Clinical Radiology 70 (2015) 858–871

Contents lists available at ScienceDirect

Clinical Radiology

journal homepage: www.clinicalradiologyonline.net

The diagnostic accuracy of magnetic resonance venography in the detection of deep venous thrombosis: a systematic review and meta-analysis

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ARTICLE INFORMATION

Article history:
Received 5 February 2015
Received in revised form
26 March 2015
Accepted 13 April 2015

AIM: To search the literature for further evidence for the use of magnetic resonance venography (MRV) in the detection of suspected DVT and to re-evaluate the accuracy of MRV in the detection of suspected deep vein thrombosis (DVT).

MATERIALS AND METHODS: PubMed, EMBASE, Scopus, Cochrane, and Web of Science were searched. Study quality and the risk of bias were evaluated using the QUADAS 2. A random effects meta-analysis including subgroup and sensitivity analyses were performed.

RESULTS: The search resulted in 23 observational studies all from academic centres. Sixteen articles were included in the meta-analysis. The summary estimates for MRV as a diagnostic non-invasive tool revealed a sensitivity of 93% (95% confidence interval [CI]: 89% to 95%) and specificity of 96% (95% CI: 94% to 97%). The heterogeneity of the studies was high. Inconsistency (I2) for sensitivity and specificity was 80.7% and 77.9%, respectively.

CONCLUSION: Further studies investigating the use of MRV in the detection of suspected DVT did not offer further evidence to support the replacement of ultrasound with MRV as the first-line investigation. However, MRV may offer an alternative tool in the detection/diagnosis of DVT for whom ultrasound is inadequate or not feasible (such as in the obese patient).

Introduction

Venous thromboembolism (VTE) is defined as a blood clot (thrombus) that originates in any deep vein of the human venous system and leads to over 50,000 deaths a year in the United States.[1–3] These can occur in the deep veins of pelvis, thighs, or legs (deep vein thrombosis, DVT), or part of

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http://dx.doi.org/10.1016/j.crad.2015.04.007
0009-9260/

the thrombus can detach as an embolus and lodge in the pulmonary vessels, leading to pulmonary embolism (PE).[4,5] Early detection is essential for immediate treatment to avoid morbidity and mortality accompanied with DVT and PE.[6]

The clinical presentation of VTE may vary from being completely asymptomatic to having a lethal outcome such as PE; moreover, a diagnosis of DVT may lead to long-term comorbidity such as chronic venous insufficiency.[7] One of the known risk factors for VTE is obesity.[8] Excessive abdominal fat limits the venous return and chronically raises the intra-abdominal pressure, leading to a decrease in the blood velocity in the femoral veins.[8,9] Obese patients also have high levels of leptin, decreased fibrinolysis, and a high level of haemostasis, which contributes to more venous thrombosis, especially in the lower limbs.[8] The reference standard for the detection of DVT is contrast venography. Risks of this technique include contrast nephropathy, systemic reactions to the contrast medium, tissue necrosis due to extravasation of the contrast medium, venous thrombosis at the catheter site, and PE as sequelae.[12] In addition, contrast venography is not ideal for imaging DVTs originating in the pelvic veins, particularly the internal iliac veins, and for the deep veins of the thigh because wash-out of contrast medium by tributaries impairs opacification.[12] Other non-invasive techniques include duplex ultrasound, contrast-enhanced computed tomography (CT) venography, and magnetic resonance venography (MRV). Duplex ultrasound is a non-invasive and relatively inexpensive tool for the detection of DVT; however, it is operator dependent, with a poor anatomical view, especially in morbidly obese patients.[7,13] It is also not useful for pelvic veins and has limited accuracy below the knee in the obese. Contrast-enhanced CT venography has a good anatomical view, but provides a high risk of ionising radiation, in addition to the contrast material used, which makes the patient more vulnerable to allergic reactions and nephrotoxicity.[7,13] X-ray venography has similar limitations to contrast-enhanced CT venography and only evaluates a single draining venous system with each venous puncture.[13,14]

MRV has been suggested as a non-invasive diagnostic tool for confirming the presence of DVT. This may benefit special populations with inadequate venous access, as in the morbidly obese patient.[15–17] MRV has lower operator dependence and provides better venous anatomy,[6] especially in the pelvic region. This is crucial in the diagnosis of DVT for the obese patient, where thicker lower limbs and excessive fat tissue obscure the view of pelvic veins.[14,16,17] Sampson *et al.*[16] explored the accuracy and benefits of MRV in a systematic review and meta-analysis in 2007. To the authors' knowledge, this is the only literature review that has been conducted on this specific topic to date. The authors concluded that MRV will not replace ultrasound as the first-line technique for DVT detection; however, they did suggest that MRV may offer an alternative in specific populations, such as obese patients, where ultrasound is not feasible or yields inconclusive results.[18]

Given the limitations of non-invasive techniques available for the detection of DVT, the aim of the present study was to compare MRV with other non-invasive techniques against the standard of contrast venography in the detection of DVT of the lower limbs.

The objective was to assess whether the diagnostic accuracy of MRV for clinically suspected and asymptomatic DVT is high enough to justify its use in clinical practice and to evaluate whether MRV can replace venography, particularly in specific populations, such as obese patients. The hypothesis was that MRV may be very useful in specific populations, offering an alternative technique when ultrasound is not feasible or yields inconclusive results.

Materials and methods

Definition of exposure

Adults or children who were suspected of having a DVT who underwent MRV for the diagnosis of DVT in the pelvis or lower limbs were included. These same patients should have undergone another diagnostic study to compare the diagnostic accuracy of the MRV. Only studies that evaluated the pelvis and lower extremities were included; studies that only included upper extremity MRV or chest MRV were excluded.

Primary outcome

The primary outcome for this review and meta-analysis was the accurate detection of DVT in the lower limb and pelvis as compared to contrast venography.

Search strategy

Prospective and retrospective cohort studies and case–control studies were included. Cross-sectional studies, case series, case reports, animal studies, and studies published in a language other than English were not included. Medline, Cochrane, EMBASE, Scopus and Web of Science were searched for papers containing the synonyms for terms "deep vein thrombosis" and "magnetic resonance imaging". Synonyms were compiled using controlled vocabulary and free text concepts. Systematic reviews and meta-analyses were also searched using the clinical queries tool in PubMed. Hand-searching was performed after narrowing down a list of 40 journals to the four most pertinent for MRV imaging: Radiology, Investigative Radiology, Journal of Magnetic Resonance Imaging, JAMA surgery, and Clinical Orthopedics and Related Research. These were searched back 6 months for additional articles. Conference proceedings were not searched for unpublished and ongoing studies. Finally, 14 articles from the Sampson analysis[18] were examined to ensure that they were included.

The list was then aggregated into EndNote X6 software. Duplicates were removed based on author, year, title, journal, volume, issue and page. Articles from PubMed were kept in preference to those in EMBASE and Scopus.