Prevention and Treatment of Thrombi after Diagnostic and Interventional Cardiac Catheterization

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Introduction:

Prevention and treatment of thromboembolic events during cardiac catheterizations have become a popular topic to address in pediatric cardiology. The American Heart Association has published a Scientific Statement surrounding anticoagulation management in children with heart disease while centers across the country have rose to the occasion to help prevent and treat these events in a safe and standardized way.

Procedural Recommendations:

AHA Scientific Statement: Prevention and Treatment of Thrombosis in Pediatric and Congenital Heart Disease; Giglia et al 2013

Recommendations for Procedural Anticoagulation in Children Undergoing Cardiac Catheterization

1. Procedural anticoagulation initiated with a UFH bolus of 100 U/kg (up to 5000-U maximum dose) is recommended in children undergoing cardiac catheterization with arterial access (Class I; Level of Evidence B).
2. Monitoring of anticoagulation during cardiac catheterization is recommended with determination of ACTs 1 hour after bolus and every half-hour for longer procedures. Additional 50 to 100 U/kg heparin should be administered to keep the ACT >200 seconds (Class I; Level of Evidence C).
3. Procedural anticoagulation initiated with a bolus of UFH 100 U/kg (up to 5000-U maximum dose) is reasonable in children undergoing cardiac catheterization via only venous access if there is a right-to-left shunt, if the procedure is interventional, or if the procedure is expected to be prolonged (Class IIa; Level of Evidence C).
4. LMWH may be considered for procedural thromboprophylaxis but offers no practical advantages over UFH (Class IIb; Level of Evidence B). Limitations of LMWH during cardiac catheterization are discussed in the text.
5. Procedural thromboprophylaxis with aspirin alone is not recommended (Class III; Level of Evidence B).

To summarize, unfractionated heparin (UFH) bolus is recommended for arterial cases. A UFH bolus is reasonable for venous cases. The heparin can be monitored by ACT (Goal of >200 sec). Aspirin is not recommended for thromboprophylaxis and low molecular weight heparin may be considered but no real practical advantage seen.

The following case studies were used to illustrate anticoagulation practices:
Case 1: Stroke after ASD Closure

Logan was a 3 year old little boy diagnosed with an ASD at birth. He presented for ASD closure in the catheterization lab with an Amplatzer device. Logan had no other medical issues. After closure he was noted to favor his R hand (which had his IV). The next day he was noted to have R facial droop. CT revealed a LMCA Embolic Ischemic Stroke

Recommendations: Giglia et al 2013

Case 2: Vascular Thrombosis

Adeline is 9-year old female with HLHS s/p Fontan, then followed by tricuspid valve repair, tricuspid valve replacement with a porcine valve complicated by complete heart block, s/p pacemaker placement now with newly noted severe single ventricle dysfunction, being presented for heart transplantation.

Pre-transplant CT scan for vessel anatomy showed: Occluded left internal jugular vein, left subclavian, and left innominate vein, and bilateral common iliac veins with the only patent venous access site being the right internal jugular vein and right subclavian vein. Arterial access currently preserved

Discussions were had around initiating chronic anticoagulation prior to transplant and issues surrounding access with a life time of catheterizations and biopsies

Recommendations: Giglia et al 2013

Venous Thrombosis

- 30% of children and adolescents with a history of prior catheterization presented with venous access issues (Celermajer et al.)
- Can limit access to certain structures
- May eliminate heart transplant as an option due to requirement for frequent biopsies
Arterial Thrombosis

- Due to smaller patient body size
- Repeat Caths
- Larger catheter use

Recommendations for the Management of Catheterization-Related Vascular Thrombosis in Children

1. Patients with lower-extremity arterial pulse loss and evidence of limb ischemia after cardiac catheterization should initially be treated with intravenous UFH for at least 12 to 48 hours (Class I; Level of Evidence B). Dosing and length of therapy should be individualized according to degree of perfusion impairment (Class I; Level of Evidence C).

2. Surgical consultation is indicated if limb ischemia persists despite therapeutic heparinization (Class I; Level of Evidence C).

3. It is reasonable to transition to fibrinolytic therapy if limb ischemia persists after therapeutic heparinization (Class IIa; Level of Evidence C). Vascular ultrasound for diagnostic confirmation is reasonable before the initiation of fibrinolytic therapy (Class IIa; Level of Evidence C).

4. Surgical or transcatheter intervention may be considered if thrombolytic therapy is contraindicated or if limb loss is imminent (Class IIb; Level of Evidence C).

Outcomes Using a Clinical Practice Pathway for the Management of Pulse Loss Following Pediatric Cardiac Catheterization

Andrew G. Glantz, MD, MSC, Rachel Keashen, MSN, CPNP-AC, Julie Chang, CRNP, Lisa-Ann Balsama, CVT, Yoav Dor, MD, PhD, Matthew J. Gillespie, MD, Therese M. Giglia, MD, Leslie Raffini, MD, and Jonathan J. Rome, MD
The Children’s Hospital of Philadelphia published their pathway on pulse loss and the use of enoxaparin to aide in treatment and preservation of arterial vessel thrombosis.

**Case 3: Generator Change**

Oliver is a 15 year old boy with a history of repaired Tetrology of Fallot and subsequent atrial arrhythmias. He is on a warfarin regimen chronically for his arrhythmias with a Goal INR of 2-3He was bridged with 1mg/kg BID of enoxaparin 5 days prior to his generator change. Procedure went well and
Oliver transitioned back to warfarin therapy the evening of the procedure. POD 2 Oliver was re-admitted for a **large pocket hematoma**.

Many centers still bridge or interrupt chronic anticoagulation management for system changes. This article by Birnie, et al, published in Circulation, reflects on the safety and efficacy of continuing chronic warfarin rather than bridging with heparin leading to better outcomes and less bleeding events.

Centralized Cardiac Anticoagulation Programs are becoming more and more prevalent in the pediatric community. Boston is the first of its kind to start a pediatric cardiac anticoagulation service. Several others have followed to achieve:

- Safe and effective maintenance of chronic therapy in this complex population
- Experienced recommendations around dosing and management around procedures and acute illness
- High patient satisfaction
- Expand on areas of research and care standardization
Improvement in Time to Therapeutic Range over 5 years at Boston Children’s Hospital


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