From the American Venous Forum

A pilot study of venous duplex ultrasound parameters in healthy children

Stevie-Jay Stapler, Katie Zurales, Alyssa Mazurek, Bamidele Otemuyiwa, Meghan Knol, Thomas W. Wakefield, MD, *and* Dawn M. Coleman, MD, *Ann Arbor, Mich*

ABSTRACT

Objective: The spectrum of chronic venous disease (CVD) in adults is well documented, whereas there is a paucity of data published commenting on pediatric CVD. We previously identified that there is often venous reflux present in cases of pediatric lower extremity edema despite an alternative confirmed diagnosis. To further assess the clinical significance of this venous reflux, this study aimed to elicit venous parameters in healthy pediatric controls.

Methods: Healthy pediatric volunteers aged 5 to 17 years were recruited for venous reflux study. A comprehensive venous reflux study was performed with the patient standing. Vein diameter, patterns of valvular reflux, and accessory venous anatomy were examined in the deep and superficial venous systems.

Results: Eighteen children including 10 boys and 8 girls were studied. Five volunteers were aged 5 to 8 years, six volunteers were aged 9 to 12 years, and seven volunteers were aged 13 to 17 years. Great saphenous vein (GSV) diameter at the saphenofemoral junction significantly increased with age. Deep vein valve closure time (VCT) did not differ significantly between groups, whereas GSV VCT was significantly higher in the 9- to 12-year age group. Incidental venous insufficiency was identified in 60% of children aged 5 to 8 years (n = 3), 50% of children aged 9 to 12 years (n = 3), and 57% of children aged 13 to 17 years (n = 4). All superficial venous reflux was confined to the GSV; there were no cases of isolated deep venous reflux. Reflux was identified at multiple GSV stations in 60% of children. There was no significant difference in incompetent GSV VCT in comparing children with and without deep venous reflux. Accessory superficial veins were identified in 20% of children aged 5 to 8 years (n = 1), 50% of children aged 9 to 12 years (n = 3), and 43% of children aged 13 to 17 years (n = 3). The presence of an accessory saphenous vein was not associated with deep venous reflux in any patient, and only 29% of those with accessory saphenous venous anatomy had evidence of superficial venous (GSV) reflux.

Conclusions: The GSV continues to grow in diameter through the teenage years. Incidental valvular incompetence and GSV reflux are common. The presence of accessory saphenous veins is similarly common and not associated with venous reflux. The clinical significance and natural history of this incidental venous reflux remain unclear. Future research should determine whether these changes seen in the pediatric age group lead to CVD during later years of life. (J Vasc Surg: Venous and Lym Dis 2017;■:1-4.)

The spectrum of chronic venous disease (CVD) is well documented in adults, with clinical guidelines standardizing both diagnosis and treatment.[1] There remains a paucity of data published commenting on pediatric CVD exclusive of Klippel-Trénaunay syndrome and post-thrombotic syndrome. We have previously attempted to define patterns of pediatric venous reflux across patients diagnosed with primary CVD, Klippel-Trénaunay syndrome, and alternative medical diagnoses.[2] Interestingly, we found that despite the presence of venous reflux on duplex ultrasound imaging and signs and symptoms consistent with venous disease, an alternative diagnosis was made in 44% of children. Additional authors have identified a 2.5% incidence of preclinical saphenous reflux in school-age children (10-12 years) without evidence of venous varicosities by clinical examination; these children had a 30% risk for development of truncal varicose veins during follow-up.[3]

Venous duplex ultrasound is much less commonly performed in children than in adults. Parameters that qualify venous insufficiency in pediatric venous reflux studies are currently extrapolated from adult protocols. Traditionally, CVD in children has been diagnosed using standards derived from adult subjects, although it remains uncertain whether these are acceptable parameters for pediatric populations. This study aimed to identify "normal" venous parameters in healthy pediatric controls.

METHODS

Healthy pediatric volunteers aged 5 to 17 years were recruited from the University of Michigan and

From the Department of Surgery, University of Michigan Cardiovascular Center.

Author conflict of interest: none.

Presented at the Twenty-eighth Annual Meeting of the American Venous Forum, Orlando, Fla, February 24-26, 2016.

Correspondence: Dawn M. Coleman, MD, Department of Surgery, University of Michigan Cardiovascular Center, 1500 E Medical Center Dr, Ann Arbor, MI 48109-5867 (e-mail: dawnbarn@umich.edu).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2213-333X

https://doi.org/10.1016/j.jvsv.2017.09.009

surrounding community. Exclusion criteria included a history of autoimmune or inflammatory disease, a recent lower extremity trauma, any arterial or venous disease, a history of lower extremity vascular access, and the inability to stand or to cooperate for the examination.

Comprehensive venous duplex ultrasound scanning (reflux study) was performed in accordance with societal guidelines.[1] Evaluation of reflux in the deep and superficial veins with duplex ultrasound scanning was performed with the patient upright and standing in all cases. The leg being examined was positioned not bearing weight. All deep veins of the proximal leg were examined, including the common femoral, femoral, and popliteal veins. The common femoral vein was specifically interrogated below the saphenofemoral junction. The superficial veins were similarly evaluated at 3- to 5-cm intervals, including the great saphenous vein (GSV), the small saphenous vein, the accessory saphenous veins, and the perforating veins. Compressibility confirmed patency in all cases. Venous flow and augmentation patterns were also assessed. Reflux was elicited by a modified Valsalva maneuver for the common femoral vein or the saphenofemoral junction when the patient's age and cooperation permitted or more commonly by manual compression and release of the limb distal to the point of examination. Reflux time simply quantifies the duration of abnormal flow reversal. A reflux time >500 milliseconds was used to define valvular incompetence of the superficial and perforating veins; a reflux time >1 second was used to define valvular incompetence of the deep venous system (ie, common femoral, femoral, and popliteal veins).

This study was approved by the Investigational Review Board (HUM00102572). Parental consent was obtained for all patients with verbal assent used as appropriate on the basis of age. Nonparametric reflux parameters across patients were compared using Kruskal-Wallis rank sum tests, followed by Dunn post hoc testing (with *P* values further adjusted by the Holm family-wise error rate method). *P* values $< .05$ were considered statistically significant.

RESULTS

Eighteen children including 10 boys and 8 girls were studied. The children were assigned to age groups as follows: 5 to 8 years (n = 5), 9 to 12 years (n = 6), and 13 to 17 years (n = 7). Not surprisingly, GSV diameter at the saphenofemoral junction increased with age (Fig 1). Deep vein valve closure time (VCT) did not differ significantly between groups (430 ± 209.7 cm/ms in the 5- to 8-year group, 559 ± 835.7 cm/ms in the 9- to 12-year group, and 442 ± 504.7 cm/ms in the 13- to 17-year group), whereas GSV VCT was significantly higher in the 9- to 12-year age group (Fig 2).

Incidental venous reflux was identified in three children aged 5 to 8 years, three children aged 9 to 12 years, and four children aged 13 to 17 years, including six boys and four girls in total (Table). All superficial venous reflux was confined to the GSV; the majority of concurrent deep venous reflux occurred in the common femoral vein when present. Reflux, when identified, was present at multiple GSV valve stations in the majority of children (n = 6). There was no significant difference in GSV VCT in comparing children with and without deep venous reflux (mean 1083 ± 538 cm/ms in the absence of deep venous reflux vs 1543 ± 1283 cm/ms in the presence of deep venous reflux; $P = .1971$). Anterior accessory superficial veins were identified in only one child aged 5 to 8 years, three children aged 9 to 12 years, and three children aged 13 to 17 years. Anterior accessory saphenous vein reflux was not encountered in any patient, and only 29% of those with accessory saphenous venous anatomy had evidence of superficial venous (GSV) reflux.

ARTICLE HIGHLIGHTS

- **Type of Research:** Prospective cohort study
- **Take Home Message**: This duplex ultrasound scan study of 18 healthy children between the ages of 5 and 17 years found incidental great saphenous vein incompetence in 60%.
- **Recommendation**: Great saphenous vein incompetence in children occurs frequently in the absence of any manifestation of a clinical disease.

DISCUSSION

Venous duplex ultrasound is much less commonly performed in children than in adults, although the incidence of venous disease across school-age children has previously been estimated as 0.2% to 2.9% and the incidence of physiologic venous reflux described as approximately 13% in children aged 14 to 16 years.[3,4] Venous reflux characterizes CVD and is defined by VCT

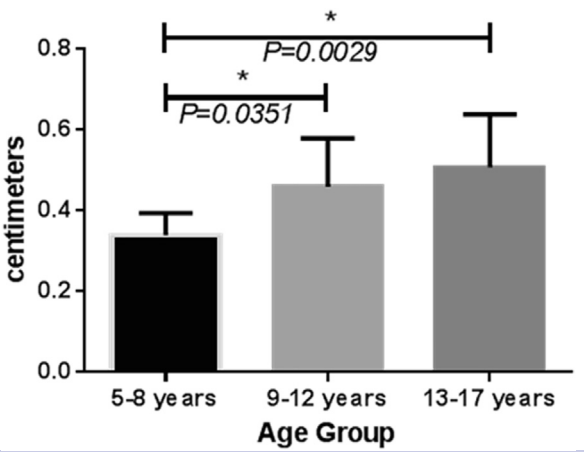

Fig 1. Saphenous vein diameter, at the saphenofemoral junction, increases with age.