CLINICAL STUDY

Arterial Recanalization for Access for Arterial Intervention in Children: Techniques and Outcomes

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ABSTRACT

Purpose: To assess technical success of arterial recanalization in children requiring repeated arterial access and intervention.

Materials and Methods: Over 14 years, 41 attempts to cross 30 arterial occlusions were made in 22 patients (13 male, 9 female). Median patient age was 12 months (15 days–14 years), and weight was 7.6 kg (3.0–77.3 kg). Techniques and outcomes were recorded.

Results: Twenty-five of 41 (61%) attempts at crossing an arterial occlusion were successful. Nineteen of 30 (63%) first attempts to cross occlusions were successful, and 6 of 11 (55%) repeat attempts were successful. The occluded segments were combinations of common femoral artery (n = 4), external iliac artery (n = 36), common iliac artery (n = 11), and aorta (n = 1). Complications occurred in 5 of 41(12%) attempts: 3 minor complications (hematoma, extravasation, and transient leg ischemia) and 2 major complications (rupture and thrombosis).

Conclusions: Arterial access by recanalization of occluded segments is technically feasible in children, with a low complication rate.

ABBREVIATIONS

CFA = common femoral artery, CIA = common iliac artery, EIA = external iliac artery

Repeat arterial access is required in some neonates, such as those with vein of Galen malformations (1), and for older children, such as those with renovascular hypertension (2). Obtaining arterial access is sometimes challenging (3), and access site complications are the most common adverse event after pediatric arteriography (3). Thrombosis is one of these risks; the rate in children is reported to be as high as 8%–10% and up to 16% in children who weigh less than 15 kg (3,4). This may prevent access for subsequent arteriography and intervention unless the resulting arterial occlusion can be recanalized. The purpose of this study was to assess the technical success and associated complication rate of arterial recanalization for immediate arterial access for diagnostic arteriography or endovascular intervention in children.

MATERIALS AND METHODS

This single-center retrospective study was exempted from institutional review board approval. Patients were identified by conducting searches of the interventional radiology database. Inclusion criteria were all consecutive patients, 0–18 years of age, who underwent an attempt at recanalization of a complete arterial occlusion for the purpose of performing diagnostic arteriography or endovascular intervention between 2002 and 2015. There were no exclusion criteria. Data sources included the Radiology Information System, the Picture Archiving Communication System, interventional radiology databases, and electronic patient charts.

Definitions and Criteria

Arterial occlusions were identified by intraprocedural Doppler ultrasound or absent opacification of a segment of artery on arteriography. A procedure was defined as the endovascular treatment for which arterial access was required.

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An attempt was defined as using 1 or more of the techniques described to cross an arterial occlusion on 1 side at a procedure, regardless of technical success. In a single procedure, a patient could have had 1 attempt to cross an occlusion or 2 attempts to cross occlusions (if there were bilateral occlusions). Technical success was defined as the successful passage of a guidewire across the occlusion, enabling completion of the intended arteriography or endovascular intervention. Complications were graded according to the Society of Interventional Radiology classification of complications (5). Occluded segments were analyzed separately.

Technique

The common femoral artery (CFA) distal to the level of occlusion was accessed percutaneously under ultrasound guidance using a micropuncture technique (21-gauge needle and 0.018-inch guidewire). The occlusions were crossed using either a blunt only or a sharp technique depending on operator preference. The blunt technique used forceful advancement of a 0.018-inch nitinol guidewire (Cope Mandril Wire Guide, Cook Medical LLC, Bloomington, Indiana); a 0.018- or 0.035-inch hydrophilic guidewire (Radifocus Guidewire, Terumo, Somerset, New Jersey); or a stiff guidewire (Amplatz Extra-Stiff Wire Guide, Cook Medical LLC) under fluoroscopy and/or ultrasound control with guidewire support provided by a 3- or 4-French vascular dilator (Standard Dilator, Cook Medical LLC) or blunt metal needle (the 15-cm rigid catheter introduction stiffening cannula from an 8.5-French pigtail drain set [Dawson-Muller, Cook Medical, Limerick, Ireland]) or diagnostic 4-French catheter until patent lumen was reached. The sharp technique involved passage of a 21-gauge needle (One-Part Percutaneous Entry Needle, Cook Medical LLC) under ultrasound guidance along the obliterated lumen until patent lumen was reached. After passage of a guidewire, a 4- or 5-French arterial sheath (Performer Introducer, Cook Medical LLC) was placed and the intended procedure was performed. Patients were heparinized (80 units/kg) only if the subsequent procedure required this. All procedures were performed by 1 of 5 pediatric interventional or pediatric neurointerventional radiologists with between 5 and 19 years (mean, 9 years) of experience in their specialty.

Statistical Analysis

Statistical analyses were performed with Microsoft Excel version 15.35 (Microsoft Corporation, Redmond, Washington) using χ^2 square analyses to compare outcomes between first and repeat attempts. P values less than .05 were considered statistically significant. For the proportion of successful attempts and proportion of complications, 95% confidence intervals (CIs) were calculated.

RESULTS

Patient Population

Over 14 years, 2690 arteriograms were performed on patients aged 0 days–20 years (mean, 7.2 years). Forty-one attempts to cross 30 arterial occlusions were made in 22 patients. Characteristics of the patient population and indications for arterial access are summarized in Table 1.

Recanalization Attempts

The 30 occluded segments were combinations of CFA (n = 4), external iliac artery (EIA) (n = 36), common iliac artery (CIA) (n = 11), and aorta (n = 1). Twenty-five of 41 (61%) attempted crossings were performed on the right side. Thirty of 41 (73%) attempts to cross occlusions were first attempts. Median age at first arterial access was 22 days (range, 1 day–4.1 months), and median time from last successful access in the occluded vessel was 5.4 months (range, 7 days–2.8 years).

Eleven of 41 (27%) attempts to cross occlusions were repeat attempts (10 were second attempts, and 1 was a third attempt). Repeat attempts were for repeat arteriography and not due to previous failure. For 20 of 30 (67%) occluded segments, 1 attempt to cross was made; for 9 of 30 (30%) occluded segments, 2 attempts were made; and for 1 of 30 (3%) occluded segment, 3 attempts were made. In the 11 repeat attempts to cross occlusions for arterial access, median time since the previous attempt to cross these segments was 5.7 months (range, 1.8 months–1.2 years).

Outcomes

Twenty-five of 41 attempts to cross occlusions and achieve arterial access were successful, giving a technical success rate (per attempt) of 61.0% (95% CI 46.0%–75.9%). Nineteen of 30 (63%) first attempts to cross occlusions were successful, and 6 of 11 (55%) repeat attempts were successful. This difference was not statistically significant ($P = .88$). Analysis outcome by age is presented in Table 2. Patients older than 3 years and between 1 and 3 years old had a higher success rate than patients younger than 1 year, but the differences were not statistically significant ($P = .41$ and $P = .31$ respectively) (Table 2). In 1 of the successful repeat attempts, the occlusion was crossed with wire and vascular dilator, but a 4-French sheath could not be passed. In this patient, the long vascular dilator was used to perform angiography as guidance for transvenous embolization of a vein of Galen malformation. After the 16 failed attempts, an attempt was made to use the contralateral side in 7 procedures, the left axillary artery was accessed in 5 procedures, and the whole procedure was abandoned in 4 procedures.

A blunt technique was used in 38 of 41 (93%) attempts to cross occluded segments. Of 38 blunt attempts, 24 (63%) were successful. Of 38 blunt attempts, 27 were first attempts, and 18 of these (67%) were successful. All except 1 were retrograde crossings. Three of 41 (7%) attempts to cross occluded segments were made using a sharp technique with a 21-gauge needle under ultrasound guidance. One of 3 (33%) of these sharp recanalization attempts was successful. In addition to recanalization for immediate arterial access, angioplasty was performed in an attempt to preserve vessel patency and make future access easier in 2 of 41 (5%).