Design & Development of Vascular Anastomosis Simulator(A Review)

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An anatomic, upper extremity arteriovenous model was constructed of tubing focusing on the circulation from the subclavian artery to subclavian vein. Tubing material, length, diameter, and wall thickness were selected to match vessel compliance and morphology. All branch points were constructed at physiologic angles.

The venous system and capillary bed were modeled using tubing and one-way valves and compliance chambers. A glycerin/water solution was created to match blood viscosity. The system was connected to a heart simulator. Pressure waveforms and flows were recorded at multiple sites along the model for the native circulation, brachiocephalic AVF configuration, and the AVF with DR without and with IL (DR no IL and DRIL) casted replicas of distal vascular graft anastomoses created by conventional technique, Millercuff, Taylor- and Linton-patch were fabricated. A pulsatile mock circulation with a high-speed video system was constructed. Flow pattern was determined at mean Reynolds numbers 100–500. Migrations of the stagnation points on the bottom of the anastomoses at mean Reynolds numbers 100, 230, and 350 were measured. a vortex forms during early systole and increases to maximum systole in all anastomoses. During the diastolic phase the vortex moves in the Miller-cuff distally to the toe of the anastomosis and remains standing, while in the other anastomotic types the vortex moves proximally to the heal of the junction and breaks down. The shift of the stagnation point in the Miller-cuff was considerably smaller than in the other anastomoses.

conventional, Linton and Taylor anastomoses show similar flow patterns. The Miller-cuff with its wider cavity shows lower shift of the bottom stagnation point, but a persistent washout of the anastomotic cavity, which may contribute to its reported good clinical performance. A reconstructed patient-specific AVF was investigated, using computational fluid dynamics (CFDs) and particle image velocimetry (PIV). The aim of this study was to validate the methodology from medical images to numerical simulations of an AVF by comparing numerical and experimental data.

Two numerical grids were presented with a refinement difference of a factor of four. A mold of the same volume was created and mounted on an experimental bench with similar boundary conditions.

Keywords-Blood, Anastomosis,vessel, Circulation.

INTRODUCTION

The complications of arteriovenous fistula (AVF)-associated steal with its concurrent surgical treatments have been clinically described but have relatively little published, concrete hemodynamic data. A further understanding of the underlying hemodynamics is necessary to prevent the occurrence of steal and improve treatment when it occurs. Specific objectives are to study the blood flow through an AVF with varying anatomic and physiologic parameters, determine what factors contribute to the development of arterial steal distal to an AVF, and create optimal interventions to treat arterial steal from an AVF when it occurs. The long-term goal is creation of AVF tailored to patient-specific parameters, resulting in higher rates of functional fistulas with decreases in fistula- related complications. The ability to study fluid dynamics using a unique, in vitro, upper extremity pulsatile arteriovenous circulation simulator creates the associated with access-related ischemia is incompletely understood. Distal revascularization and interval ligation (DRIL) is among one of the corrective procedures improving distal ischemia; however, its underlying hemodynamics are unclear. Our goal was to create an in vitro model because of its advantages over expensive, not easily reproducible animal models. (1)In the last 25 years of vascular graft research, it has been widely

confirmed that local haemodynamics play a significant role in the development of intimal hyperplasia. In most locations, the blood flow in the arteries is laminar. However, when there is an abrupt change in the vessel diameter and angle, as at distalend-to-side anastomosis, flow separation, recirculation and flow stagnation occur. In these areas the haemodynamic forces are thought to be correlated with the development of intimal hyperplasia, which is an important cause of late graft failure. Furthermore, the geometrical shape of the bypass configuration mayplay a role in the development and progression of the disease process intimal hyperplasia is reported to occur mainly at the heel and the toe of the anastomosis, on the floor of the artery and at the suture lines.(2)End Stage Renal Disease (ESRD) corresponds to the ultimate loss of the kidneys' ability to perform their main functions, i.e. to eliminate excess fluid and waste material from the blood. The most common treatment (about 1.3 million patients worldwide) is hemodialysis.

1) 12V Diaphragm Pump

A diaphragm pump is a specific type of displacement pump that uses two flexible membranes. The membranes are connected by a central shaft, and create a separation between thecompressed air and the fluid. A centrally located air valve alternately pushes one of the membranes to the side. As a result, one membrane expels fluid, while membrane number two draws new fluid in. The suction is the result of a partial vacuum that is created when the air behind the membrane is pushedinto the atmosphere; when the vacuum occurs, atmospheric pressure pushes the liquid into the empty room. In the next stroke, the process is reversed: one membrane pushes liquid out of the filled chamber, while the empty chamber is filled with the help of atmospheric pressure.A diaphragm pump, also known as a membrane pump, is an air-powered pump that is designed to transport fluids. In this article, we'll explain the working principle of diaphragm pumps, during which we'll pay special attention to ARO diaphragm pumps. As a distributor for this quality brand, part of Ingersoll-Rand, we have a large assortment ARO diaphragm pumps for saleand for rent.

2) Power Supply System

12V power supplies (or 12VDC powersupplies) are one of the most common power supplies in use today. In general, a 12VDC output is obtained from a 120VAC or 240VAC input using a combination of transformers, diodes and transistors. 12V power supplies can be of two types: 12V regulated power supplies, and 12Vunregulated power supplies.12V regulated power supplies come in three styles: Switching regulated AC to DC, Linear regulated AC to DC, and Switching regulated DC to DC.
Switching regulated 12VDC power supplies, sometimes referred to as SMPS power supplies, switchers, or switched mode power supplies, regulate the 12VDC output voltageusing a complex high frequency switching technique that employs pulse width modulation and feedback. Acopian switching regulated power supplies also employ extensive EMI filtering and shielding to attenuate both common and differential mode noise conducted to the lineand load. Galvanic isolation is standard in our 12VDC switchers, affording our users input to output and output to ground isolation for maximum versatility. Acopian switching regulated power supplies are highly efficient, small and lightweight, and are available in both AC-DC single and wide-adjust output and DC-DC configurations. Our Low Profile wide adjust output switchers can be voltage or current regulated and are externally programmable.

3) Water Flow Sensor

We use a water flow sensor to measure the water flow rate. The water flow rate is the volume of fluid that passes per unit time. People often use water flow sensor for automatic water heater control, DIY coffee machines, water vending machines, etc.There are a variety of flow sensors of different principles, but for makers using Arduino or Raspberry Pi, the most common flow sensor is based on a Hall device. For example, the most classic water flow sensor YF-S402and YF-S201 rely on Hall sensors. It's quite simple inside. The main components are the Hall Effect sensor, turbine wheel, and magnet. The water flows in through the inlet and out through the outlet. The water current drove the wheel to turn, and the magnet on the wheel turned with it. Magnetic field rotation triggers the Hall sensor, which outputs high and low level square waves (pulse).

4) Aurdino Board UNO R3 SM & It's Components

Power USB

Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection (1).

Power (Barrel Jack)

Arduino boards can be powered directly from the AC mains power supply by connecting it to the Barrel Jack (2).

Voltage Regulator

The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements.

Crystal Oscillator

The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate time? The answer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz.

Arduino Reset

You can reset your Arduino board, i.e., start your program from the beginning. You can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET (5).

PROBLEM STATEMENT

As we know that medical interns are notallowed to do experiments directly on humans. So the main purpose of creatingthis project is to understand the blood flow pattern in human hand. This project will be completely used for studying purpose. We created this project to make the study ofblood flow easier so we created an artificial vein system for human hand To give theknowledge about pulsatile flow as well as steady flow and their differences To make the study of human hand easier

LITERATURE SURVEY

1) Nicole Varble, MS,a Steven Day, PhD,aDaniel Phillips, PhD,b Doran Mix, BS,c Karl Schwarz, MD,d Karl A. Illig, MD,e and Ankur Chandra, MD (Received 26 February 2013, Accepted 23 April 2013, Available online 9 July 2013)

In this research paper we have studied flow rate of the blood per min average atomic compliance of arteries, different sizes of veins ,samples of tubings, comparision ofhuman blood and the fluid viscosity that we are using in our project, approximate viscosity of human blood, Types of pulse pressure and here we have also studied about tygon tubing, latex tubing as well as polyurethane tubing.

2) N. Noori1, R. Scherer1, K. Perktold2, M. Czerny1, G. Karner2, W. Trubel†1, P. Polterauer1 and H. Schima1.(Accepted 23 November 1998, Available online 25 May 2002.)

In this research paper we have studied Flow pattern of blood according to Reynold's no, types of blood flow Steady, Laminar, Pulsatile, Percentage of glycerol and Distilled water solution to create blood type liquid, viscosity of liquid diameter of graft,pump used for pulsatile flow(ie, Piston Pump or vivitro superpump) steps of vortex forming, & we have also studied about the graft that shows the vortex forming in early systole

3) M. Czerny1, G. Karner2, W. Trubel†1, P. Polterauer1 and H. SchimaZaher Kharboutlya, Valerie Deplano b, Eric Bertrandb. (Received 3 May 2009, Revised 21 October 2009, Accepted 22 October 2009, Available online 4 December 2009.)

In this research paper we have studied that when kidneys did not perform their function ie, to eliminate excess fluid & waste material from the blood here hemodialysis isused as treatment, and deeper information about steps of hemodialysis, average blood flow rate, different vessel wall thicknesses, different diameter of arteries.

4) Cecile LegallaisC K Chong, C S Rowe, S Sivanesan, A Rattray, R A Black, A P Shortland and T V How.(Received 3 June 2020, Accepted 16 July 2020, Available online 23 July 2020, Version of Record 13 August 2020.)

In this research paper we have studied advantages and disadvantages of non living and living models,

Different types of pumps for generating steady and pulsatile flow battery specifications for power supply,information about the surgical dopler system to verify the arterial flow and frequency of pulsatile flow.

5) Federico Carlos Gallardo1, Jorge Luis Bustamante1,2, Clara Martin1, Cristian Marcelo Orellana1 , Mauricio Rojas Caviglia1 , Guillermo Garcia Oriola3, Agustin Ignacio Diaz1, Pablo Augusto Rubino1, Vicent Quilis Quesada.(Date Added to IEEE *Xplore*: 14 March 2005)
In this research paper we have studied about the diameter of radial artery and cephalic vein micture of Nacl and glycerol to create blood type liquid containing blood viscosity properties, information about laser dopler anemometer, material used for tubings information about two channel ultrasound flow meter to set the flow ratio and finally we found that the flow patterns in pulsatile flow were very similar to those in steady flow.

CONCLUSION

The model makes the study of human hand easier, Physical model helps to understand the concept quickly Through the construction and validation of an in vitro, pulsatile arteriovenous model, the intricate hemodynamics of AVF and treatments for ischemic steal can be studied. Thefindings of the AVF as a pressure sink and the relative role of IL with DR bypass has allowed this model to provide hemodynamic insight difficult or impossible to obtain in animal or human models. We observed: (1) the DR with orwithout IL maintains AVF flow rates unchanged from the native state; and (2) the DR bypass can be performed without IL to promote a higher flow rate through the bypass at a smaller sacrifice to distal flow and pressure. Further study of these phenomena with thismodel shouldallow for more effective AVF placement Up to 30% of hospital admissions for hemodialysis patients are related to vascular access complications and failure. Significant outpatient resources, including vascular access monitoring and diagnostic radiology are used to maintain the patency of the access [26]. It is thus of prime importance to provide reliable tools for nephrologists and physicians to help them better understand fluid dynamics in these specific vessels. As illustrated in the present paper and inother works, appropriate CFD should be of help for the clinicians to visualize the complex flow path occurring in the venous part of the AVF and to quantify velocity and shear as match-up criteria, we compared qualitatively the velocity vectors and quantitatively the velocity profiles acquired by both PIV and CFD. Since exact geometry was used in both, the challenges were to reproduce exact mold geometry, control the boundary condition set-up and correctly register the corresponding planes and lines. The PIV/CFD comparison allowed us to set-up an adequate numerical model. The complex flow characteristics were closely observed. This comparison increased the confidence levels of the consecutive physiopathological analysis. In the previous sections we particularized complex non-uniform hemodynamic flow in the AVF. Velocity vector cartography in both planes demonstrated a number of axial separation flows. They were of particular importance since they affected physical processes such as pressureand energy loss. Further analysis of their effect on AVF is now required on other fistula cases.

REFERENCE

Nicole Varble, MS,a Steven Day, PhD,a Daniel Phillips, PhD,b Doran Mix, BS,c Karl Schwarz, MD,d Karl A. Illig, MD,e and Ankur Chandra, MD (Received 26 February 2013, Accepted 23 April 2013, Available online 9 July 2013)
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