis of a superficial venous aneurysm with thrombosis.

Case Report

A 61-year-old female presented with a painless soft tissue mass on the medial aspect of the right lower leg just superior to the medial malleolus. She was referred for an ultrasound examination. Her clinical history indicated she was hit by her bicycle pedal in the medial right lower leg above the ankle 7 months ago. After the injury the area became red, swollen, and

very painful and an ice pad was applied to the injured area for 2 days. Gradually the swelling disappeared. About 4 months after the injury the patient found a painless lump at the original injured area, which grew very slowly. She had no history of any systematic diseases. Physical examination revealed a painless soft mass that measured about 2 cm in diameter on the medial aspect of the right lower leg 2-cm superior to the medial malleolus. Local skin over the mass appeared a faint blue color. The mass was partially compressible, non-pulsatile, and without tenderness. There were no visible varicose veins in the leg. The mass had no significant changes with the leg in dependent or elevated position.

An ultrasound examination was performed with a linear high-frequency transducer (8–17 MHz) at a frequency of 15 MHz with the patient in a supine position. A well-defined solid, hypoechoic structure was identified in the subcutaneous tissue, measuring 2.1 × 1.7 × 1.3 cm (Figures 1A and B). Applying transducer pressure over the mass could partially compress this structure (Figure 2). Power Doppler of this area showed vascularity at the cranial and caudal aspects of this mass (Figures 3A and 4B) indicating that the well-defined structure was a dilated vessel, and the solid structure within the lumen was a thrombus. The sample volume of the pulsed-wave Doppler, was dropped within the lumen, at both cranially and caudally to the solid structure, spectral analysis showed a venous flow waveform in each area (Figures 5A and B). Follow-up information after the ultrasound was unavailable.

Discussion

Pulmonary embolism (PE) is a life threatening condition and can be caused by thromboses migrating from both the deep and superficial venous aneurysms (VA).[1,2,7] Even though PE risk is very low in the superficial thrombosed VA compared with deep thrombosed

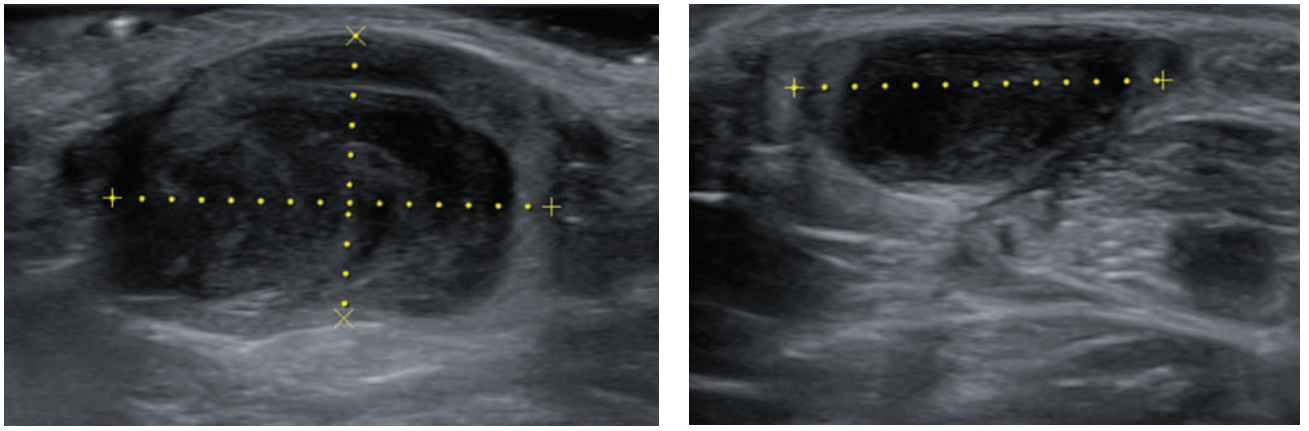

Figure 1. The soft mass in the subcutaneous tissue appearing as a well-defined hypoechoic structure in longitudinal (A) and transverse view(B), measuring 2.1 × 1.7 × 1.3 cm.

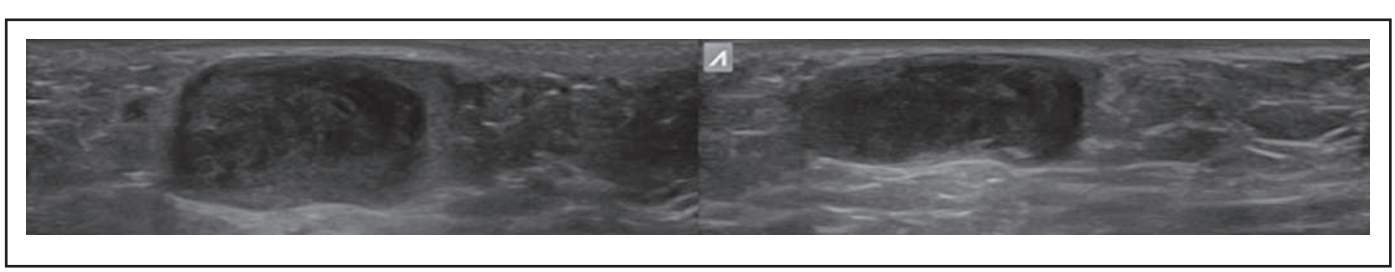

Figure 2. Compression test over the soft mass. Before (left panel) and after (right panel) compression. The soft mass could only be partially compressed.

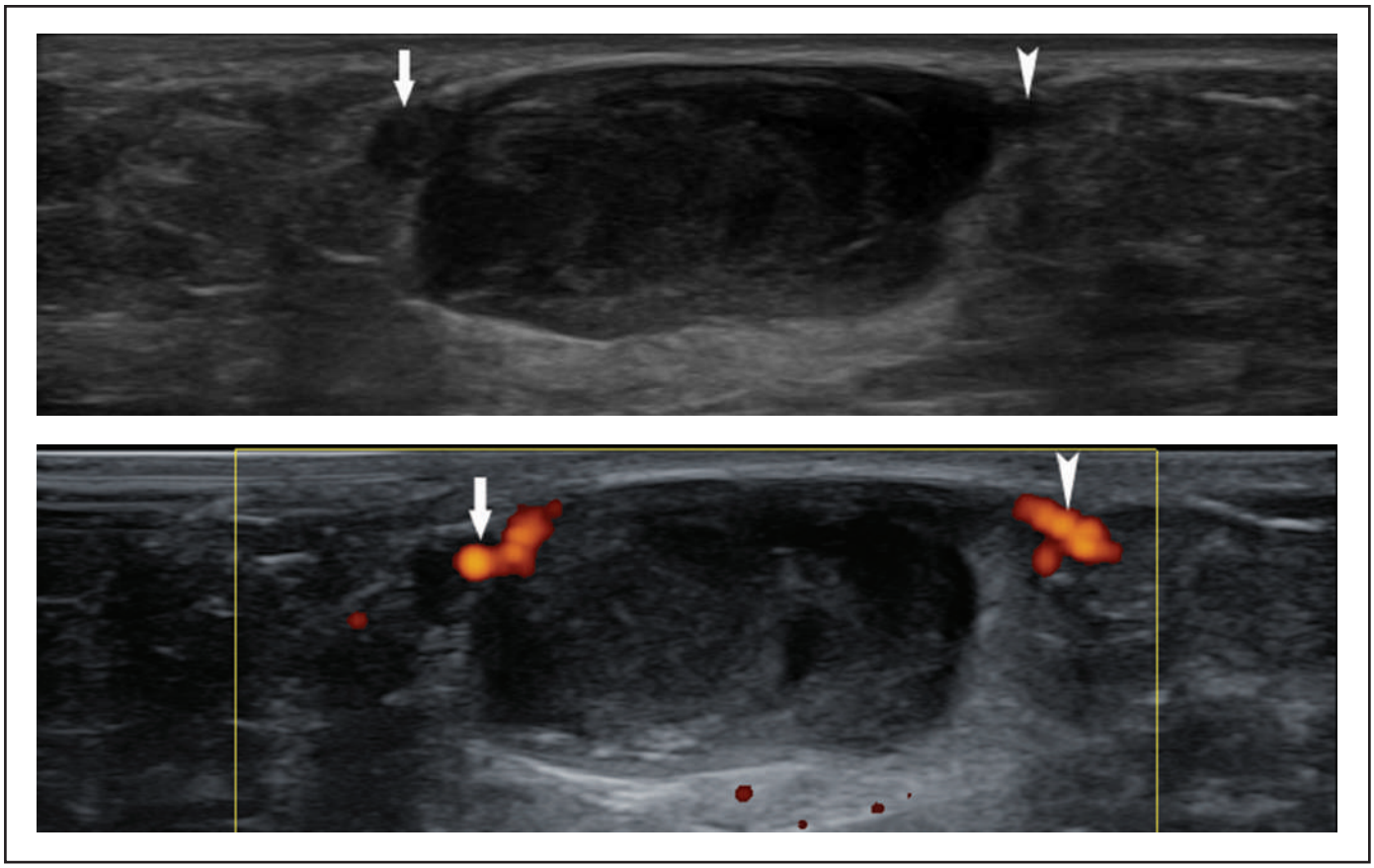

Figure 3. The hypoechoic structure and its vessel connections. (A) The hypoechoic structure connects with the cranial vessel (arrow) and the caudal vessel (arrow head). (B) Power Doppler demonstrates blood flow in the connections.

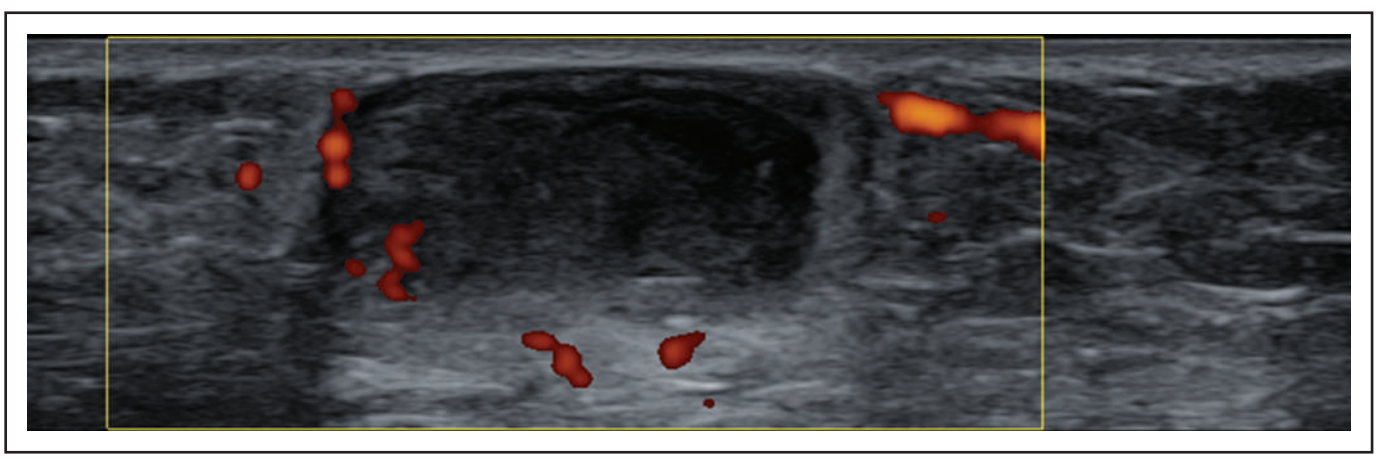

Figure 4. Blood flow in the hypoechoic structure revealed by Power Doppler. Only limited space has blood flow.

VA, early and accurate diagnosis of superficial VA, especially with thrombus, is still a significant diagnosis. The reason that deep VAs present more frequently with pulmonary embolism may be that during muscular contraction, the vigorous emptying of the deep vein may dislodge thrombus in the deep VA.[8] For superficial VAs in the lower extremities, the majority were identified in the great saphenous vein (GSV) compared with the lesser saphenous vein.[1,9] The location of superficial VA in the present case was on

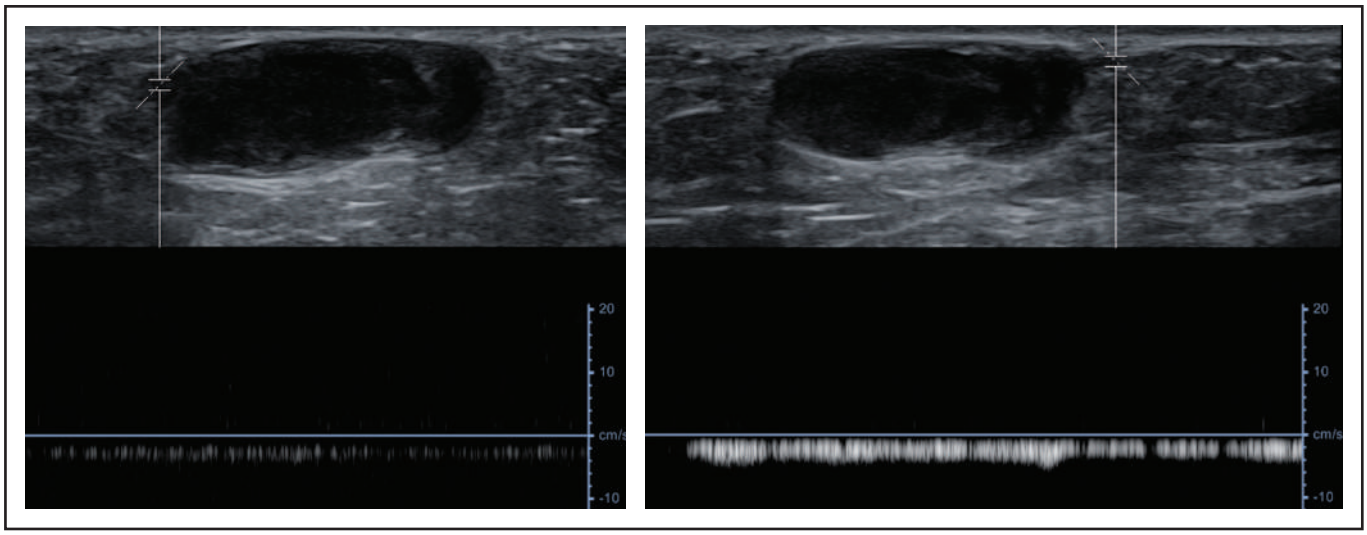

Figure 5. Pulsed-Wave Doppler analysis in the connection vessels. (A) The cranial vessel demonstrates venous flow waveform estimated around 3.3 cm/second. (B) The caudal vessel demonstrates venous flow waveform estimated around 4.0 cm/second.

the medial aspect of the distal right leg anatomically, this could be a small branch of GSV. However, this branch was so small and tortuous that it was could not be traced proximally to the GSV. Gray scale and power Doppler images demonstrated a thrombus almost occupying the entire aneurysm with limited blood flow inside the aneurysm. This was consistent with the fact that applying pressure over the aneurysm could only partially compress it. When comparing the vein connected to the cranial end of the aneurysm with the thrombus in the aneurysm, the difference in diameters suggested that the chance of the thrombus to go passing through a tiny proximal vessel to cause thromboembolism was very low.

The possible mechanism of traumatic VA may be that the localized injury may cause degenerative changes with loss of normal connective tissue components leading to a weak vein wall, with increased risk of local vein dilatation.[2] For the present case of VA, the injured vein is superficial and in the distal lower leg, with increased static pressure and less emptying power which may eventually become aneurysmal and thrombosed

Most superficial VAs are asymptomatic and are noted initially as a soft mass. This patient experienced a focal blunt injury, followed by swelling, remission and later onset of a soft tissue painless mass indicating that the mass is an injury-related lesion. Clinically, it is not uncommon to misdiagnose masses such as these as subcutaneous soft-tissue tumors, varicose veins, or venous malformation.[5] Superficial VA without thrombosis normally has two clinical features. The first is that it can be compressed easily and completely and can expand immediately after removing pressure. The second feature is that it is more prominent in dependent position and diminishes in an elevated position. In this particular case the patient did not present with either clinical feature and an ultrasound was requested for further investigation.

A venous malformation is a malformation of blood vessels with slow flow and an abnormal venous network.[10] The malformation is congenital and usually grows slowly until adulthood. Venous malformations are usually solitary in the skin and subcutaneous tissues, and sometimes deep in the muscle. They present as either faint blue patches or soft masses.[10,11] For soft tissue mass venous malformations, the signs and symptoms are similar to that of a VA. To differentiate between a VA and a venous malformation a vascular ultrasound is indicated. Varicose veins can also get aneurysms but in this patient a varicose aneurysm was ruled out since this patient did not have any varicose veins.

Duplex ultrasound vascular imaging is the first imaging choice for the diagnoses of VA and thrombosis.[3] It has the benefit of being non-ionizing, non-invasive, has real-time imaging, it is portable and inexpensive compared to other imaging modalities. Duplex Ultrasound imaging can accurately assess the presence of a VA as well as thrombus and accurately assess the location and size of both. Duplex scanning in this case confirmed a VA, presence of thrombus, and size of the aneurysm. The typical appearance of a VA without thrombus is a well-defined anechoic structure continuous with a superficial vein. It can be easily compressed with pressure and dilates immediately on removing the pressure.[5] These characteristics can help to differentiate it from venous malformation, which appears either as well-circumscribed, sponge-like vascular spaces or as poorly marginated collections of veins.[11] With thrombus formation, hypoechoic content could be seen within the lumen of the dilated vessel either partially or completely occupying the dilated segment. This case has a thrombus occupying most of the dilated segment with a small area showing blood flow within the lumen. Computed tomography (CT) or magnetic resonance imaging (MRI) are other diagnostic imaging choices that can also asses venous anatomy, VA location and, size VA and may be required before surgery.[2]

The most frequent severe complication of VA is a pulmonary embolism. About 24–32% VAs had concomitant pulmonary embolism(s).[12] However, in 67% of cases the PE occurred in patients with deep VAs.[1,2] Superficial VA's have lesser risk of PE since they rarely have thrombosis and even if they do the venous distal superficial veins are very small in diameter and the vessels also have increased static pressure and less emptying power supporting the theory that the thrombus can not easily migrate.[1,3] Other complications, such as rupture, seldom happen in superficial VAs.[2] For superficial VAs without thrombosis, if the patient has no symptoms or cosmetic demands, regular follow-up may be the choice. However, if the aneurysm has thrombosis, surgical intervention to ligate the afferent and efferent veins and excise the dilated segment is recommended.[2,5]

Conclusion

The most frequent severe complication of VA is a pulmonary embolism. There is a strong association of PE and VAs with the majority being deep vein aneurysms with thrombosis. Superficial VAs have a lesser risk of PE since they rarely have thrombosis and blunt force injuries rarely result in thrombosed VA but as this case shows it is possible and as a sonographer all possibilities should be entertained when it comes to both deep and superficial vein aneurysms.

References

1. Gillespie DL, Villavicencio JL, Gallagher C, et al. Presentation and management of venous aneurysms. J Vasc Surg 1997; 26(5): 845-852.
2. Gabrielli R, Rosati MS, Siani A, et al. Management of symptomatic venous aneurysm. Scientific World Journal 2012; 2012:6.
3. Lee HY, Lee W, Cho YK, et al. Superficial venous aneurysm: reports of 3 cases and literature review. J Ultrasound Med 2006; 25:771-776.
4. Paes T, Andrews S, Wyatt A: Acquired venous aneurysms. Br J Sports Med 1991; 25: 140.
5. Seo SH, Kim MB, Kwon KS, et al. Primary venous aneurysms of the superficial venous system. Angiology 2008; 59(5):593-8.
6. Sadr AH, Paes TRF. Venous aneurysm of the dorsal venous arch a case with an unusual etiology. J Am Podiatr Med Assoc 2010; 100(2): 143-145.
7. Pascarella L, Al-Tuwaijri M, Bergan JJ, et al. Lower extremity superficial venous aneurysms. Ann Vasc Surg 2005; 19:69-73.
8. Chen SI, Clouse WD, Bowser AN, et al. Superficial venous aneurysms of the small saphenous vein. J Vasc Surg 2009; 50:644-7.
9. Marcucci G, Accrocca F, Antignani PL, et al. An isolated aneurysm of the thigh anterolateral branch of the greater saphenous vein in a young patient presenting as an inguinal hernia. Interactive Cardiovascular and Thoracic Surgery 2010; 10:654-655.
10. Cox MA, Krishnan S, Aidinian G. Fatal pulmonary embolism associated with asymptomatic popliteal venous aneurysm. J Vasc Surg 2008; 48:1040.
11. Dubois J, Soulez G, Oliva VL, et al. Soft-tissue venous malformations in adult patients: imaging

and therapeutic issues. Radiographics 2001; 21(6):1519-31.
12. Paltiel HJ, Burrows PE, Kozakewich HP, et al. Soft-tissue vascular anomalies: utility of US for diagnosis. Radiology 2000; 214(3):747-54.
13. Sessa C, Nicolini P, Perrin M, et al. Management of symptomatic and asymptomatic popliteal venous aneurysms: a retrospective analysis of 25 patients and review of the literature. J Vasc Surg 2000; 32(5): 902-912.

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Article title: Traumatic Superficial Venous Aneurysm with Thrombosis

Author's Names: Tony Y. Li, RDMS, RVT, RMSK, CRGS, CRVS

1. In this case report the superficial venous aneurysm may have been caused by

a) Plaque
b) Open wounds
c) Atherosclerosis
d) Blunt force trauma

2. A secondary superficial venous aneurysm is most commonly associated with the following abnormalities of the vein wall except

a) Trauma
b) Thrombus
c) Inflammatory changes
d) Congenital wall weakness

3. Most superficial venous aneurysms are asymptomatic True or False:

4. A superficial venous aneurysms has the following features

a) Soft mass
b) Compressible
c) Prominent in dependent position
d) All of the above

5. Pulmonary embolism's are a greater risk in patients with

a) Lower extremity venous aneurysms
b) Superficial venous aneurysms with thrombus
c) Upper extremity venous aneurysms with thrombus
d) Lower extremity deep venous aneurysms with thrombus

Grace Park, BA, Salwa Bahador, BSc and Linda La, BSc

Infection Control and Safety Protocols to Protect Sonographers and Patients During the COVID-19 Pandemic

About the Authors

Grace Park, BA (Hon R.Kin), CEP, (CRGS in progress)

Salwa Bahador, BSc (Hon Psychology), (CRGS in progress)

Linda La, BSc, (Hon Biomedical Science), (CRGS in progress)

All the authors are students at The Michener Institute of Education at UHN, Toronto. Ontario

Corresponding author: Grace Park: 19GLP1@michener.ca

ABSTRACT

The coronavirus disease (COVID-19) pandemic has had an extensive health, social, and economic impact around the world. Owing to its high rate of transmission, implementing infection control and safety protocols become crucial in protecting sonographers and patients. This literature review explored various databases and search engines to acquire published peer-reviewed articles and multiple resources related to Canadian COVID-19 statistics and evidence-based practices. Information was used to discuss the importance of infection control and recommendations in adopting proper personal protective equipment (PPE) protocols. This includes wearing appropriate PPE, correct donning and doffing procedures prior to and after interactions with patients, and proper hand hygiene. To effectively fight COVID-19, it is essential for both sonographers and patients to adhere to these recommendations and protocols.

Introduction

The World Health Organization (WHO) declared the coronavirus disease (COVID-19) a pandemic on March 11, 2020.[1] Close contact and droplets are the main routes of transmission and can be transmitted by symptomatic and pre-symptomatic patients.[1] In these crucial times, healthcare workers are the world's most vital aid. With a high rate of transmission, being in direct contact, and providing services to patients put healthcare workers at a greater risk of contracting

the virus. It is important for healthcare workers to be educated and comply with safety protocols and infection control procedures to protect themselves and their patients; this includes appropriate personal protective equipment (PPE) for types of isolation, donning and doffing of PPE, and stringent hand hygiene protocols.[1]

Methodology

This literature review explored published journal articles and data from various resources. Articles were selected from PubMed, Cochrane Library, Center for Disease Control, WHO, Sonography Canada, European Center for Disease Prevention and Control, and American Institute of Ultrasound in Medicine. Information and statistics were also acquired from the Public Health Ontario and Government of Canada websites. Published information that was explored and acquired from these databases and government websites was up to date containing relevant data from reliable sources. Owing to the present and ongoing research on this topic, articles with the most recent and updated data were selected.

Articles were searched using advanced filters to obtain relevant information. Key terms used to search included: sonographers, ultrasound, COVID-19, infection prevention, infection control, personal protective equipment (PPE), and hand hygiene. Articles were limited by language in PubMed to filter for articles published in English. Publication dates were limited to search for articles and information published within the last 5 years (2015–2020).

Demographics and Epidemiology

Individuals who are at an increased risk of infection include those aged 65+, immunocompromised, and/or having other underlying medical conditions.[1] Other factors include being in close proximity to those infected and not adopting proper safety precautions and protocols. Infected individuals may experience flu-like symptoms, including fever, cough, difficulty in breathing, and pneumonia, which can take up to 14 days to appear after exposure.[1] In severe cases, infection can lead to death.[1]

The outbreak of the virus was originally detected in Wuhan, China with several cases from the region reported to WHO on December 31 2019.[1,2] The first case in Canada was reported on January 25, 2020.[1] As of February 14, 2021, a total of over 820,000 cases of COVID-19 were confirmed in Canada by WHO and Government of Canada (see Table 1).[3,4] It is reported

Table 1. Provincial summaries of the COVID-19 Cases Reported in Canada as of February 14, 2021[4]

Province	Total Cases	Recovered	Total Deaths
Ontario	285,868	267,128	6,693
Quebec	276,790	256,270	10,214
Alberta	128,824	121,829	1,780
British Columbia	72,750	67,008	1,288
Manitoba	30,766	28,276	871
Saskatchewan	26,550	24,332	354
Nova Scotia	1,593	1,519	65
New Brunswick	1,400	1,227	22
Newfoundland and Labrador	697	394	4
Nunavut	311	299	1
Prince Edward Island	114	112	0
Yukon	71	69	1
Northwest Territories	38	32	0
Total	**825,785**	**768,508**	**21,293**

in the epidemiological summary published by the Government of Canada that there is approximately an equal split of males and females of these confirmed cases and one-fifth are individuals aged 60+.[5]

On February 13, 2021, Public Health Ontario reported in an epidemiologic summary that 14,895 of the provincial cases were among long-term care home residents and 6484 were among long-term care healthcare workers.[6] The reported number of deaths among long-term care residents was 3797, making up over half the total deaths related to COVID-19 to date in Ontario.[6] Residents are more susceptible to the virus because of being an older population and having weaker immune systems, disabilities, and underlying health conditions.[7,8] Communal meals, cohabiting confined spaces, activities, and staff assisting residents in their personal hygienic duties contribute to the increased risk of transmission.[8] Limited rooms for isolation and lack of resources to treat the virus in long-term care facilities make it difficult to suppress the transmission of COVID-19. A lack of training in PPE protocol puts healthcare workers in these facilities at risk. It is important to recognize that these factors have been detrimental to the health of everyone in long-term care facilities. Equally important is to consider them during future implementations for greater protection and infection control.

Impact on the World

COVID-19 has caused great challenges and has affected everyone worldwide. An increasing amount of new information, research, and concerns on the pandemic's effects have been published by numerous sources.

In response to the health concerns of this pandemic, governments globally have enforced travel restrictions, border shutdowns, and quarantine (see Table 2).[9]

It is imperative to recognize how populations are coping with this major adversity. Global strategies and resources are employed to stop the spread of the virus and to inform us on its physical effects. COVID-19 has had a major economic and social impact around the world. Evidently, transmission and infection control of COVID-19 should be top priority, but it should not distract us from the other arising consequences.

Infection Control and Prevention

Infection control and prevention refers to evidence-based practices that can prevent the risk of transmission from person to person.[10] As an emerging infectious disease, limited information is currently available for COVID-19. However, infected individuals may experience no or mild symptoms making it difficult to recognize and control.[11] It is also highly contagious and can transmit through droplets.[11] To date, no concrete findings or specific antiviral treatments are available. Thus, the most crucial and effective weapon against the virus is the prevention of its spread.[11] Intense infection control, surveillance, and being vigilant are vital for decreasing the transmission rate. These are all important measures in healthcare settings.

Sonographers are at a high risk of exposure in this pandemic because of close patient interaction during examination that last for 20 min or longer.[12] Occupational health and safety standards and public

Table 2. Areas of the COVID-19 Impact[9]

Economics/Business	• Closure of businesses/community events, decline in stock market, etc.
Healthcare System	• High healthcare costs • Shortages of protective equipment • Low number of ICU beds and ventilators
Travel/Tourism	• Hardest-hit sector • Loss of jobs
Employment	• Increase in unemployment due to quarantine and closure of business/stores
Food Sector	• Concerns of food shortages due to people panic buying and stocking

health guidelines from local authorities should be followed by both sonographers and patients to prevent spread of COVID-19.[13]

Recommendations

Facility policies and practices should be established to minimize exposure to COVID-19.[14] Measures should be implemented before arrival of patient, throughout the duration of the patient's visit, and until the patient's room is cleaned and disinfected.[14] Scheduling, pre-screening, and monitoring healthcare personnel are crucial areas for infection control.[14] See Figure 1 for recommendations.

Room Preparation and Disinfection

Sonographers have the responsibility to appropriately prepare and disinfect ultrasound machines, materials, and rooms used during the examination. This is crucial for infection control and for the safety of both patient and sonographer. The Majority of disinfection protocols and standard precautions performed prior to the COVID-19 pandemic remain unchanged. It is recommended to take droplet and contact precautions when caring for patients with suspected or confirmed COVID-19.[15] Additional precautions taken during the pandemic include implementation of airborne PPE protocols for both suspected and confirmed COVID-19 positive patients, performing portable ultrasounds for the COVID-19 positive patients in their rooms rather than in the imaging department, and assigning an isolated room for symptomatic patients who are to be scanned in the ultrasound department.

Aside from PPE, having plastic coverings for the ultrasound machine and keyboard can be useful in preventing transmission of the virus.[16] In addition, after each examination, the sonographer should disinfect and clean used surfaces using registered disinfectants.[17] Sonographers should take extra precautions in the disinfection process of the rooms that were used for examination of isolated or symptomatic patients. This includes thorough wipe down of beds, machines, and any exposed or used surfaces by either the sonographer or the patient. The sonographer should ensure that the room is properly disinfected and ready for the next patient, as this process becomes more crucial moving forward during the pandemic.

Standard and Transmission-Based Precautions

Personal Protective Equipment

In order to prevent the potential asymptomatic and pre-symptomatic transmission, source control measures are recommended for everyone in a healthcare facility, even if they do not have symptoms of COVID-19.[14] Source control refers to use of well-fitting cloth masks, facemasks, or respirators to cover a person's mouth and nose to prevent spread of respiratory secretions when they are breathing, talking, sneezing, or coughing.[14] Cloth masks, facemasks, and respirators should not be placed on children aged less than 2 years or any person who cannot wear these safely (e.g., someone who has a disability or an underlying medical condition that prohibits mask use). In addition, it can also include any person who is unconscious, incapacitated, or otherwise unable to remove their cloth mask, facemask, or respirator without assistance.[14]

In addition to source control, sonographers should follow guidelines issued by local authorities regarding PPE for infection control.[13] See Table 3 and Figure 2.

Face masks are required at all times in a healthcare facility.[14] Figure 2 demonstrates appropriate and acceptable PPE. This includes face shields or goggles, N95 or higher respirators, clean and non-sterile gloves, and isolation gowns. Masks should be replaced if they are wet, visibly soiled, or damaged and discarded at the end of shifts and changed during breaks.[18] Cloth face masks are appropriate when not engaged in direct patient care activities, switching only to a respirator or facemask when PPE is required.[14] Cloth face coverings are not PPE and should not be worn in care of patients with known or suspected COVID-19.[14] Face shields are considered PPE but should not be used as the only respiratory protection.[20] They may be used as replacement for nonmedical masks only under special circumstances, such as mask shortage or for those impacted by heat stress.[20] Personal eyeglasses

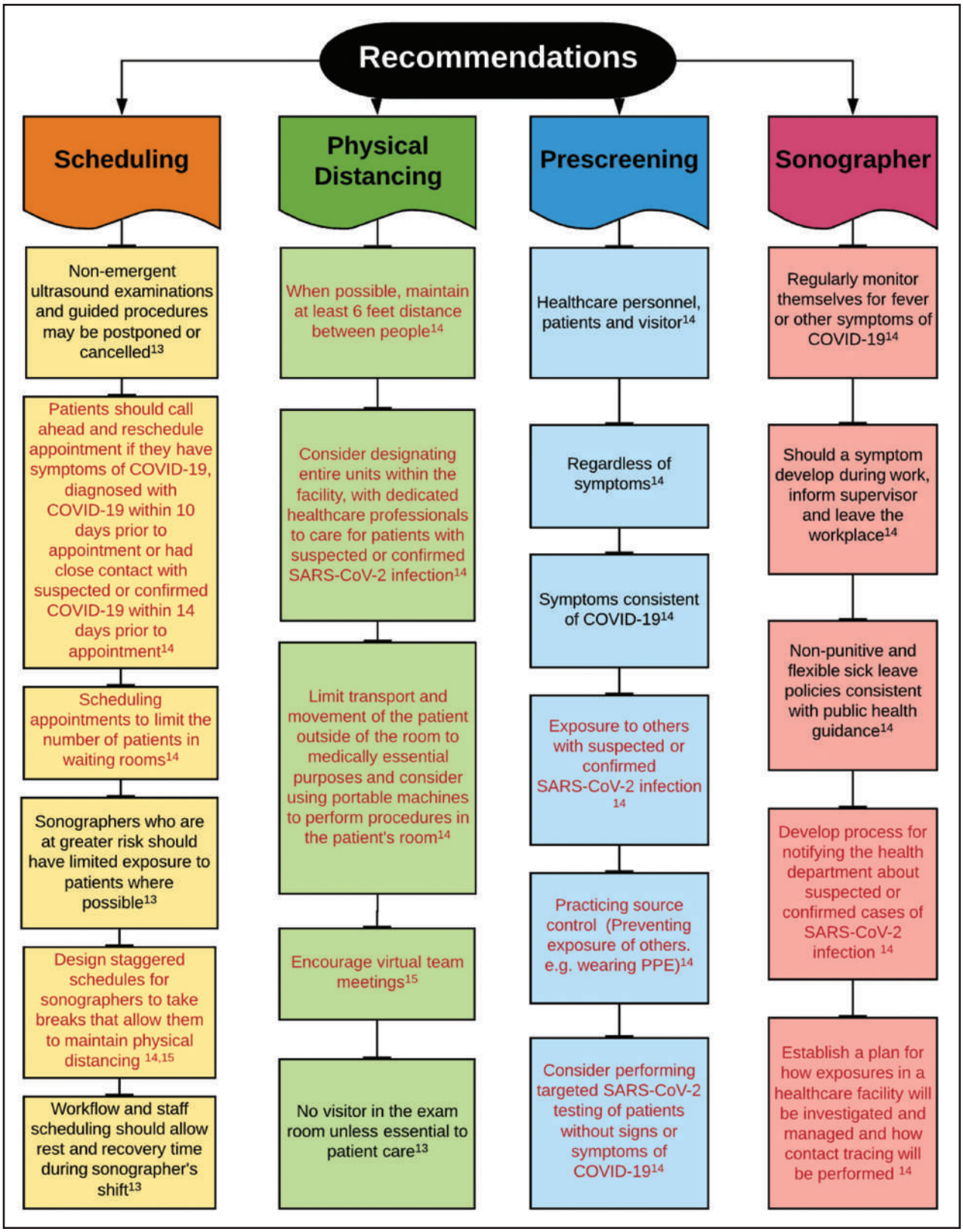

Figure 1. Recommendations for sonographers and healthcare facilities.

Table 3. PPE Recommendations for Patients and Sonographers

Target personnel	Activity	PPE	Safety Protocol
Patients and visitors regardless of symptoms	Upon arrival and throughout their stay in the facility[14]	• Well-fitting source control (e.g., cloth masks, facemasks, or respirators)[14] • Patients may remove their source control when in their rooms but should put them back on when around others or leaving their roomi[4]	• Maintain physical distance of at least 6 feet where possible[14] • Perform hand hygiene[19]
Patient with symptoms suggestive of COVID-19	Upon arrival and throughout their stay in the facility[14]	• Well-fitting source control (e.g., cloth masks, facemasks, or respirators)[14] • If source control is not tolerated or unavailable, use tissues to cover mouth and nose while out of their roomi[4]	• Single room with door closed[14,16] • Perform hand hygiene[19]
Target personnel	**Activity**	**PPE**	**Safety Protocol**
Sonographer	At all times while they are in the healthcare facility[14]	• Well-fitting source control[14] • To reduce the number of times sonographers must touch their face and risk for self-contamination, consider continuing to wear the same respirator or well fitting facemask throughout the entire work shift[14]	• Maintain physical distance of at least 6 feet where possible[14] • Perform hand hygiene[19]

	Providing direct care to patients without symptoms suggestive of COVID-19	Standard precautions and Transmission-Based Precautions (as required based on the suspected diagnosis)[14]
		• One of the following source control:
		  • N95 respirator[14]
		  • A respirator approved under standards used in other countries that are similar to NIOSHapproved N95 filtering facepiece respirators[14]
		  • A well-fitting facemask (with a nose wire to help the facemask conform to the face; selection of a facemask with ties rather than ear loops)[14]
		• Gloves[14]
		• Eye protection (Safety glasses, face shield or
		• Visors)[16,19]
			• Perform hand hygiene[19]
			• TEE performed on confirmed negative COVID-19 patients still require droplet precaution[14]

	Providing direct care to suspected or confirmed COVID-19 patients, in the absence of aerosolgenerating procedures[19]	Standard precautions and Transmission-Based Precautions (Droplet and contact precautions)[16] • NIOSH-approved N95 or equivalent or higherlevel respirator[14] • Gloves[14] • Gown[19] • Eye protection (Safety glasses, face shield or • Visors)[16,19]	• Perform hand hygiene[19] • Single room with door closed[14,16]

(table 3 continues)

	Providing direct care to suspected or confirmed COVID-19 patients, in settings where aerosolgenerating procedures are frequently in place[19]	Standard precautions and Transmission-Based Precautions (Droplet and contact precautions)[16] • Respirator N95 or higher level respirator[14] • Gloves[14] • Gown[19] • Eye protection (Safety glasses, face shield or Visors)[16,19]	• Perform hand hygiene[19] • Airborne infection isolation rooms prioritized for patients who will be undergoing aerosol generating procedures[14]
	Leaving the facility at the end of the shift[14]	• Remove respirator or facemask, perform hand hygiene, and put on community source control[14,15] • Consider designated work clothing and change prior to going home[15]	

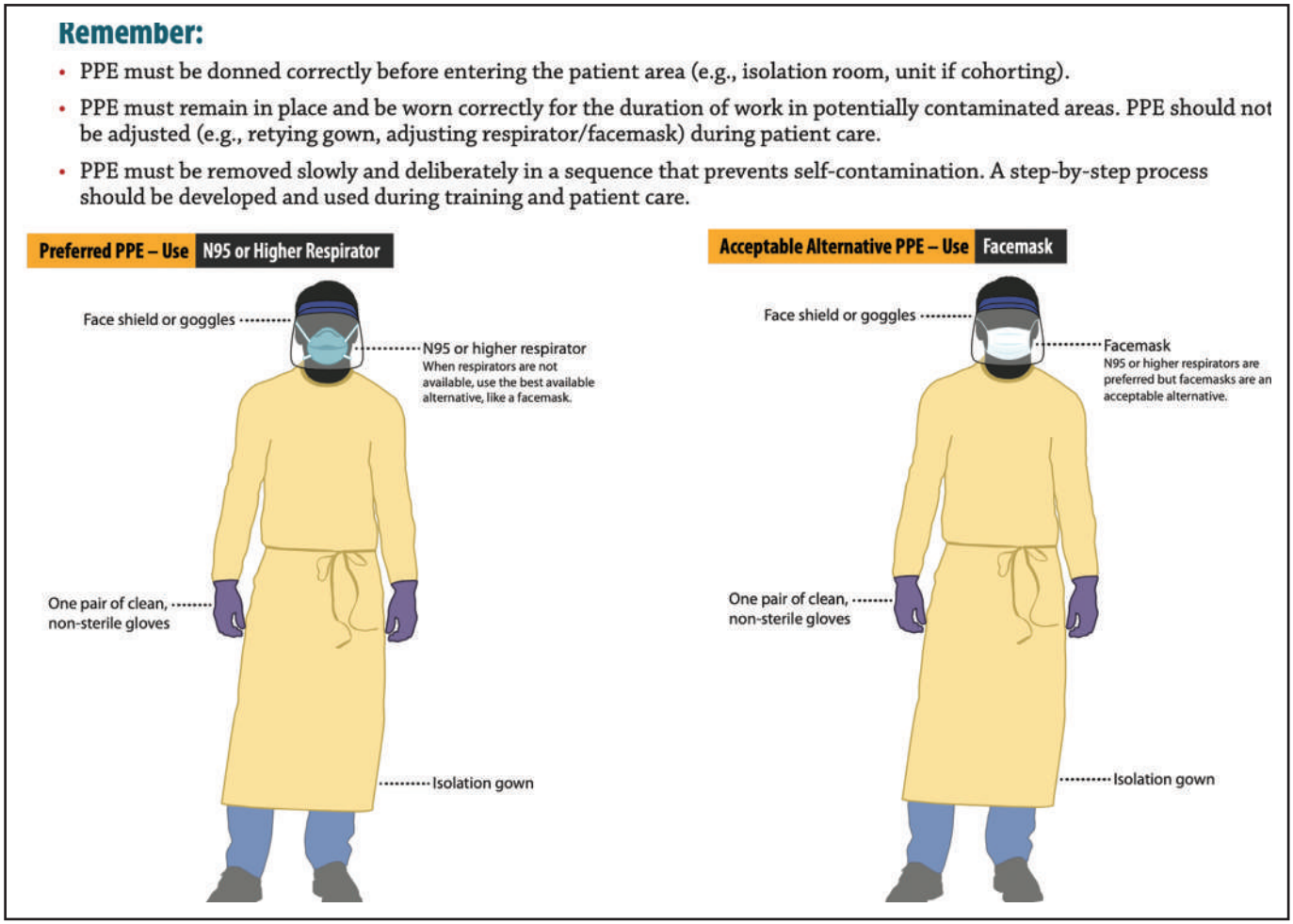

Figure 2. Preferred personal protective equipment (PPE) and acceptable alternative. Available from: https://www.cdc.gov/coronavirus/2019-ncov/downloads/A_FS_HCP_COVID19_PPE_11x17.pdf. Accessed on June 3, 2020

Donning (putting on the gear):

More than one donning method may be acceptable. Training and practice using your healthcare facility's procedure is critical. Below is one example of donning.

1. **Identify and gather the proper PPE to don.** Ensure choice of gown size is correct (based on training).
2. **Perform hand hygiene using hand sanitizer.**
3. **Put on isolation gown.** Tie all of the ties on the gown. Assistance may be needed by another HCP.
4. **Put on NIOSH-approved N95 filtering facepiece respirator or higher (use a facemask if a respirator is not available).** If the respirator has a nosepiece, it should be fitted to the nose with both hands, not bent or tented. Do not pinch the nosepiece with one hand. Respirator/facemask should be extended under chin. Both your mouth and nose should be protected. Do not wear respirator/facemask under your chin or store in scrubs pocket between patients.*
   - » **Respirator:** Respirator straps should be placed on crown of head (top strap) and base of neck (bottom strap). Perform a user seal check each time you put on the respirator.
   - » **Facemask:** Mask ties should be secured on crown of head (top tie) and base of neck (bottom tie). If mask has loops, hook them appropriately around your ears.
5. **Put on face shield or goggles.** Face shields provide full face coverage. Goggles also provide excellent protection for eyes, but fogging is common.
6. **Perform hand hygiene before putting on gloves.** Gloves should cover the cuff (wrist) of gown.
7. **HCP may now enter patient room.**

Doffing (taking off the gear):

More than one doffing method may be acceptable. Training and practice using your healthcare facility's procedure is critical. Below is one example of doffing.

1. **Remove gloves.** Ensure glove removal does not cause additional contamination of hands. Gloves can be removed using more than one technique (e.g., glove-in-glove or bird beak).
2. **Remove gown.** Untie all ties (or unsnap all buttons). Some gown ties can be broken rather than untied. Do so in gentle manner, avoiding a forceful movement. Reach up to the shoulders and carefully pull gown down and away from the body. Rolling the gown down is an acceptable approach. Dispose in trash receptacle.*
3. **HCP may now exit patient room.**
4. **Perform hand hygiene.**
5. **Remove face shield or goggles.** Carefully remove face shield or goggles by grabbing the strap and pulling upwards and away from head. Do not touch the front of face shield or goggles.
6. **Remove and discard respirator (or facemask if used instead of respirator).*** Do not touch the front of the respirator or facemask.
   - » **Respirator:** Remove the bottom strap by touching only the strap and bring it carefully over the head. Grasp the top strap and bring it carefully over the head, and then pull the respirator away from the face without touching the front of the respirator.
   - » **Facemask:** Carefully untie (or unhook from the ears) and pull away from face without touching the front.
7. **Perform hand hygiene after removing the respirator/facemask** and before putting it on again if your workplace is practicing reuse.

Figure 3. Donning and Doffing PPE. Available from: https://www.cdc.gov/coronavirus/2019-ncov/downloads/A_FS_HCP_COVID19_PPE_11x17.pdf. Accessed on June 3, 2020.

Figure 4. Hand washing steps. Available from: https://ipac-canada.org/photos/custom/pdf/IPAC_cleaninghands85x11English.pdf. Accessed on February 14, 2021.

Figure 5. Alcohol-based hand rub steps. Available from: https://www.publichealthontario.ca/-/media/documents/j/2009/jcyh-handrub.pdf?la=en. Accessed on October 16, 2020.

and contact lenses are not considered appropriate for eye protection. See Table 3 for appropriate PPE recommendations.[14]

Training on PPE

Sonographers should be trained on PPE and demonstrate competency with selection and proper use.[14]

Information materials should cover the following[21]:

- Hand hygiene
- Guidelines for PPE (when to use PPE, which PPE is necessary, donning and doffing PPE, disposal, and limitations of PPE)[14]
- Internal and external communication lines

- Placement and movement of patients and visitors' access
- Sick-leave policy and guidelines for symptomatic staff
- Location of training materials

Donning and doffing

Refer to Figure 3 for specific donning and doffing protocol.

Hand Hygiene

Sonographers should perform hand hygiene before and after removing PPE and after all contact with patients or potential infectious material.[13,18] Washing hands with soap and water for at least 20 sec (see Figure 4) or alcohol-based hand rubs (60–95% alcohol; see Figure 5) should be used. Visibly soiled hands require washing with soap and water before using alcohol-based hand rub.[13]

All literature materials reviewed in this section refer to information from the Center for Disease Control (CDC) and WHO, which are in agreement with universal precaution protocols.

Owing to the current and ongoing nature of the COVID-19 pandemic, there is limited availability of peer-reviewed articles. For this reason, this review included gray literature resources. Information was acquired from peer-reviewed resources as well as ones produced by government agencies.

Conclusion

It is evident that COVID-19 has had a social and economic impact around the world. To effectively fight this highly transmissible disease, recommended precautions in adopting proper PPE protocols and infection control should be followed to ensure safety of both sonographers and patients.

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References

1. Government of Canada. Coronavirus disease (COVID-19): Outbreak update [Internet]. [cited 2020 Jun 06]. Available from: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection.html
2. World Health Organization (WHO). WHO timeline – COVID-19 [Internet 2020 Apr 27]. [cited 2020 Jun 06]. Available from: https://www.who.int/news-room/detail/27-04-2020-who-timeline---covid-19
3. World Health Organization (WHO). Canada [Internet]. [cited 2021 Feb 14]. Available from: https://covid19.who.int/region/amro/country/ca
4. Government of Canada. Coronavirus disease 2019 (COVID-19): Epidemiology update [Internet 2021]. [cited 2021 Feb 14]. Available from: https://health-infobase.canada.ca/src/data/covidLive/Epidemiological-summary-of-COVID-19-cases-in-Canada-Canada.ca.pdf
5. Government of Canada. Coronavirus disease 2019 (COVID-19): Epidemiology update [Internet 2021]. [cited 2021 Feb 14]. Available from: https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html
6. Public Health Ontario. Epidemiologic summary: COVID-19 in Ontario: January 15, 2020 to February 13, 2021 [Internet 2021]. [cited 2021 Feb 14]. Available from: https://www.publichealthontario.ca/-/media/documents/ncov/epi/covid-19-daily-epi-summary-report.pdf?la=en
7. D'Adamo H, Yoshikawa T, Ouslander Joseph G. Coronavirus disease 2019 in geriatrics and long-term care: The ABCDs of COVID-19 [Internet]. [cited 2020 Jun 06]. J Am Geriatr Soc. 2020;65(5):912–17. Available from: https://pubmed.ncbi.nlm.nih.gov/32212386/
8. Gardner W, States D, Bagley N. The coronavirus and the risks to the elderly in long-term care [Internet]. [cited 2020 Jun06]. J Aging Soc Policy. 2020;1–6. Available from: https://www.tandfonline.com/doi/full/10.1080/08959420.2020.1750543
9. Nicolaa M, Alsafib Z, Sohrabic C, Kerwand A, Al-Jabird A, Iosifidisc C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19):

A review. Int J Surgery. 2020;78:185–93. https://doi.org/10.1016/j.ijsu.2020.04.018
10. Public Health Ontario. Infection prevention and control [Internet 2020]. [cited 2020 Jun 06]. Available from: https://www.publichealthontario.ca/en/health-topics/infection-prevention-control
11. Guner R, Hasanoglu I, Aktas F. COVID-19: Prevention and control measures in community. Turk J Med Sci. 2020;50:571–7. https://doi.org/10.3906/sag-2004-146
12. Brewer N, Huang G, Kwon Y. Sonographer safety issues during the COVID-19 pandemic [Internet 2020]. [cited 2020 May 28]. J Echocardiogr. 2020. Available from:https://lrc.michener.ca:4280/32430790/?from_term=%28COVID-19%29+AND+sonographers&from_filter=simsearch3.fft&from_filter=ds1.y_1&from_filter=language.english&from_pos=4
13. American Institute of Ultrasound in Medicine (AIUM). Quick guide on COVID-19 protections – Patient and ultrasound provider protection [Internet 2020]. [cited 2020 Jun 03]. Assoc Med Ultrasound. Available from: https://aium.s3.amazonaws.com/covid19/Covid19_Quick_Guide_PUPP.pdf
14. Centers for Disease Control and Prevention (CDC). Coronavirus disease 2019 (COVID-19) [Internet]. [cited 2021 Feb 15]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html
15. Infection Prevention and Control Vancouver Coastal Health. IPAC personal protective equipment (PPE) key messages refresher [Internet 2021 Jan 13]. [cited 2021 Feb 14]. Available from: http://ipac.vch.ca/Documents/COVID-19/Dress%20Codes%20and%20PPE/PPE%20Key%20Messages%20Refresher.pdf
16. Public Health Ontario. IPAC recommendations for use of personal protective equipment for care of individuals with suspect or confirmed COVID-19 [Internet 2021 Jan 29]. [cited 2021 Feb 14]. Available from: https://www.publichealthontario.ca/-/media/documents/ncov/updated-ipac-measures-covid-19.pdf?la=en
17. Sonography Canada. Sonography department safety guidelines during COVID-19 [Internet 2020]. [cited 2020 Aug 08]. Available from: https://sonographycanada.ca/resources/covid-19-statements-resources-and-information-for-diagnostic-medical-sonographers-in-canada/sonography-department-operations
18. Centers for Disease Control and Prevention (CDC). Get your clinic ready for coronavirus disease 2019 (COVID-19) [Internet 2020]. [cited 2020 Aug 08]. Available from:https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinic-preparedness.html
19. World Health Organization (WHO). Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages [Internet 2020]. [cited 2020 Jun 03]. Available from: https://apps.who.int/iris/bitstream/handle/10665/331695/WHO-2019-nCov-IPC_PPE_use-2020.3-eng.pdf
20. Public Health Ontario. Focus on face shields for source control of COVID-19 [Internet 2020]. [cited 2021 Feb 14]. Available from: https://www.publichealthontario.ca/-/media/documents/ncov/main/2020/07/covid-19-face-shields-source-control.pdf?la=en
21. European Center for Disease Prevention and Control. Checklist for hospitals preparing for the reception and care of coronavirus 2019 (COVID-19) patients [Internet 2020]. [cited 2020 Jun 03]. Available from: https://www.ecdc.europa.eu/en/publications-data/checklist-hospitals-preparing-reception-and-care-coronavirus-2019-covid-19

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Article title: Infection Control and Safety Protocols to Protect Sonographers and Patients During the COVID-19 Pandemic

Author's Names: Grace Park, BA, Salwa Bahador, BSc and Linda La, BSc

1. Which of the following is not considered appropriate PPE for healthcare workers?

a) Gloves
b) Surgical mask
c) Cloth face mask
d) Isolation Gown

2. Which of the following is a recommendation for infection control of COVID-19 in healthcare facilities?

a) Encourage virtual meetings
b) Regularly monitoring oneself for fever and other symptoms of COVID-19
c) Staggering sonographer schedules and breaks to maintain physical distancing
d) All of the above

3. Based on current literature, how long should you be washing hands after patient interaction?

a) 5-10 seconds
b) 10-12 seconds
c) 15-30 seconds
d) 5-15 seconds

4. Which of the following is a good practice of care when scanning a suspected and or confirmed patient with COVID-19?

a) Wearing glasses
b) Wear cloth face mask
c) Performing hand hygiene only if visibly soiled
d) Have a designated Ultrasound machine and equipment

5. Which of the following is the correct PPE doffing order?

a) Remove facemask/respirator → perform hand hygiene → remove gown →remove gloves → → remove face shield/goggles → perform hand hygiene
b) Remove gloves → remove gown → perform hand hygiene → remove face shield/goggles → remove facemask/respirator → perform hand hygiene
c) Remove facemask/respirator → perform hand hygiene → remove gown → remove gloves → → remove face shield/goggles → perform hand hygiene
d) Perform hand hygiene → remove gown → remove gloves → remove facemask/respirator → remove face shield/goggles → perform hand hygiene

A Narrative Review

Lacey Fischer, MSRS, RDMS, RVT, RDCS, RT (R)(M)[1] and Brandon Hirsch, MS, CMD, RT(R)(CT)(T)[1]

Diagnostic Imaging Examinations for Suspected Appendicitis: A Narrative Review

About the Authors

Lacey Fischer, MSRS, RDMS, RVT, RDCS, RT (R)(M) and Brandon Hirsch, MS, CMD, RT(R)(CT)(T) are both with Southern Illinois University, Carbondale, IL, USA.

Corresponding authors: lacfisch@gmail.com; Bhirsch110@siu.edu

ABSTRACT

The vermiform appendix is a unique organ, especially when considering its role in human physiology, which has been speculated and debated for centuries. Recent findings and correlations indicate that the vermiform appendix has some homeostatic function in gut health and plays a critical role in the microbial makeup of the large intestine. Diagnostic Imaging to rule out an inflamed appendix is a routine procedure in health emergencies. Yet the associated risks with appendicitis and appendectomy elicit continued research on the topic. The lifetime risk of appendicitis was found to be 8.6% for males and 6.7% for females, with the highest incidence rate in individuals aged 10 to 19 years (23.3 cases per 10,000 people annually). A family history of appendicitis has also been shown to increase the risk for appendicitis in adulthood. Acute appendicitis is the most common cause of emergency abdominal surgery in children. The concern for radiation dose, especially for pregnant and pediatric populations, makes appendiceal imaging a balancing act between various patient populations and image modality tradeoffs. While computed tomography remains the imaging modality of choice for nonpregnant adult populations, the implementation of ultrasound is an invaluable imaging modality without the concern for ionizing radiation.

Key words: appendicitis; appendectomy; computed tomography; magnetic resonance imaging; ultrasound

The Vermiform Appendix

The large intestine may be divided structurally into the cecum, colon, rectum, and anal canal. The cecum is the inferior portion of the proximal large intestine which resembles a dilated pouch.[1] Attached to the lower posteromedial surface of the cecum is the vermiform appendix, a slender, hollow appendage. It is usually about 9 cm long, with about a diameter of 6–7 mm.[2,3] The classic description of the location is of an origin at the cecum with a protruding tip draped

over the iliac vessels in the right lower quadrant.[4] It has also been found to adhere to the mesentery to display a bent tip.[5,6] The location of the appendix has also shown to be more fixed in the pregnant population.[7] A smaller study demonstrated a gradual superior displacement of the appendix and cecum as the pregnancy progressed.[8] Ultimately, the appendix position is dictated by the changes in the shape and position of the cecum.[9]

Vermiform is of Latin origin, where vermis means worm, and vermiform indicates the resemblance of a worm.[10] It was formally named in 1530 by Guido Guidi. Early efforts to pinpoint the functionality of the vermiform appendix were made by prominent scientists such as Charles Darwin, who suggested an early evolutionary role now lost. Described as an evolutionary vestige, Like the wings of an ostrich described as an evolutionary vestige, the vermiform appendix had a rudimentary function but is now likely obsolete. The cecum varies with species but is the largest in herbivores. The vermiform appendix is coupled with the cecum, housing specialized and symbiotic bacteria to secrete cellulase to break down cellulose. It is often speculated, especially among evolutionary theorists, that the appendix is vestigial.[11]

The appendix wall has a heavy concentration of lymphoid follicles, a small collection of lymphoid tissues known as mucosa-associated lymphatic tissue. This functions to protect passages that are open to the external environment from invading foreign bodies.[12] The appendix also produces a biofilm, a thick mucus component that is insoluble and functions to provide a barrier in the colon against pathogens. The second biofilm component is a thin mucin layer that overlies the thicker biofilm component.[13,14]

The microbiota of the appendix resembles the rectum, which suggests that the appendix functions as a reservoir for reseeding the colon with normal flora during conditions like diarrhea.[3,15,16]

The appendix has also drawn other suspicions as a facilitator of immune function as it is the primary site of immunoglobulin A production.[15] In a study with 507 patients, it was found that patients who underwent appendectomy had an increased risk for severe *Clostridium difficile* infection.[17] Other studies have also shown an association of appendectomy and severe *C. difficile* infection with colectomy.[18] However, there has been conflicting data in some studies which showed no difference between *C. difficile* infection in patients with intact appendix versus prior appendectomy.[19,20] Further research is needed to properly assess the relationship between appendectomy and gastrointestinal complications after surgery.

Appendicitis Epidemiology

The prevalence of acute appendicitis is high, with a 7% lifetime risk and an incidence of about 1.1/1000 people annually.[21] Male's experience higher rates of acute appendicitis in all age groups. The lifetime risk of appendicitis was found to be 8.6% for males and 6.7% for females and was highest in individuals aged 10 to 19 years (23.3 cases per 10,000 population annually). [21,22] A family history of appendicitis also increases the risk for appendicitis in adulthood.[4,23] Acute appendicitis is the most common cause of emergency abdominal surgery in children.[4]

Gravid females are less likely to experience appendicitis, especially during the third trimester, versus nongravid females.[24] Acute appendicitis was the most common non-obstetric surgical emergency experienced during pregnancy.[25–27] It was found that 0.2– 1.0% of pregnant women require a non-obstetric surgical procedure.[26] The estimated incidence for pregnant women who will experience appendicitis is about 1/766 pregnancies.[24,28]

The rate of appendicitis in developing countries such as South Africa, South Korea, Chile, and Turkey is increasing.[29,30] The higher rate of appendicitis in developed countries has several hypotheses, including hygiene-associated immune over-reactivity.[3] Another hypothesis offered is decreased dietary fiber replaced by high-fat foods in developing countries.[31] The identification of increased incidence in developing nations is another opportunity for the continued research.

Appendicitis Etiology

Acute appendicitis results because of an obstruction in trapping infectious bacteria in the appendix lumen.[12] Fecaliths and fecal stasis are the most common cause of bacterial overgrowth from the blockage.[32–35] The inability of the appendix to empty results in swelling of the appendix, which has the potential to rupture and expel infectious bacteria into the abdominal cavity, a condition known as peritonitis.[12] The fatality rate of appendicitis increases from 1% for non-perforation to 5% when perforation occurs.[36,37] Acute appendicitis, therefore, becomes even more critical in pregnant patients.[38]

Diagnosis

The diagnosis of acute appendicitis is often (or at least initially) clinical, with presenting symptoms of right lower quadrant pain, nausea and vomiting, fever, and rebound tenderness.[22,39–41] Palpation of the left lower quadrant can also cause right lower quadrant pain, which is the Rovsing's sign. The psoas sign may be present, whereby a patient experiences pain with right thigh extension. Pain with internal right thigh rotation may accompany the psoas sign, known as the obturator sign.[39] In 1891, physician Charles McBurney described the "exact locality where the greatest sensitiveness to pressure exists," now known as the McBurney sign. It is located on an imaginary line that runs from the right anterior superior iliac spine (ASIS) to the umbilicus. This point location is 1.5–2.0 inches away from the right ASIS landmark.[42,43] Appendiceal wall thickening and the absence of intraluminal air, both detectable with computed tomography (CT), are also signs related to appendicitis.[44]

Only about 50% of those affected by acute appendicitis exhibit the classic symptoms, and many have conflicting or vague presentations that may lead to misdiagnosis.[22] Laboratory values can also aid in diagnoses, such as an elevated white blood cell count and c-reactive protein.[39,45,46] The c-reactive protein value increases rapidly in response to trauma, inflammation, and infection.[47]

The Alvarado score is a clinical scoring system used to diagnose appendicitis. A score of ≥ 7 is considered high risk for appendicitis, and < 5 is at exceptionally low risk.[46,48] This 10-point scoring system uses the acronym "MANTRELS" to list the symptoms, signs, and laboratory values used in the assessment. The symptoms include migration, anorexia-acetone, and nausea-vomiting, while the signs include tenderness in the right lower quadrant, rebound pain, and temperature elevation. Laboratory values include leukocytosis and shift to the left (a neutrophil count of over 75%).[48] Table 1 indicates the point values for each symptom that aids in making a cumulative score for appendicitis assessment.

The Alvarado score introduced in 1986 is a well-calibrated predictive score for men but inconsistent with children and over-predictive with women.[49]

When a physician is presented with a patient suspected to have acute appendicitis, they have several imaging modalities to choose from, including ultrasound, radiography, CT, magnetic resonance imaging (MRI), and nuclear medicine. The preferred imaging modality varies with the patient population, especially for children and pregnant women. Reducing radiation dose is imperative; therefore ultrasound or MRI is the preferred imaging modality for pediatric populations. Identification of the appendix can also be especially challenging for sonographers because of the variable location, overlying bowel segments, gas interference, and patient habitus.[4]

Table 1. MANTRELS Mnemonic for Acute Appendicitis Diagnostic Score

		Value
Symptoms	Migration	1
	Anorexia-acetone	1
	Nausea-vomiting	1
Signs	Tenderness in right lower quadrant	2
	Rebound pain	1
	Elevation of temperature	1
Laboratory	Leukocytosis	2
	Shift to the left	1
		10

Many of the studies cited throughout this article have objectives to reduce the false-negative rates (missed diagnoses), as well as reducing the false-positive rate (unnecessary surgeries).[50] Diagnostic imaging is crucial in this effort as it supports the ability to rule out appendicitis.[51] Alternative diagnoses may also be obtained as signs and symptoms common to appendicitis could also be present with adnexal cysts, colitis, pyelonephritis, and hydronephrosis.[52]

Diagnostic Imaging Findings

Radiography

As radiography often serves as a preliminary examination for several clinical presentations, it is pivotal to consider the benefits it could offer in appendicitis diagnosis. Radiographic findings that could indicating appendicitis include appendiceal fecalith, gas in the appendix and air-fluid levels, or distention of the terminal ileum, cecum, or ascending colon. Appendicoliths "are generally regarded as the most specific plain radiographic sign of appendicitis."[5,53] Other findings include loss of the cecal shadow and poor visualization of the right psoas muscle or right sacroiliac joint.[46] The technological developments in CT and ultrasound have caused a decline in plain film abdominal radiography. From 1972 to 1992, the prominence of abdominal radiography for patients suspected of appendicitis decreased from 43% to 30% of patients. By 2007, the use of plain abdominal radiography further decreased to 21%.[54]

Another indication of appendicitis detected by fluoroscopy is the inability of the appendix to fill with barium because of obstruction. A study reported 82% of patients with a normal appendix manifested a contrast-filled appendix during barium enema examination.[55] In surgical suites, plain film radiography and fluoroscopy are often the only immediately available imaging choices. These can be utilized during appendectomy, including use for foreign body detection.[56] Methods utilizing ionizing radiation like fluoroscopy are not recommended for imaging pregnant and pediatric populations because of increased radiation dose. *Ultrasound*

In 1886, Reginald H. Fitz deduced that acute inflammation of the appendix required surgery for most cases. Since then, there has been a quest to improve the diagnostic response time and accuracy.[5,57] Developments in ultrasound technology and equipment have been important in providing real-time imaging without the worry of radiation dose. The compound contact scanner was developed by Ian Donald and Tom Brown (1958) produced early images that lacked the necessary greyscale. The following decades saw technological gains in static scanning machines, but were initially only available in research centers where physicists were needed to monitor electronic components. Real-time scanning was introduced in the mid to late 1970s with the development of multi-element linear array and phased array scanners.[58]

In 1986, Julian Puylaert performed a study that introduced the potential of diagnostic medical ultrasound with graded compression utilizing a 5 MHz and 7.5 MHz 30 mm focus linear array transducer for clear visualization of the appendix.[59,60] This graded compression technique involves applying increasing pressure slowly over the region of maximum tenderness. When normal bowel becomes compressed, the intraluminal bowel gas becomes displaced away from the compression site, and peristaltic activity is visualized. When abnormal bowel becomes compressed, there is no alteration as seen in normal bowel, and no peristaltic activity is demonstrated.[41]

In 1987, a study utilizing high-resolution real-time ultrasound evaluated 90 patients suspected of acute appendicitis. The study aimed to decrease the incidence of unnecessary laparotomy for acute appendicitis (reduce the false positive rate). This study outcome determined that the ability to visualize a noncompressible appendix is a sensitive and specific method for appendicitis diagnosis. The presence of localized periappendiceal fluid or an appendicolith were noted as confirmatory findings.[61] The appearance of an appendicolith on ultrasound images is visualized as bright echogenic focus with distal acoustic shadowing.[41,62]

A systematic approach was suggested by Rapp et al. (1998) to increase the visualization of a normal appendix in individuals with right lower quadrant pain with a protocol that includes strategies to identify the

normal appendix, such as anatomical referencing and landmarks, as well as segmental imaging limitations.[63] While the authors estimated from their literature review that the visualization of a normal appendix in individuals with right lower quadrant pain to be only 2–10%, they found their approach to yield a greater frequency for visualization. It was found that 66% of all patients who did not have appendicitis in the study demonstrated an appendix on ultrasound. The study also concluded that the demonstration of a normal-sized appendix in its entire length is critical in excluding appendicitis in patients with right lower quadrant pain.[63]

Incidental findings during transvaginal ultrasound have been found to include an abnormal appendix.[51,64,65] Transvaginal ultrasound of a case report discovered a mucinous adenocarcinoma lateral to the right ovary. The patient underwent a baseline transvaginal ultrasound for ovulation induction before the finding.[64] Though, transvaginal ultrasound is not a primary diagnostic method for appendiceal pathology. It has been incidentally discovered during the transvaginal ultrasound examination. In another case report, a transabdominal and pelvic ultrasound demonstrated an obstructed appendix by bowel loops. A transvaginal ultrasound examination later indicated a partially thickened appendix with an appendicolith present.[65]

The study of Scott et al. (2004) showed that ultrasound was inferior to helical CT with a sensitivity rate of 95% versus 78%.[60] Tissue harmonic imaging (THI) and real-time spatial compounding ultrasound methods showed improved visualization of the lumen and walls of the appendix compared with that of conventional ultrasound techniques.[60,66]

The benefit of ultrasound not utilizing ionizing radiation makes it an attractive research inquiry.[60] To be explicit, the risks from ionizing radiation being described are about the increased risk for radiation-induced cancer as well as for fetal effects with pregnant patients.[67] The dose from an abdomen/pelvis CT exam delivers an approximate effective radiation dose of 10 mSv or about 3 years' worth of natural background radiation one would receive.[68]

As a bonus to the radiation dose removal, ultrasound offers a portable, non-invasive, cost effective and real time examination when compared with CT, MRI, and nuclear medicine.[28,69–72]

Computed Tomography

CT acquires raw data in the axial plane, then utilizes reconstruction algorithms to reproduce nonaxial images. The raw data is most often used to produce sagittal and coronal images and oblique planes too.[73] In general, a CT examination of the abdomen and pelvis begins just above the diaphragm dome and ends below the ischial tuberosities. The scan also utilizes a 5 mm or less slice thickness with suspended respiration. In addition to the axial images, there should be at least one multiplanar reformation made available, such as coronal imaging planes or even sagittal or oblique imaging planes.[74]

When intravenous contrast is used, it is common to use an injection rate of 3 mL/s and a scan delay of 90 seconds following the start of contrast injection.[40,75] Diagnostic sensitivity has shown to be better with intravenous contrast administration compared with non-contrast CT.[76] The use of enteral contrast media was not shown to improve the diagnosis of appendicitis with CT.[77–80] It must also be noted that the scan initiation following enteral contrast administration is proportional to the time delay required for contrast to progress through the entire small bowel, then through the ileocecal valve into the cecum.

Like all other imaging modalities, CT has inherent tradeoffs as well as indications and contraindications. For example, body habitus can make ultrasound appendiceal imaging more laborious. When a patient is highly obese and has a higher chance of producing an indeterminate scan, CT may be a better first imaging examination. CT has also been described as less operator-dependent compared with ultrasound.[81]

Sauvain et al. (2016) evaluated the challenges and likelihood of visualizing the appendix based on the patient's body mass index (BMI).[82] The role of ultrasound in patients with a BMI ≥ 25 kg/m^2 with suspected acute appendicitis is questionable because of its high rate of inconclusive findings.[82,83] Patient

size is known to affect the scan resolution.[4] Therefore, abdominal CT scans should be the preferred imaging modality used to investigate suspected appendicitis in overweight nonpregnant patients if clinical findings are inconclusive.[82] CT was found to have excellent sensitivity and specificity for appendicitis regardless of BMI.[84]

Given the benefits of CT imaging, including contrast resolution, image acquisition speed, and reconstruction options, the effort to reduce dose in CT is pivotal for optimizing imaging options.[81,85] Whereas traditional abdomen pelvis CT imaging protocols acquire images from the diaphragm through the pubic symphysis and are unnecessary for imaging the appendix. Despite some anatomical differences in appendix location along the colon, all appendix visualized in the pediatric patient population were located at or below the first lumbar vertebral level. Hence, a CT scan was estimated to provide a 30% dose reduction from standard abdomen and pelvis protocols.[85]

The implementation of reduced- or low-dose CT techniques is also of interest, as some studies have shown similar results between low- and regular-dose CT methods insensitivity. A reduction in dose by 76.6% was found in a comparison study, which yielded higher image noise in low-dose techniques, but without image deterioration for assessment.[86] Another study determined that a CT examination performed with a 37.5% exposure reduction and reconstructed with sinogram-affirmed iterative reconstruction was diagnostically acceptable for detecting urinary stones.[87] While the image contrast and tissue differentiation may differ for stone detection compared with appendicitis, such efforts for dose reduction offer techniques to reduce the patient dose when applicable.

As stated earlier, CT is less desirable for pregnant women because of radiation risks. For pregnant women, abdomen ultrasound, abdomen MRI, and pelvis without contrast are most appropriate.[88]

Magnetic Resonance Imaging

MRI has shown to be effective for imaging the appendix, but it is significantly costlier.[71,72,89] Indeterminant ultrasound examinations for pregnant patients prefer MRI compared with CT because of the radiation dose.[38] Additionally, suspected appendicitis in pediatric patients favoring MRI imaging modality at some facilities is increasing.[52,90] A rapid, four-sequence MRI examination that is non-contrast and non-sedated has been implemented, which utilizes an axial and coronal T2 single-shot turbo spin-echo (SS-TSE) and an axial and coronal T2 SS-TSE with fat saturation.[52] Efforts to reduce scan time may be of specific importance for critical applications and for patients unable to lie still for long periods.

The accessibility of MRI in rural areas is another consideration for acute appendicitis imaging and creates a problem for prompt diagnosis. Providing MRIs around the clock in every location and at imaging centers with high clinical volumes, fitting urgent unscheduled MRIs into an already tight schedule might be a logistical challenge.[91] MRI for pediatric appendicitis assessment is perhaps best suited for facilities with MRI availability round the clock.[72] Performing rapid MRI examinations without contrast agents or sedation also has the potential to improve patient throughput, reduce demands on personnel, and thereby facilitate MRI implementation.[91]

Another inherent disadvantage of MRI is the scan time. Many children are unable to lie still for an extended period, especially when they are in pain. Studies performed in 2017 and 2018 have shown great improvements in scan time for MRI.[52,72] In another abbreviated MRI protocol, it had similar accuracy to CT and a potential for reducing imaging and interpretation time.[92]

A meta-analysis on MRI utilization for diagnosing appendicitis in pregnant women analyzed 19 studies from 2009 to 2018 and found that MRI had a sensitivity of 91.8% at a 95% confidence interval.[93] In another study evaluating the accuracy of MRI in the diagnosis of acute appendicitis in 125 pregnant patients, 100% sensitivity, 95% specificity, and 96% accuracy with diffusion-weighted techniques was reported.[94]

Concerning contrast utilization in MRI, a Gadolinium-enhanced T1 imaging sequence was not diagnostically

superior to a noncontrast technique.[72] A high probability of appendicitis (96%) was shown when there was an appendix diameter greater than 7 mm, periappendiceal fat infiltration, and restricted diffusion of the appendiceal wall. The probability of appendicitis was only 2% in the absence of these symptoms.[95]

Nuclear Medicine

While CT and ultrasound remain the most performed imaging studies to demonstrate appendicitis, nuclear medicine imaging could also offer an additional imaging modality. Technetium-labeled fanolesomab was approved by the Food and Drug Administration in 2004 as a radiotracer for appendicitis imaging. This radiopharmaceutical showed a high affinity and specificity for binding to white blood cells, which helps detect infection. A 90% sensitivity and 87% specificity were found for detecting acute appendicitis with nuclear medicine.[39] The dose, however, for positron emission tomography /CT scans can be around 25 mSv.[68]

Appendectomy

The first recorded appendectomy was performed in 1735 by the French surgeon Claudius Amyand on an 11-year-old boy. During the 30 minutes surgery, a fecal fistula caused by an appendiceal perforation from an ingested pin was detected.[39,96,97]

While open appendectomy is considered a "clean-contaminated" procedure, there is a 0.67–4.85% infection risk for uncomplicated cases of acute appendicitis. The use of laparoscopic surgery for patients with no risk factors has demonstrated the lowest infection rates that drop to 0.67%.[33]

The open appendectomy described by McBurney in 1894 was originally utilized for appendicitis.[42,98] This muscle-splitting procedure is performed at the right lower quadrant and yields a higher infection rate and mean hospital stay for patients when compared with a laparoscopic approach.[99] In the United States, laparoscopy is commonly performed (60 to 80%) compared with an open appendectomy. The contraindications of laparoscopy are for patients who should not experience gas infiltration into the abdominal cavity, such as with patients with cardiopulmonary conditions. Additionally, most open appendectomy procedures are initiated with laparoscopic surgery and then converted to an open approach because of complications, including those from prior surgery, technical limitations, advanced disease, body habitus, or an inexperienced surgeon.[89]

Appendectomy is suitable for most patients with uncomplicated appendicitis. But there has been an argument that an antibiotics-first strategy could be utilized for patients who do not prefer surgery or when contraindications for surgery exist.[89] This antibiotic-first strategy is rooted in retaining the appendix as a component in immunity and gastrointestinal health. However, patients participating in an antibiotic-first strategy received an eventual appendectomy in the range of 10–37% across three studies.[89,100]

An interesting correlation of note was that the overall risk of developing Parkinson's disease was 19.3% lower for patients who had an appendectomy.[101] Adverse outcomes from appendectomy were also associated with several risk factors, which include prolonged ileus, failure to wean from ventilator, pneumonia, and wound infection.[102]

Conclusion

According to the American College of Radiology appropriateness criteria, a CT scan of the abdomen and pelvis with intravenous contrast is the most appropriate imaging approach for a patient presenting with right lower quadrant pain, fever, and leukocytosis. While enteral and image acquisition without contrast and image with intravenous contrast is available, a single scan with intravenous contrast is preferred due to decreased scan time and dictation time and reduced radiation dose.[80]

An ultrasound of the abdomen or an MRI of the abdomen and pelvis without contrast is most appropriate for pregnant patients.[88] Therefore, suspected appendicitis retains a preference for CT for the adult and nonpregnant population due to scan time, differential diagnosis, and less user-dependency compared with ultrasound.

Lastly, ultrasound should undoubtedly be the default imaging modality for patients with an intermediate

clinical risk for acute appendicitis for pregnant and pediatric populations. It should also be the first imaging choice for non-pregnant and non-pediatric patients suspected of acute appendicitis, whereafter MRI and CT would be the next option for patients following an inconclusive exam[88] If necessary, CT should be performed by reducing the scan range to the lumbar vertebral level as well as utilizing technical factors and computational algorithms to reduce the dose necessary for high quality image formation.[81,85,86]

References

1. Van De Graaff KM. Human anatomy. 3rd ed. Dubuque, IO: William C Brown; 1992.
2. Tortora GJ. Principles of human anatomy. 15th ed. Hoboken, NJ: Wiley; 2017.
3. Laurin M, Everett ML, Parker W. The cecal appendix: One more immune component with a function disturbed by post-industrial culture. Anat Rec. 2011;294(4):567–79. https://doi.org/10.1002/ar.21357
4. Davie K, Gillis KW, Logan SN. Appendicitis in the deep pelvis. J Diagn Med Sonogr. 2011;27(3):148–52. https://doi.org/10.1177/8756479311407199
5. Fitz RH. Perforating inflammation of the vermiform appendix: With special reference to its early diagnosis and treatment. Am J Med Sci. 1886;92:321–46.
6. Ghorbani A, Forouzesh M, Kazemifar AM. Variation in anatomical position of vermiform appendix among Iranian population: An old issue which has not lost its importance. Anat Res Int. 2014;2014:1–4. https://doi.org/10.1155/2014/313575
7. Hodjati H, Kazerooni T. Location of the appendix in the gravid patient: A re-evaluation of the established concept. Int J Gynaecol Obstet. 2003;81(3):245–7. https://doi.org/10.1016/s0020-7292(03)00074-2
8. Oto A, Srinivasan PN, Ernst RD, Koroglu M, Cesani F, Nishino T. Revisiting MRI for appendix location during pregnancy. Am J Roentgenol 2006;186(3):883–7. https://doi.org/10.2214/ajr.05.0270
9. Wakely CPG. The position of the vermiform appendix as ascertained by an analysis of 10,000 cases. J Anat. 1933;67(2):277–83.
10. Meyers T, editor. Mosby's medical dictionary. 8th ed. St. Louis, MO: Mosby; 2009.
11. Ansaloni L, Catena F, Pinna AD. What is the function of the human vermiform appendix? Eur Surg Res. 2009;43(2):67–71. https://doi.org/10.1159/000219236
12. Marieb EN, Hoehn K. Human anatomy & physiology. 7th ed. San Francisco, CA: Pearson; 2007.
13. Heindl SE, Tsouklidis N. Appendectomy as a potential predisposing factor for the development of recurrent and fulminant Clostridium difficile. Cureus. 2020;12(8):1–7. https://doi.org/10.7759/cureus.10091
14. Bollinger RR, Barbas AS, Bush EL, Lin SS, Parker W. Biofilms in the large bowel suggest an apparent function of the human vermiform appendix. J Theor Biol. 2007;249:826–83. https://doi.org/10.1016/j.jtbi.2007.08.032
15. Girard-Madoux MJ, Agüero MGD, Ganal-Vonarburg SC, Mooser C, Belz GT, Macpherson AJ, et al. The immunological functions of the appendix: An example of redundancy? Semin Immunol. 2018;36:31–44. https://doi.org/10.1016/j.smim.2018.02.005
16. Kawanishi K, Kinoshita J, Abe H, Kakimoto T, Yasuda Y, Hara T, et al. Appendectomy as a risk factor for bacteremic biliary tract infection caused by antibiotic-resistant pathogens. BioMed Res Int. 2017;2017:3276120. https://doi.org/10.1155/2017/3276120
17. Yong FA, Alvarado AM, Wang H, Tsai J, Estes NC. Appendectomy: A risk factor for colectomy in patients with Clostridium difficile. Am J Surg Title. 2015;209(3):532–5. https://doi.org/10.1016/j.amjsurg.2014.12.001
18. Clanton J, Subichin M, Drolshagen K, Daley T, Firstenberg MS. Fulminant Clostridium difficile infection: An association with prior appendectomy? World J Gastrointest Surg. 2013;27(5):233–8. https://doi.org/10.4240/wjgs.v5.i8.233
19. Fujii L, Fasolino J, Crowell MD, Dibaise JK. Appendectomy and risk of Clostridium difficile recurrence. Infect Dis Clin Pract. 2013;21(1):28–32. https://doi.org/10.1097/ipc.0b013e31826e80e0
20. Khanna S, Baddour L, DiBaise JK, Pardi D. Prior appendectomy is not associated with adverse outcomes in Clostridium difficile infection – A population based study presidential poster. Am J Gastroenterol. 2013;108(4):626–7. https://doi.org/10.1038/ajg.2012.47

21. Buckius MT, Mcgrath BP, Monk JS, Grim R, Bell T, Ahuja V. Changing epidemiology of acute appendicitis in the United States: Study period 1993 to 2008. J Surg Res. 2012;175(2):185–90. https://doi.org/10.1016/j.jss.2010.11.798
22. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. Am J Epidemiol 1990;132(5):910–25. https://doi.org/10.1093/oxfordjournals.aje.a115734
23. Drescher M, Marcotte S, Grant R, Staff I. Family history is a predictor for appendicitis in adults in the emergency department. West J Emerg Med. 2012;13(6):468–71. https://doi.org/10.5811/westjem.2011.6.6679
24. Andersen B, Nielsen TF. Appendicitis in pregnancy: Diagnosis, management and complications. Acta Obstet Gynecol Scand. 1999;78:758–62. https://doi.org/10.1034/j.1600-0412.1999.780903.x
25. Zingone F, Sultan AA, Humes DJ, West J. Risk of acute appendicitis in and around pregnancy. Ann Surg. 2015;261(2):332–7. https://doi.org/10.1097/sla.0000000000000780
26. Parangi S, Levine D, Henry A, Isakovich N, Pories S. Surgical gastrointestinal disorders during pregnancy. Am J Surg. 2007;193:223–32.
27. Cheng HT, Wang YC, Lo HC, Su LT, Soh KS, Tzeng CW, et al. Laparoscopic appendectomy versus open appendectomy in pregnancy: A population-based analysis of maternal outcome. Surg Endosc. 2015;29(6):1394–9. https://doi.org/10.1007/s00464-014-3810-5
28. Penny SM. Imaging the vermiform appendix. Radiol Technol. 2018;89(6):571–90.
29. Ferris M, Quan S, Kaplan BS, Molodecky N, Ball CG, Chernoff GW, et al. The global incidence of appendicitis. Ann Surg. 2017;266(2):237–41. https://doi.org/10.1097/sla.0000000000002188
30. Kong VY, Sartorius B, Clarke DL. Acute appendicitis in the developing world is a morbid disease. Ann R Coll Surg Engl. 2015;97(5):390–5. https://doi.org/10.1308/003588415x14181254790608
31. Walker ARP, Segal I. Appendicitis: An African perspective. J R Soc Med. 1995;88:616–19.
32. Limaiem F, Arfa N, Marsaoui L, Bouraoui S, Lahmar A, Mzabi S. Unexpected histopathological findings in appendectomy specimens: A retrospective study of 1627 cases. Indian J Surg. 2015;77(S3):1285–90. https://doi.org/10.1007/s12262-015-1278-8
33. Healy JM, Olgun LF, Hittelman AB, Ozgediz D, Caty MG. Pediatric incidental appendectomy: A systematic review. Pediatr Surg Int. 2016;32(4):321–35. https://doi.org/10.1007/s00383-015-3839-0
34. Alemayehu H, Snyder CL, St. Peter SD, Ostlie DJ. Incidence and outcomes of unexpected pathology findings after appendectomy. J Pediatr Surg. 2014;49(9):1390–93. https://doi.org/10.1016/j.jpedsurg.2014.01.005
35. Singh JP, Mariadason JG. Role of the faecolith in modern-day appendicitis. Ann R Coll Surg Engl. 2013;95(1):48–51. https://doi.org/10.1308/003588413x13511609954851
36. Old JL, Dusing RW, Yap W, Dirks J. Imaging for suspected appendicitis. Am Fam Physician. 2005;71(1):71–8.
37. Liu CD. Acute abdomen and appendix. In: Greenfield LJ, Mulholland MW, editors. Surgery: scientific principles and practice. 2nd ed. Philadelphia, PA: Lippincott-Raven; 1997. p. 1246–
38. Long SS, Long C, Lai H, Macura KJ. Imaging strategies for right lower quadrant pain in pregnancy. Am J Roentgenol. 2011;196(1):4–12. https://doi.org/10.2214/ajr.10.4323
39. Harris A, Bolus NE. Appendicitis imaging. Radiol Technol. 2005;77(2):111–17.
40. Martin M, Lubrano J, Azizi A, Paquette B, Badet N, Delabrousse E. Inflammatory appendix mass in patients with acute appendicitis: CT diagnosis and clinical relevance. Emerg Radiol. 2015;22(1):7–12. https://doi.org/10.1007/s10140-014-1256-7
41. White EK, MacDonald L, Johnson G, Rudralingham V. Seeing past the appendix: The role of ultrasound in right iliac fossa pain. Ultrasound. 2014;22(4):248. https://doi.org/10.1177/1742271x14554750
42. McBurney C. The indications for early laparotomy in appendicitis. Ann Surg. 1891;13:233–54. https://doi.org/10.1097/00000658-189101000-00061
43. Grover CA, Sternbach G. Charles McBurney: McBurney's point. J Emerg Med. 2012;42(5):578–81. https://doi.org/10.1016/j.jemermed.2011.06.039

44. Thompson AC, Olcott EW, Poullos PD, et al. Predictors of appendicitis on computed tomography among cases with borderline appendix size. Emerg Radiol. 2015;22(4):385–94. https://doi.org/10.1007/s10140-015-1297-6
45. Khan MN, Davie E, Irshad K. The role of white cell count and c-reactive protein in the diagnosis of acute appendicitis. J Ayub Med Coll Abbottabad. 2004;16:17–19.
46. Petroianu A. Diagnosis of acute appendicitis. Int J Surg. 2012;10(3):115–19. https://doi.org/10.5772/25303
47. Du Clos TW. Function of c-reactive protein. Ann Med. 2000;32(4):274–8. https://doi.org/10.3109/07853890009011772
48. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med. 1986;15:557–64. https://doi.org/10.1016/S0196-0644(86)80993-3
49. Ohle R, O'Reilly F, O'Brien KK, Fahey T, Dimitrov BD. The Alvarado score for predicting acute appendicitis: A systematic review. BMC Med. 2011;9(1):1–13. https://doi.org/10.1186/1741-7015-9-139
50. Graff L, Russell J, Seashore J, Tate J, Elwell A, Prete M, et al. False-negative and false-positive errors in abdominal pain evaluation failure to diagnose acute appendicitis and unnecessary surgery. Acad Emerg Med. 2000;7(11):1244–55. https://doi.org/10.1111/j.1553-2712.2000.tb00470.x
51. Schuveiller M, Stading R. Acute appendicitis. J Diagn Med Sonogr. 2004;20(6):426–30. https://doi.org/10.1177/8756479304269947
52. Moore MM, Kulaylat AN, Hollenbeak SC, Engbrecht BW, Dillman JR, Methratta ST. Magnetic resonance imaging in pediatric appendicitis: A systematic review. Pediatr Radiol. 2016;46(6):928–39. https://doi.org/10.1007/s00247-016-3557-3
53. Rao PM, Rhea JT, Rao JA, Conn AKT. Plain abdominal radiography in clinically suspected appendicitis: Diagnostic yield, resource use, and comparison with CT. Am J Emerg Med. 1999;17(4):325–8. https://doi.org/10.1016/s0735-6757(99)90077-3
54. Gans SL, Stoker J, Boermeester MA. Plain abdominal radiography in acute abdominal pain; past, present, and future. Int J Gen Med. 2012;5:525–33. https://doi.org/10.2147/ijgm.s17410
55. Sakover RP, Del Fava RL. Frequency of visualization of the normal appendix with the barium enema examination. Am J Roentgenol. 1974;121(2):312–17. https://doi.org/10.2214/ajr.121.2.312
56. Ekingen G, Guvenc BH, Senel U, Korkmaz M. Fluoroscopy-guided laparoscopy in the management of intraabdominal foreign body. J Pediatr Surg. 2003;38(9):1–2. https://doi.org/10.1016/s0022-3468(03)00420-2
57. Berry J, Malt RA. Appendicitis near its centenary. Ann Surg. 1984;200(5):567–75.
58. Campbell S. A short history of sonography in obstetrics and gynaecology. Facts Views Vis Obgyn. 2013;5(3):213–29.
59. Puylaert JB. Acute appendicitis: US evaluation using graded compression. Radiology. 1986;158(2):355–60. https://doi.org/10.1148/radiology.158.2.2934762
60. Scott T, Swan H, Jurriaans E, Voss M. Sonographic detection of the normal appendix. J Diagn Med Sonogr. 2004;20(5):326–34. https://doi.org/10.1177/8756479304267641
61. Jeffrey B, Laing F, Lewis F. Acute appendicitis: High-resolution real-time US findings. J Diagn Med Sonogr. 1987;163:11–14. https://doi.org/10.1148/radiology.163.1.3547490
62. Al-Marzooq TJM, Hassan QA, Majeed GH, Manea AN, Abboud AH. The diagnostic accuracy of sonography, with graded compression to image acute appendicitis compared to histopathologic results. J Diagn Med Sonogr. 2018;34(2):85–9. https://doi.org/10.1177/8756479317712196
63. Rapp CL, Stavros AT, Meyers PR. Ultrasound of the normal appendix: The how and why. J Diagn Med Sonogr. 1998;14(5):195–201. https://doi.org/10.1177/875647939801400501
64. Hull ME, Maulik D, Clout A. Mucinous adenocarcinoma of the appendix: Transvaginal ultrasound findings. J Diagn Med Sonogr. 1997;13(5):245–7. https://doi.org/10.1177/875647939701300504
65. Larcos G. Detection of appendicitis by transvaginal ultrasound: A case report. Ultrasound Obset Gynecol. 1996;7:361–2. https://doi.org/10.1046/j.1469-0705.1996.07050361.x
66. Sivit C, Applegate K, Stallion A, Dudgeon D, Salvator A, Schluchter M, et al. Imaging evaluation of suspected appendicitis in a pediatric population:

Effectiveness of sonography versus CT. Am J Roentgenol. 2000;175(4):977–80. https://doi.org/10.2214/ajr.175.4.1750977
67. Sodickson A, Baeyens PF, Andriole KP, Prevedello LM, Nawfel RD, Hanson R, et al. Recurrent CT, cumulative radiation exposure, and associated radiation-induced cancer risks from CT of adults. Radiology. 2009;251(1):175–84. https://doi.org/10.1148/radiol.2511081296
68. American College of Radiology. Radiation dose to adults from common imaging examinations [Internet]. [cited 2020 Sep 29]. Available from: https://www.acr.org/-/media/ACR/Files/Radiology-Safety/Radiation-Safety/Dose-Reference-Card.pdf
69. Hobbs JM. Diagnostic imaging of appendicitis with supplementation by transabdominal and transvaginal sonography. J Diagn Med Sonogr. 2015;31(6):345–51. https://doi.org/10.1177/8756479315611656
70. Mallin M, Craven P, Ockerse P, Steenblik J, Forbes B, Boehm K, et al. Diagnosis of appendicitis by bedside ultrasound in the ED. Am J Emerg Med. 2015;33(3):430–2. https://doi.org/10.1016/j.ajem.2014.10.004
71. Sistrom CL, Mckay NL. Costs, charges, and revenues for hospital diagnostic imaging procedures: Differences by modality and hospital characteristics. J Am Coll Radiol. 2005;2(6):511–19. https://doi.org/10.1016/j.jacr.2004.09.013
72. Brian JM, Moore MM. MRI for Appendicitis in pediatric patient. Appl Radiol. 2017;46(9):18–24.
73. Seeram E. Computed tomography: physical principles, clinical applications, and quality control. 3rd ed. St. Louis, MO: Saunders; 2009.
74. Yeh BM, Kambadokone A, Thoeni RF, Towbin AJ. SPR Practice parameter for the performance of computed tomography (CT) of the abdomen and computed tomography of the pelvis. J Am Coll Radiol. 2016;1–15.
75. O'Malley ME, Halpern E, Mueller PR, Gazelle GS. Helical CT protocols for the abdomen and pelvis. Am J Roentgenol. 2000;175(1):109–13. https://doi.org/10.2214/ajr.175.1.1750109
76. Chiu YH, Chen JD, Wang SH, Tiu CM, How CK, Lai JI, et al. Whether intravenous contrast is necessary for CT diagnosis of acute appendicitis in adult ED patients? Acad Radiol. 2013;20(1):73–8. https://doi.org/10.1016/j.acra.2012.07.007
77. Drake FT, Alfonso R, Bhargava P, Cuevas C, Dighe MK, Florence MG, et al. Enteral contrast in the computed tomography diagnosis of appendicitis. Ann Surg. 2014;260(2):311–16. https://doi.org/10.1097/sla.0000000000000272
78. Latifi A, Labruto F, Kaiser S, Ullberg U, Sundin A, Torkzad MR. Does enteral contrast increase the accuracy of appendicitis diagnosis? Radiol Technol. 2011;82(4):294–9.
79. Hekimoglu K, Yildirim UM, Karabulut E, Coskun M. Comparison of combined oral and i.v. contrast-enhanced versus single i.v. contrast-enhanced MDCT for the detection of acute appendicitis. J Belg Soc Radiol. 2011;94:278–82. https://doi.org/10.5334/jbr-btr.664
80. Kepner AM, Bacasnot JV, Stahlman BA. Intravenous contrast alone vs intravenous and oral contrast computed tomography for the diagnosis of appendicitis in adult ED patients. Am J Emerg Med. 2012;30:1765–73. https://doi.org/10.1016/j.ajem.2012.02.011
81. Sayed A, Zeidan N, Fahmy D, Ibrahim H. Diagnostic reliability of pediatric appendicitis score, ultrasound and low-dose computed tomography scan in children with suspected acute appendicitis. Ther Clin Risk Manag. 2017;13:847–54. https://doi.org/10.2147/tcrm.s134153
82. Sauvain MO, Tschirky S, Patak MA, Clavien PA, Hahnloser D, Muller MK. Acute appendicitis overweight patients: The role of preoperative imaging. Patient Saf Surg. 2016;10(1):13. https://doi.org/10.1186/s13037-016-0102-0
83. Josephson T, Styrud J, Eriksson S. Ultrasonography in acute appendicitis: Body mass index as selection factor for US examination. Acta Radiol. 2000;41(5):486–8. https://doi.org/10.1080/028418500127345749
84. Abo A, Shannon M, Taylor G, Bachur R. The influence of body mass index on the accuracy of ultrasound and computed tomography in diagnosing appendicitis in children. Pediatr Emerg Care. 2011;27(8):731–6. https://doi.org/10.1097/pec.0b013e318226c8b0
85. Davis J, Roh AT, Petterson MB, Kopelman TR, Matz SL, Gridley DG, et al. Computed tomography

localization of the appendix in the pediatric population relative to the lumbar spine. Pediatr Radiol. 2017;47(3):301–5. https://doi.org/10.1007/s00247-016-3773-x
86. Park HR, Park SB, Lee ES, Park HJ, Lee JB, Kim YS. Unenhanced computed tomography for normal appendix detection: Comparison of low-dose with statistical iterative reconstruction and regular-dose with filtered back projection. Clin Imaging. 2017;43:117–21. https://doi.org/10.1016/j.clinimag.2017.02.010
87. Kim SH. Effective radiation dose reduction in computed tomography with iterative reconstruction in patients with urinary stone. J Comput Assist Tomogr. 2019;43(6):877–83. https://doi.org/10.1097/RCT.0000000000000921
88. American College of Radiology. Appropriateness criteria [Internet]. [cited 2020 Sep 29]. Available from: https://acsearch.acr.org/docs/69357/Narrative/
89. Flum DR. Acute appendicitis – Appendectomy or the "antibiotics first" strategy. N Engl J Med. 2015;372(20):1937–43. https://doi.org/10.1056/NEJMcp1215006
90. Swenson DW, Schooler GR, Stamoulis C, Lee EY. MRI of the normal appendix in children: Data toward a new reference standard. Pediatr Radiol. 2016;46(7):1003–10. https://doi.org/10.1007/s00247-016-3559-1
91. Didier RA, Hopkins KL, Coakley FV, Krishnaswami S, Spiro DM, Foster BR. Performance characteristics of magnetic resonance imaging without contrast agents or sedation in pediatric appendicitis. Pediatr Radiol. 2017;47(10):1312–20. https://doi.org/10.1007/s00247-017-3897-7
92. Mian M, Khosa F, Ali IT, McLaughlin P, Klass D, Chang S, et al. Faster magnetic resonance imaging in emergency room patients with right lower quadrant pain and suspected acute appendicitis. Pol J Radiol. 2018;83:340–47. https://doi.org/10.5114/pjr.2018.77790
93. Kave M, Parooie F, Salarzaei M. Pregnancy and appendicitis: A systematic review and meta-analysis on the clinical use of MRI in diagnosis of appendicitis in pregnant women. World J Emerg Surg. 2019;14(1)1–14. https://doi.org/10.1186/s13017-019-0254-1
94. Wi SA, Kim DJ, Cho E, Kim KA. Diagnostic performance of MRI for pregnant patients with clinically suspected appendicitis. Abdom Radiol. 2018;43(12):3456–61. https://doi.org/10.1007/s00261-018-1654-5
95. Leeuwenburgh MM, Jensch S, Gratama JW, Spilt A, Wiarda BM, Van Es HW, et al. MRI features associated with acute appendicitis. Eur Radiol. 2014;24(1):214–22. https://doi.org/10.10 07/s00330-013-3001-0
96. Michalinos A, Moris D, Vernadakis S. Amyand's hernia: A review. Am J Surg. 2014;207(6):989–95. https://doi.org/10.1016/j.amjsurg.2013.07.043
97. Hutchinson R. Amyand's hernia. J R Soc Med. 1993;86(2):104–5.
98. Nazir A, Farooqi S, Chaudhary NA, Bhatti HW, Waqar M, Sadiq A. Comparison of open appendectomy and laparoscopic appendectomy in perforated appendicitis. Cureus. 11(7):e5105. https://doi.org/10.7759/cureus.5105
99. Long KH, Bannon MP, Zietlow SP, Helgeson ER, Harmsen WS, Smith CD, et al. A prospective randomized comparison of laparoscopic appendectomy with open appendectomy: Clinical and economic analyses. J Surg. 2001;129(4):390–400. https://doi.org/10.1016/s0039-6060(01)15621-7
100. Eriksson S, Granström L. Randomized controlled trial of appendicectomy versus antibiotic therapy for acute appendicitis. Br J Surg. 1995;82:166–9. https://doi.org/10.1002/bjs.1800820207
101. Killinger BA, Madaj Z, Sikora JW, Rey N, Haas AJ, Vepa Y, et al. The vermiform appendix impacts the risk of developing Parkinson's disease. Sci Transl Med. 2018;10:1–15. https://doi.org/10.1126/scitranslmed.aar5280
102. Margenthaler JA, Longo WE, Virgo KS, Johnson FE, Oprian CA, Henderson WG, et al. Risk factors for adverse outcomes after the surgical treatment of appendicitis in adults. Ann. Surg. 2003;238(1):59–66. https://doi.org/10.1097/01.sla.0000074961.50020.f8

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Article title: Diagnostic Imaging Examinations for Suspected Appendicitis: A Narrative Review

Author's Names: Lacey Fischer, MSRS, RDMS, RVT, RDCS, RT (R)(M) and Brandon Hirsch, MS, CMD, RT(R)(CT)(T)

1. What is the lifetime risk for males experiencing appendicitis in their lifetime?

a) 15%
b) 1%
c) 2%
d) 8.6%

2. Where does the vermiform appendix most typically attach to on the GI tract?

a) Cecum
b) Sigmoid Colon
c) Hepatic Flexure
d) Transverse Colon

3. What is the most common cause of acute appendicitis?

a) Volvulus
b) Diverticulitis
c) Laceration from trauma
d) Obstruction trapping bacteria in the appendix

4. Which sign or symptom describes pain associated with the most sensitive area to abdominal pressure, located on the imaginary line between the right anterior superior iliac spine (ASIS) and the umbilicus?

a) Snow's sign
b) Psoas sign
c) Rovsing's sign
d) McBurney's sign

5. What is the name of the scoring system used to diagnose appendicitis which utilizes a 10-point scale, whereby multiple signs, symptoms and laboratory values attribute to the total score?

a) Rovsing score
b) Alvarado score
c) McBurney score
d) Karnofsky score

Case Study

Jody Chantler, BSc, DMS CRCS

A Case of a Tricuspid Valve Papillary Fibroelastoma and Nonspecific Cardiac Symptoms

About the Author

Jody has Bachelor of Science in Human Kinetics, graduated from the Diagnostic Cardiac Sonography program at Mohawk College and is the lead cardiac sonographer at Georgian Cardiology Associates.

ABSTRACT

A 66-year-old woman was referred for investigation of syncope, dyspnea, and mild chest discomfort. A transthoracic echocardiogram revealed a mass attached to the atrial aspect of the septal leaflet of the tricuspid valve. Blood cultures were immediately taken to rule out a differential diagnosis of infective endocarditis. The patient underwent successful surgery to excise the mass and preserve the tricuspid apparatus. Surgical pathology confirmed the diagnosis of a papillary fibroelastoma. Surgical intervention should be considered in these cases due to the risk of embolization and the possibility of malignant tumors. This case emphasis the importance of a conducting an echocardiogram and including the cardiac valves.

Introduction

A papillary fibroelastoma is a benign cardiac tumor that usually arises on valvular tissue.[1] It is predominately located on the left-sided valves but can be found on the tricuspid or pulmonic valves or from a nonvalvular site[1,2]. Papillary fibroelastomas account for less than 10% of all primary cardiac tumors in adults.[1,3]

Here we document a case of nonspecific cardiac symptoms, the diagnostics, and the successful surgical resection of a tricuspid valve papillary fibroelastoma.

Case Description

A 66-year-old female with symptoms of syncope, chest discomfort, and dyspnea was referred by her family physician for an echocardiogram. There was no previous cardiac history. A transthoracic echocardiogram (TTE) demonstrated normal left ventricular function and normal chamber sizes; valvular function was unremarkable. There was no evidence of outflow tract obstruction. However, an echogenic mass, measuring 11 mm x 10 mm was visualized on the atrial side of the septal tricuspid valve leaflet (Figures 1–3). Only trivial tricuspid regurgitation was documented. The TTE was performed using a GE Vivid S70 ultrasound machine. The patient had a resting blood pressure of 123/83 mm Hg, and a resting heart rate of 90 bpm.

The patient was immediately seen by the attending cardiologist, and blood cultures were ordered to rule out infective endocarditis. The blood cultures came back normal, and the patient was referred for surgical resection. A transesophageal echocardiogram

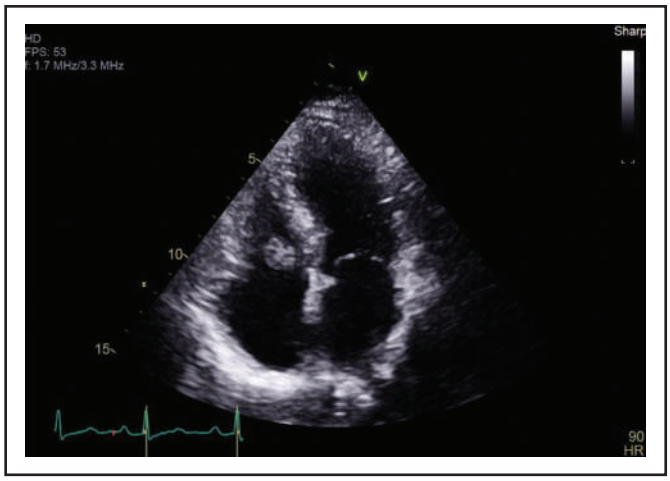

Figure 1. Apical four-chamber view demonstrating a mass on the tricuspid valve.

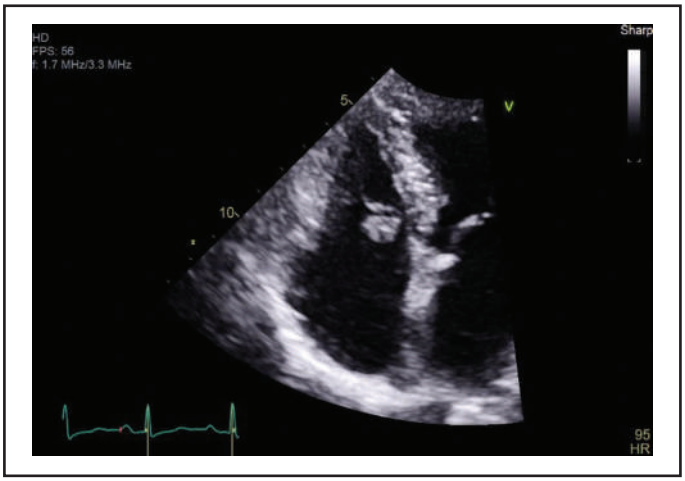

Figure 2. A focused view of the right side of the heart shows a mass on the atrial aspect of the septal leaflet of the tricuspid valve.

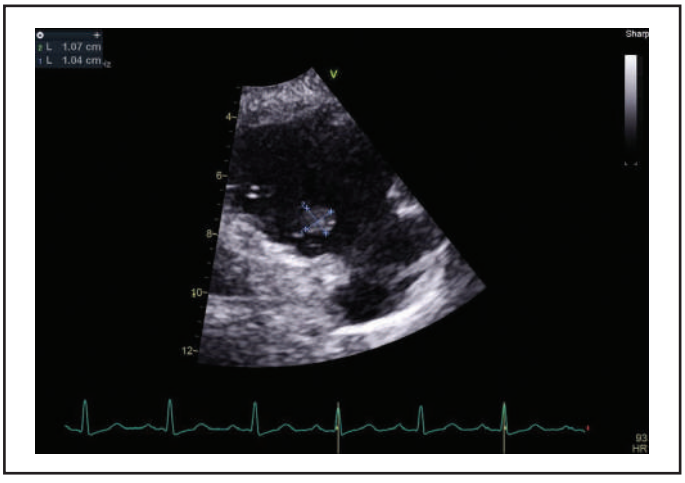

Figure 3. Right ventricular inflow view from the parasternal window demonstrating a mass on the tricuspid valve measuring 11 mm × 10 mm.

(TEE;) was performed using a Philips Epiq ultrasound machine for better visualization of the tricuspid valve mass (Figures 4–6). The mass was described as solid, heterogeneous and mobile. A Holter monitor did not show any arrhythmias of significance. A coronary angiogram was also performed prior to surgery; there was no evidence of coronary artery disease.

The mass was removed via a minimally invasive right mini thoracotomy. A sharp dissection was used to remove the mass from the septal tricuspid leaflet. TEE demonstrated that the leaflet was unaffected, and the patient was removed from the cardiopulmonary bypass list and transferred to the intensive care unit in stable condition. The mass was described as having a cauliflower appearance. Surgical pathology confirmed the mass to be a papillary fibroelastoma with no evidence of malignancy.

The patient recovered well from surgery and was seen 2 months later for a TTE (Figure 7) and cardiac consultation. There was no evidence of reoccurrence, the tricuspid apparatus was functioning normally and the patient had no further syncopal episodes.

Discussion

Papillary fibroelastomas are the third most common primary cardiac tumor, following myxomas and lipomas.[1,3] However, they are reported to be the most common tumorous lesion of the cardiac valves.[2,3] They are benign masses that most often arise from valvular tissue; thus, they must be differentiated from vegetations.

The etiology of these tumors is unknown. One theory is that they may result from damage to the valvular tissue, allowing for further growth.[2,3] Most often, the presenting symptoms are nonspecific, or in some cases, the patient is asymptomatic, and it is an incidental finding. There is some disagreement in the literature regarding the removal of papillary fibroelastomas[1]. However, there have been cases and concerns regarding the formation of thrombus or possible embolization of tumor fragments.[2–4]

It is always important to complete a thorough echocardiogram on every patient. Thorough imaging

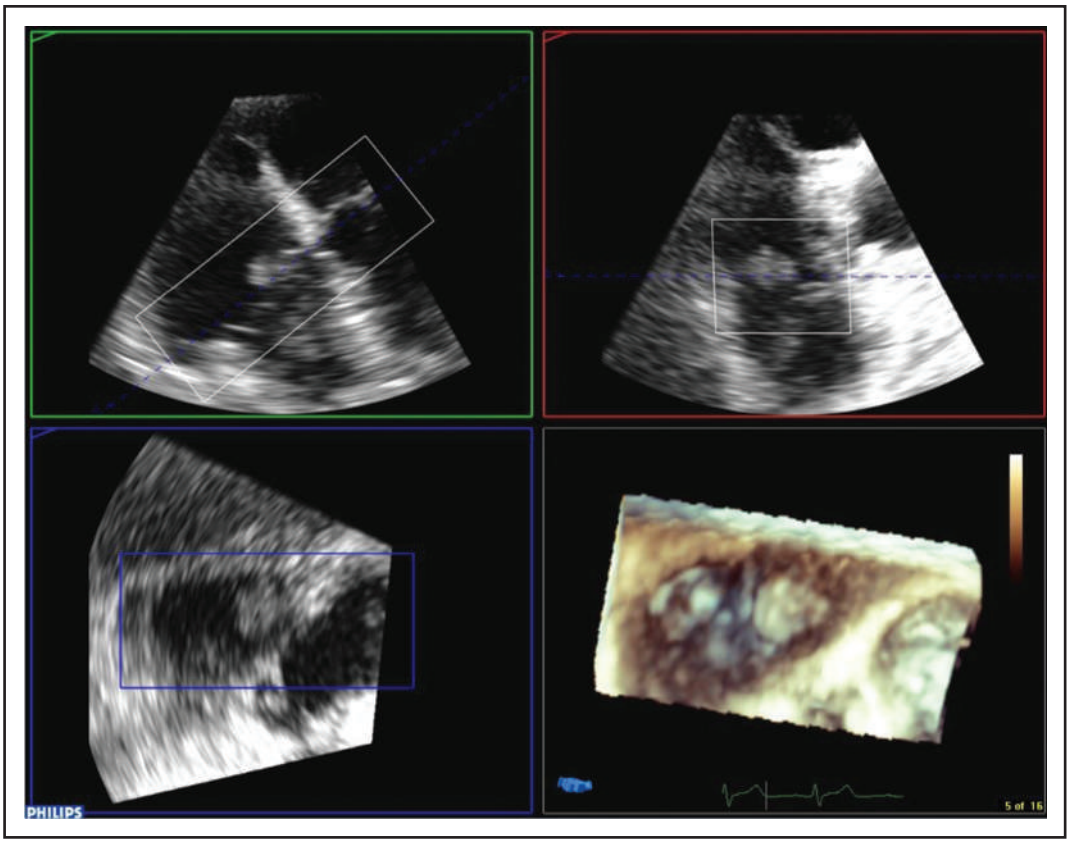

Figure 4. 3D multiplane reconstruction of the mass, obtained during the TEE.

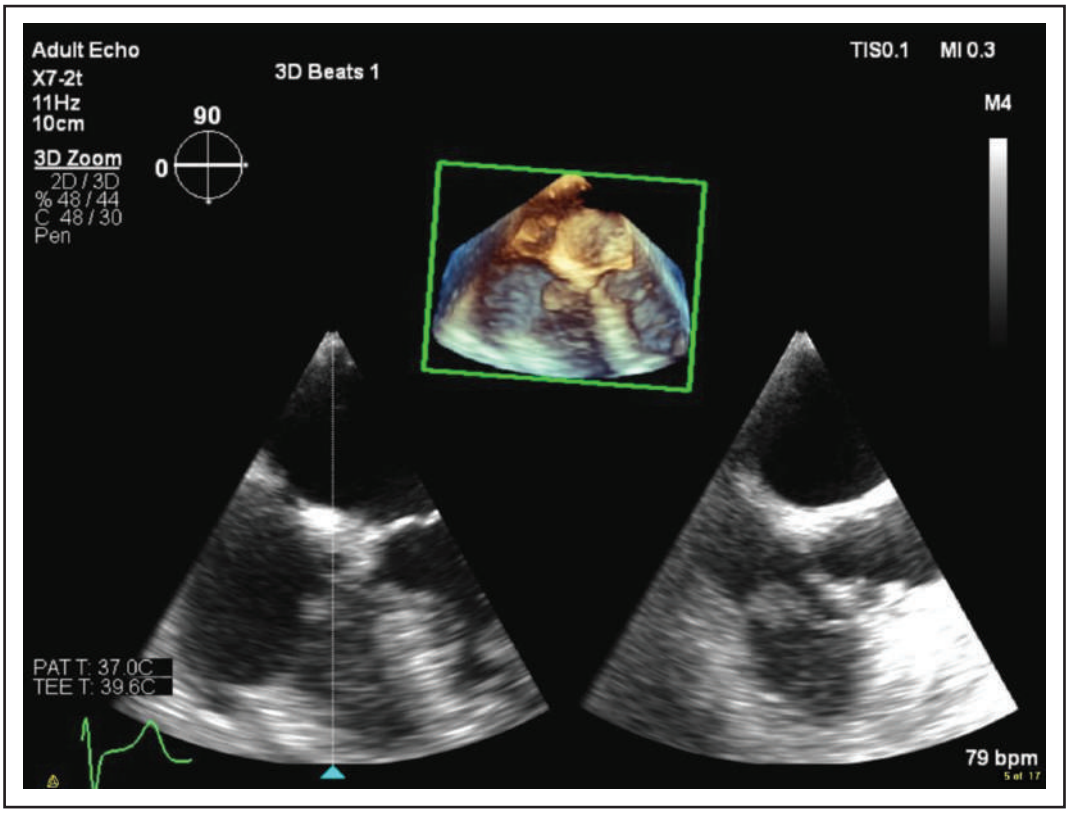

Figure 5. 3D image of the mass, obtained during the TEE.

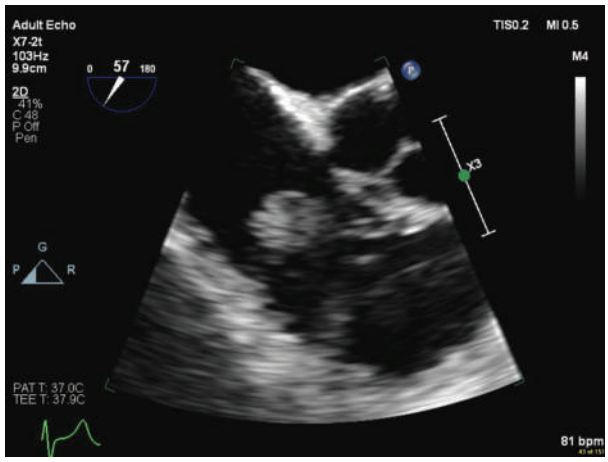

Figure 6. 2D image of the mass, obtained during the TEE.

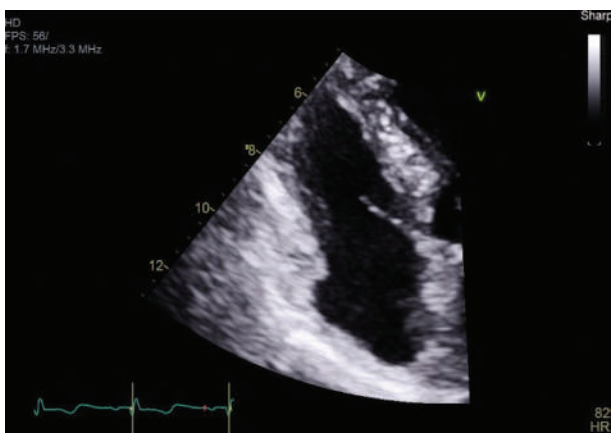

Figure 7. A focused view of the right side of the heart showing the normally functioning tricuspid valve 2 months post mass removal.

of the tricuspid valve is of particular importance in these cases, taking care to explore off-axis imaging angles and windows. The use of contrast may be of value to determine the presence of vascularization of the mass. Masses may exhibit some contrast uptake where thrombi will be avascular, allowing contrast use to help to exclude the presence of a thrombus. Patient symptoms are often nonspecific, especially regarding cardiac masses and tumors. In this case, the study was of adequate quality, and the papillary fibroelastoma (PFE) was well circumscribed. A PFE can be detected and well documented using echocardiography.[4]

Conclusion

Papillary fibroelastomas are rare tumors, and it is even less common for them to present on the right-sided valves.[1] These right-sided lesions typically do not present with distinct symptoms.Nonspecific symptoms can be a challenge for both physicians and sonographers. This case served as a good example of why a complete TTE should be performed on each patient. Ultrasound proved to be a critical imaging modality; using a non-invasive method to diagnose this patient. Patients and their physicians need to carefully consider all options. In most documented cases of tricuspid valve papillary fibroelastomas, the medical teams have chosen invasive intervention. The rate of reoccurrence following surgical resection is unknown. and follow-up ultrasound imaging is recommended.[3,4]

References

1. Otto CM, Cardiac masses and potential cardiac source of embolus. In: Otto CM, editor. Textbook of clinical echocardiography. 5th ed. Pennsylvania: Elsevier Inc; 2013; p. 402.
2. Strecker T, Scheuermann S, Nooh E, Weyand M, Agaimy A. Incidental papillary fibroelastoma of the tricuspid valve. J Cardiothorac Surg. 2014;9:123. https://doi.org/10.1186/1749-8090-9-123
3. Georghiou GP, Erez E, Vidne BA, Aravot D. Tricuspid valve papillary fibroelastoma: An unusual cause of intermittent dyspnea. EJCTS. 2003;23:429–31. https://doi.org/10.1016/s1010-7940(02)00761-3
4. Gomadam PS, Stacey RB, Johnsen AE, Kitzman DW, Kon ND, Upadhya B. Papillary fibroelastoma of the mitral valve chordae with systemic embolization. JC Cases. 2014;10:125–8. https://doi.org/10.1016/j.jccase.2014.06.004

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Article title: A Case of a Tricuspid Valve Papillary Fibroelastoma and Non-specific Cardiac Symptoms

Author Name: Jody Chantler, BSc, DMS CRCS

1. A papillary fibroelastoma is a _____ cardiac tumour that typically arises on _____ tissue

a) Malignant, left sided valvular
b) Benign, right sided valvular
c) Malignant, right sided valvular
d) Benign, left sided valvular

2. When patients present with a papillary fibroelastomas they describe which of the following:

a) Dyspnea
b) Chest pain
c) Bilateral leg pain
d) Non-specific or asymptomatic

3. When valvular masses are identified it is often prudent to perform blood cultures to rule out the presence of:

a) Lipomas
b) Myxomas
c) Vegetations
d) Fibroelastomas

4. The tricuspid valve is challenging to image due to the inability to view all 3 cusps in a single view.

a) True
b) False

5. Post-surgical resection echocardiography in these types of lesions is important for which of the following reasons:

a) Determine recurrence of lesion
b) Determine degree of stenosis of affected valve
c) Determine degree of regurgitation of affected valve
d) All of the above

Sonography Canada Survey on COVID-19 vaccinations for sonographers in Canada

In March 2021, Sonography Canada conducted an initial survey via Survey Monkey to determine if its members had been given the opportunity to be vaccinated and, if not, when they may expect to be. The brief 5-question survey was distributed to all members. We received responses from 1,464 individuals, from both small and large communities across the country. Approximately half of all respondents were sonographers working in hospital settings (51%) or private clinics (47%), with the remaining respondents representing educational institutions (1%) or other practice settings (1%).

Where you live matters

Alberta was clearly identified as the province in which the availability of the vaccine was most problematic. In fact, only 2.7% of survey respondents indicated vaccine availability in that province at the time of the survey. While Ontario would seem to be making the most promising progress, the vaccination rate amongst responding sonographers was 65%. Manitoba had one of the highest vaccination rates amongst sonographers at 97%.

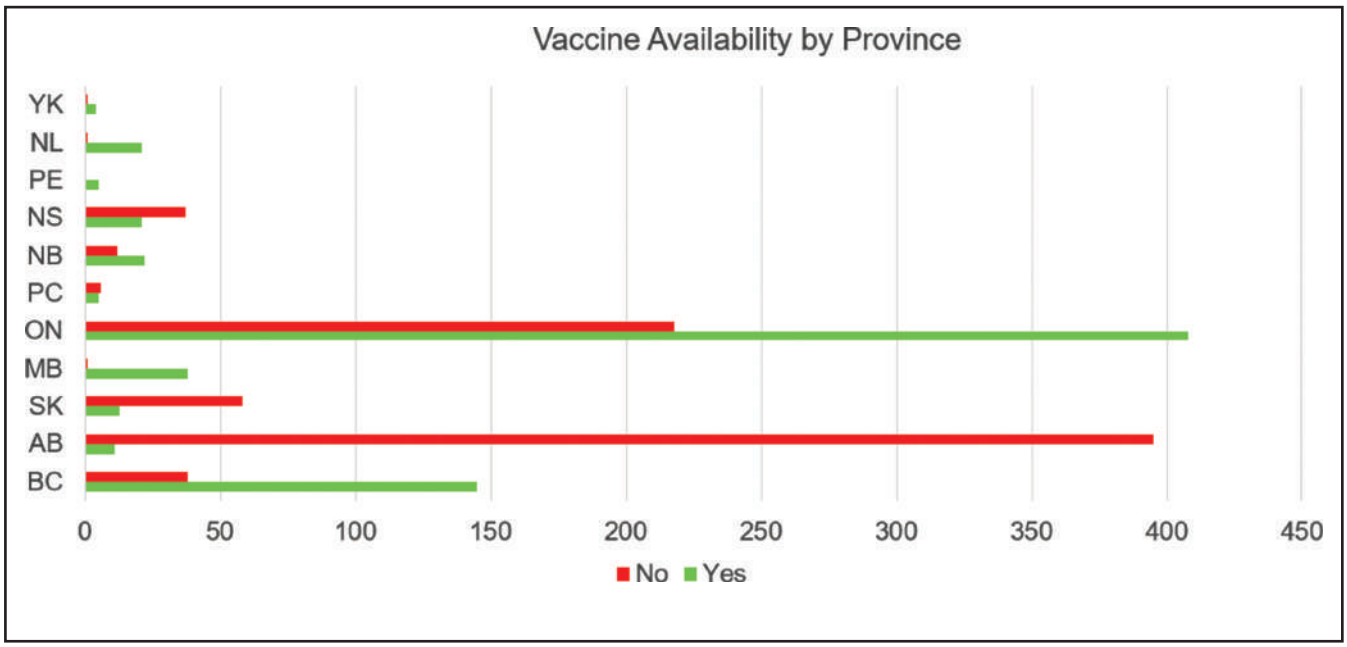
Where you work matters

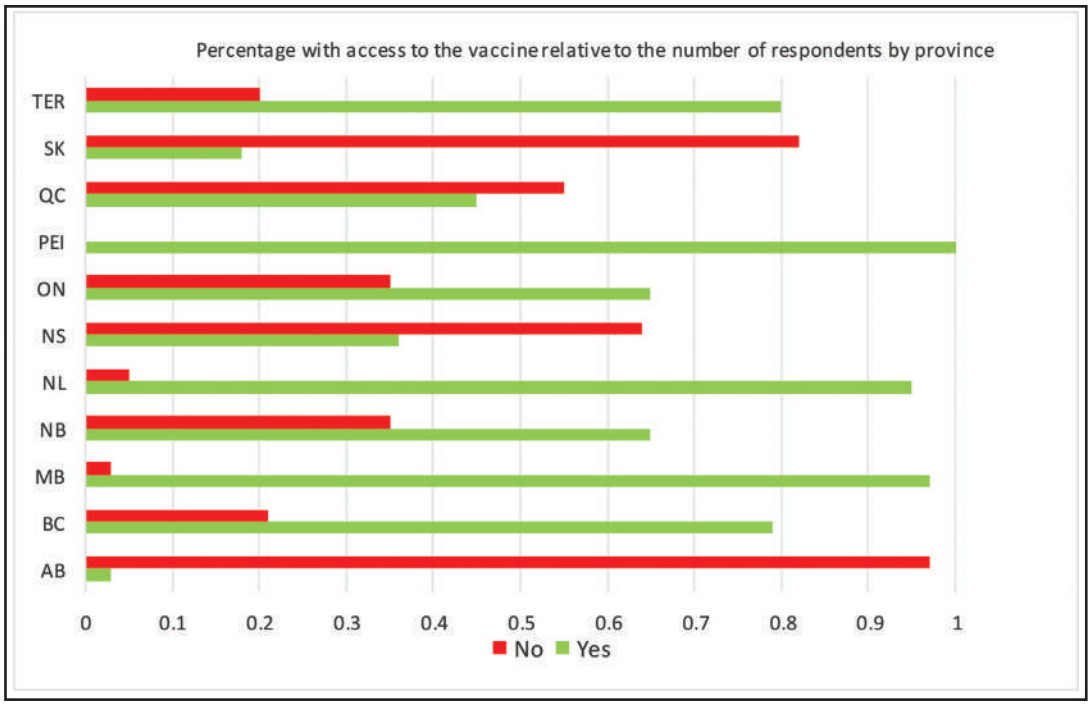
About the same number of respondents indicated that the COVID-19 vaccine had been made available to them at their workplace (47%) as those who said it had not (53%). While a majority of respondents (561) working in a hospital setting indicated that the vaccine was available to them, the same number of sonographers (560) indicated that the vaccine was not yet available to those working in private clinics.

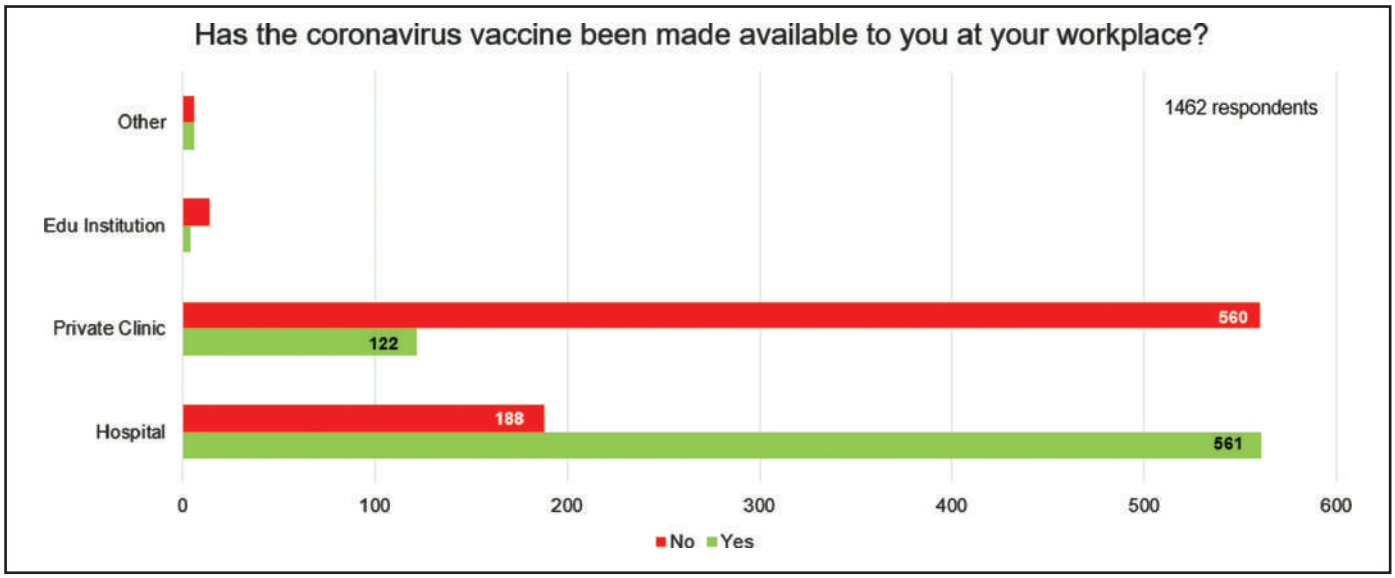
Of those respondents to whom the vaccine had not yet been made available, a majority did not know when it would be, and 47% had not received any communications regarding when they might expect to be vaccinated, particularly if they worked in private clinics.

Tracking the trend

Since the original survey was conducted, the situation has evolved and changed in many regions of the country. To assess progress being made, Sonography Canada launched version 2.0 of the COVID-19 vaccination survey in early May 2021.



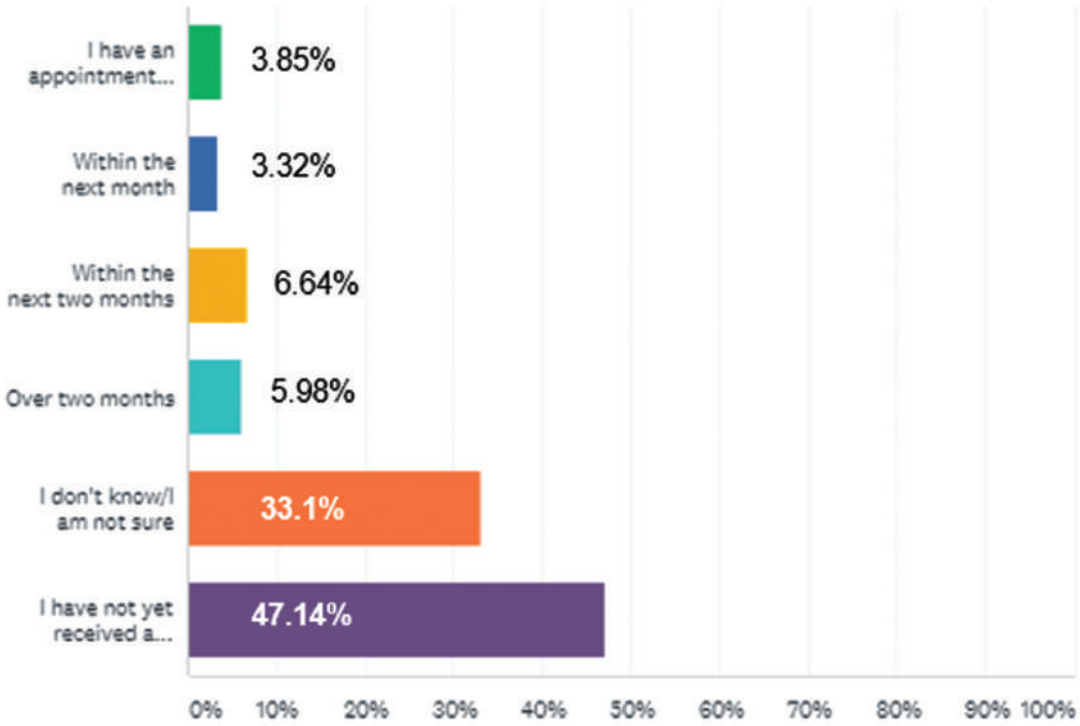




The original and follow-up surveys were conducted to help the association direct its advocacy efforts to authorities in areas where the vaccine has not yet been made available, where sonographers have not been included with other healthcare workers as a priority to receive the vaccine, and/or where communications have been absent or lacking.

If no, when do you expect to to receive the vaccine?

Answered: 753 Skipped: 711



Celebrating 20 years of sonography credentials in Canada

IN THE YEAR 2000, CARDUP WAS BORN

The concept of Canadian examinations and a national registry existed in the early 1980s. By 1999, the need for a Canadian registry became acute to address accreditation requirements, bilingual policies, and provincial regulatory issues. In addition, surveys of employers and others by the Canadian Society of Diagnostic Medical Sonographers (CSDMS) conducted in 1993 & early 2000 indicated a 70% positive response for the development of a Canadian registry.

Prior to the creation of the Canadian Association of Registered Diagnostic Ultrasound Professionals (CARDUP) in 2000, the only credential available to Canadian sonographers was the American credential conferred by the American Registry for Diagnostic Medical Sonography® (ARDMS). ARDMS is a widely respected certification agency, but its standards are based upon the needs of the profession in the United States.

ARDMS CREDENTIALS DID NOT MEET 3 IMPORTANT CRITERIA:

1. A Canadian focus to ensure certification relevant to Canadian practice.
2. A practical examination to ensure that registered sonographers were clinically competent when entering the Canadian workplace.
3. A bilingual exam available to Canadian candidates in both official languages.

MEETING CANADIAN NEEDS

ARDMS was approached with a request to develop examinations to address these Canadian needs. It was unable to accede to this request. As a result, CARDUP was created.

CARDUP accomplishments since 2000:

1. A nation-wide survey of Canadian employers
2. Canadian credentials for the generalist, cardiac, and vascular sonographer
3. A *National Competency Profile* for each of the three sonography specialties
4. A practical examination called the *Clinical Skills Assessment*
5. An Exam Committee to produce high-quality examination questions referenced to the National Competency Profiles
6. Bilingual knowledge-based written exams
7. A psychometric evaluation to ensure the statistical validity and defensibility of the examination

CANADIAN CREDENTIALS

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CRCS®: Canadian Registered Cardiac Sonographer
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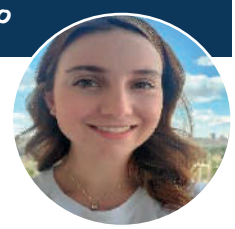

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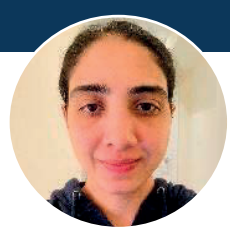

Student Achievement Award
Mohamed Nashnoush

Peter McLardie Memorial Education Bursary - Student
Emma MacCulloch

Each year, Sonography Canada recognizes and celebrates individuals who have made significant contributions to the profession of sonography or to the association. Our awards acknowledge the various roles and accomplishments sonographers can have in their careers starting as students, then as mentors, educators or colleagues.

Congratulations to this year's laureates!

Visit our website at www.sonographycanada.ca/about-us/awards to access the award booklet and to learn more about the individuals who have distinguished themselves among their peers!