

# Distal Femur Flow Dynamics and Catheter Stability Comparative in Juvenile Capria Hircus and Sus Domesticus

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## Introduction

The ability to safely access numerous anatomical locations for intraosseous (IO) access would aid providers of emergency medicine when selecting suitable insertion sites in the emergent care setting. This pilot study was designed to compare flow dynamics and catheter stability of the distal femur and proximal tibia by evaluating the vascular pathways, intramedullary pressure, stability, and comparative human anatomy for the two sites.

## Methods Phase 1

*This study was completed in two (2) phases.*

**Phase 1:** Investigators placed 15 gauge IO catheters in the distal femur and proximal tibia of the right lower extremity of a sedated, ventilated, normotensive juvenile Capria Hircus (goat) weighing 15.2 kg. Using digital fluoroscopy and a timed 10 mL bolus of Hypaque™ 76 (contrast), femoral and tibial IO infusions were administered while simultaneously obtaining fluoroscopic imagery. The images were evaluated by a board-certified radiologist. During fluid administration, continuous manual catheter manipulation of the femur and the tibia was used to comparatively assess catheter stability and evidence of extravasation. *Phase 1 was conducted at The University of Texas Health Science Center, Animal Surgery Facility, San Antonio, USA.*

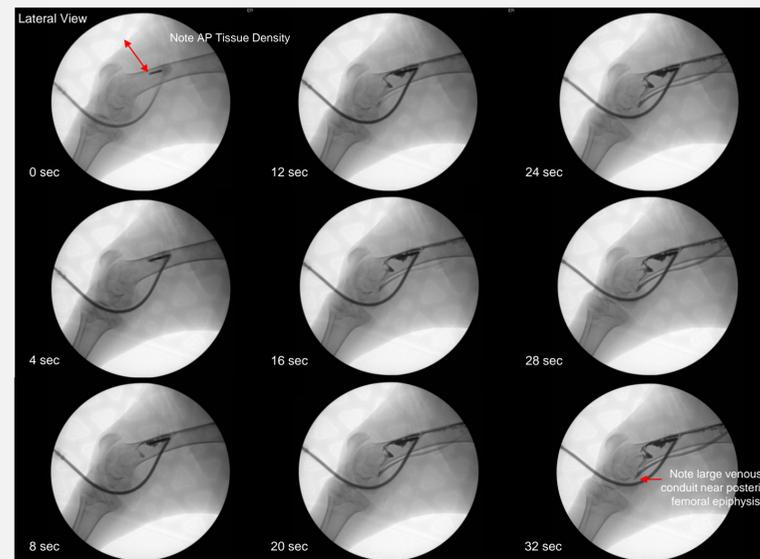
## Methods Phase 2

**Phase 2:** Investigators placed 15 gauge IO catheters in the left distal femur and right proximal tibia of a sedated, ventilated, normotensive juvenile Sus Domesticus (swine) weighing 25.6 kg. Arterial and intraosseous pressures were evaluated using three (3) invasive pressure monitors.

## Methods Phase 2 Continued

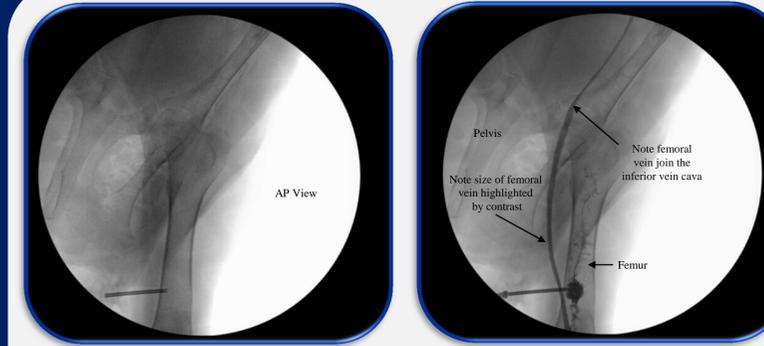
Warm, normal saline (.9% sodium chloride) and a 10 ggt/mL (macro) infusion set with a standard inflatable infuser (pressurized to 300 mmHg) were utilized for the infusions. MIOP (Mean Intraosseous Pressure) was initially recorded and then repeated following a 10 ml syringe flush at each IO site. After the syringe flush and reassessment of MIOP pressures, flow characteristics were evaluated over one (1) and five (5) minute intervals with standard drip calculations used to determine rate. *Phase 2 was conducted at Erasmus Medical Center, Surgical Training Lab, Rotterdam, Netherlands.*

## Phase 1 Fluoroscopy



Phase 1: 15.2 kg Capria Hircus Lateral Right Leg

The traditional IO insertion pathway for the distal femur is commonly considered to be “two (2) cm proximal to the patella, along the anterior midline.” *Note: Study specimen’s anterior muscle structure required a medial approach to achieve placement.*



Phase 1: 15.2 kg Capria Hircus Lateral Left Leg

## Phase 2 MIOP & Flow Dynamics

Time	Distal Femur	Proximal Tibia
<b>DF 1305 / DT 1306</b>	MIOP pre-flush 6 / 4 mmHg HR 89, MAP 89, SaO2 100%	MIOP pre-flush 8 / 2 mmHg
<b>DF 1312 / DT 1313</b>	MIOP post-flush 8 / 4 mmHg	MIOP post-flush 12 / 4 mmHg
<b>DF 1316 / DT 1319</b> <i>infusion accomplished with standard pressure infuser @ 300mm/Hg</i>	Flow rate calculated >2000mL/hour (steady stream)	792mL/hour
<b>DF 1321 / DT 1324</b> <i>infusion accomplished with standard pressure infuser @ 300mm/Hg</i>	Flow rate calculated >2000mL/hour (steady stream)	792mL/hour

Phase 2: 25.6 kg Sus Domesticus Medial Left Distal Femur and Lateral Right Proximal Tibia

## Findings

The proximity, location, and size of the venous pathway suggest that flow from the distal femur may be equivalent, if not superior, to the proximal tibia. On fluoroscopic evaluation, the distal femur was noted to have greater density than the proximal tibia. With manipulation, catheter stability at the distal femur site was subjectively noted to be superior to the proximal tibia.

IO flow characteristics appeared to favor the distal femur when compared to the proximal tibia in these specimens.

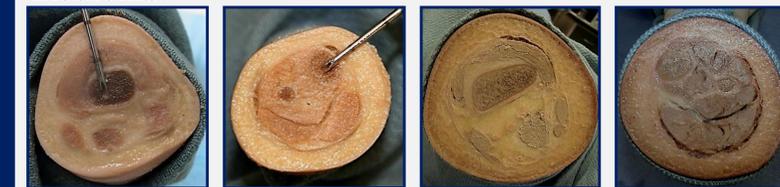
Distal femur MIOP was lower than proximal tibia MIOP (both pre-flush and post-flush), suggesting limited resistance to intramedullary flow.

## Findings Continued

Distal femur flow rates appeared superior (>2000mL/hour {steady stream}) to the proximal tibial flow rates (792mL/hour) in this specimen.

## Human Anatomical Review

Understanding how the study specimens’ anatomy compares to human anatomy represents a clinical challenge. Dissections of two human specimens, a 3.1 kg female and a 17.9 kg male, were completed and comparatively assessed by board certified physicians specializing in pediatrics and emergency medicine.



3.1 Kg Human Female Left Leg      17.9 Kg human Male Right Leg

## Limitations

Non-emergent intraosseous contrast and flow studies on live human pediatric volunteers are not possible. Anatomical differences between humans and animal models should be considered when making conclusions. Due to the selected study specimens, anatomical and structural differences as well as available catheter length, a medial, rather than anterior approach, was utilized to access the distal femur sites.

## Conclusion

In this study and anatomical review, based on the involved vascular pathways and subjective catheter stability assessment, the investigators suspect that the distal femur may present a suitable location for IO catheter placement and infusion. Further study is needed to confirm these findings.