A Dissertation on

A PROSPECTIVE RANDOMIZED COMPARATIVE STUDY OF USG GUIDED RADIAL ARTERY CANNULATION BY LONG AXIS AND MODIFIED SHORT AXIS TECHNIQUE

submitted to

TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

In partial fulfillment of the requirements

For the award of the degree

M.D. (Branch-X)

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GOVERNMENT STANLEY MEDICAL

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MAY 2018

DECLARATION BY THE CANDIDATE

I, **Dr. AISHVARYA SHREE N,** solemnly declare that the dissertation, titled **'A PROSPECTIVE RANDOMIZED COMPARATIVE STUDY OF USG GUIDED RADIAL ARTERY CANNULATION BY LONG AXIS AND MODIFIED SHORT AXIS TECHNIQUE'**, is a bonafide work done by me during the period of AUGUST 2017 to SEPTEMBER 2017 at Government Stanley Medical College and Hospital, Chennai under the expert guidance of **Prof. Dr. SEVAGAMOORTHY, M.D., D.A.**, Professor, Department Of Anaesthesiology, Government Stanley Medical College & Hospital, Chennai.

This dissertation is submitted to The Tamil Nadu Dr. M.G.R. Medical University in partial fulfillment of the rules and regulations for the M.D. degree examinations in Anaesthesiology to be held in May 2018.

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This is to certify that the dissertation titled, **'A PROSPECTIVE RANDOMIZED COMPARATIVE STUDY OF USG GUIDED RADIAL ARTERY CANNULATION BY LONG AXIS AND MODIFIED SHORT AXIS TECHNIQUE'**, is a genuine work done under my supervision and guidance, by **Dr. AISHVARYA SHREE N,** for the partial fulfillment of the requirements for M.D. (Anaesthesiology) Examination of The Tamil Nadu Dr. M.G.R. Medical University to be held in May 2018

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This is to certify that the dissertation titled, **'A PROSPECTIVE RANDOMIZED COMPARATIVE STUDY OF USG GUIDED RADIAL ARTERY CANNULATION BY LONG AXIS AND MODIFIED SHORT AXIS TECHNIQUE',** presented herein by **Dr.AISHVARYA SHREE N,** is an original work done in the Department of Anaesthesiology, Government Stanley Medical College and Hospital, Chennai in partial fulfillment of regulations of the Tamil Nadu Dr. M.G.R. Medical University for the award of degree of M.D. (Anaesthesiology) Branch X, under the supervision and guidance of **Prof. Dr.SEVAGAMOORTHY, M.D., D.A.**, during the academic period 2015-2018.

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CONTENTS

INTRODUCTION

Intra-arterial blood pressure (IABP) measurement is often considered to be the gold standard for blood pressure measurement. Percutaneous radial artery cannulation is a procedure done commonly in operating room and in the intensive care units. Thus a thorough understanding of the relevant anatomy, procedural skills and the complications of the procedure is essential.

The first recorded arterial cannulation was performed in 1714 by the reverend, Stephen Hales. Continuous recording of arterial blood pressure during the perioperative period with small plastic catheters was first described in 1949 by Peterson et all. He inserted them into the brachial artery through a metal needle. In 1953, the Swedish radiologist Sven Seldinger described the now used catheter over guide wire technique.

Radial artery is most commonly chosen for arterial cannulation for its ease of access and high success rate. Any failure during cannulation requires multiple attempts but this may cause arterial spasm making any further attempt difficult.

Thus ultrasound imaging is a simple non-invasive technique to provide a more accurate assessment and localization of area of interest. With more compact and portable modern machines better resolution and enhanced tissue penetration for identification and desired intervention is available.

The ultrasound guidance for radial artery cannulation had been shown to increase the rate of cannula insertion success in the first attempt thus reducing complications.

AIM AMD OBJECTIVES

The aim of this study is to compare the traditional long axis approach with the modified short axis approach for radial

artery cannulation.

PRIMARY OBJECTIVES

1. success of First insertion attempt
2. Cannulation time

SECONDARY OBJECTIVES

1.ultrasonic location time

2 . Number of attempts

3 .Number of redirections

4 . complications- Hematoma, vasospasm and posterior wall puncture

GENERAL PRINCIPLS INVOLVED IN ARTERIAL PRESSURE MONITORING

The measurement of arterial pressure waveform is to be done in ascending aorta. The measurement in peripheral arteries differs from central aorta. The systolic pressure in the dorsalis pedis artery is higher than in the radial artery ,which is in turn higher than that in the aorta[1]. The pulse waveform gets distorted like the disappearance of certain high frequency components that is the dicrotic notch. There is also increase in the systolic peak pressure, decrease of the lowest diastolic pressure (fig:1). This modification of the waveform is caused by the change in diameter of the vessels and their elasticity and also because of the

Reflection of the wave pattern from the vessel walls.

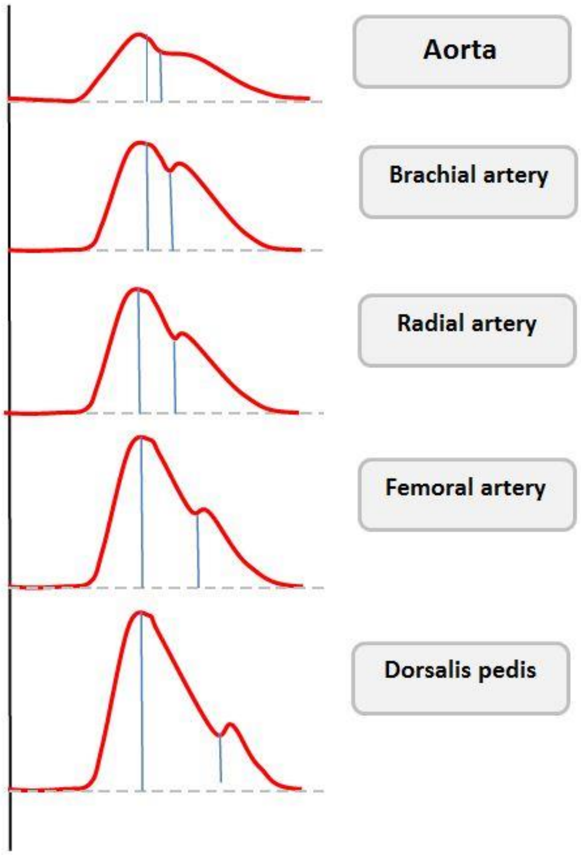


fig:1 variations in arterial wave contour from central to peripheral arteries

COMPONENTS OF AN IABP MESURING SYSTEM

When the artery is cannulated a direct measurement of blood pressure can be obtained with the help of an infusion system, transducer and recorder.

Intra-arterial cannula:

The arterial system is accessed using a short, narrow, parallel sided cannula made of polyurethane or Teflon™ to reduce the risk of arterial thrombus formation. Although non-ported venous cannulas can be used, (non-ported to reduce the risk of inadvertent injection) there are a number of specially designed arterial cannulas available. The risk of arterial thrombus formation is directly proportional to the diameter of the cannula, hence small-diameter cannulas are used (20-22g), however, this may increase damping in the system. The radial artery is the most commonly used site of insertion as it usually has a good collateral circulation and is easily accessible.

Fluid filled tubing:

This is attached to the arterial cannula, and provides a column of non-compressible, bubble free fluid between the arterial blood and the pressure transducer for hydraulic coupling. Ideally, the tubing should be short, wide and non-compliant (stiff) to reduce damping – extra 3-way taps and unnecessary lengths of tubing should be avoided where possible. This tubing should be colour coded or clearly labelled to assist easy recognition and reduce the risk of intra-arterial injection of drugs. A 3-way tap is incorporated to allow the system to be zeroed and blood samples to be taken.

Transducer:

Fluid in the tubing is in direct contact with a flexible diaphragm, which in turn moves strain gauges in the pressure transducer, converting the pressure waveform into an electrical signal.

Infusion/flushing system:

A bag of either plain 0.9% saline or heparinised 0.9% saline is pressurised to 300mmHg and attached to the fluid filled tubing via a flush system. This allows a slow infusion of fluid at a rate of about 2-4ml/hour to maintain the patency of the cannula. A flush system will also allow a high-pressure flush of fluid through the system in order to check the damping and natural frequency of the system and to keep the tubing clear.

Signal processor, amplifier and display :

The pressure transducer relays its electrical signal via a cable to a microprocessor where it is filtered, amplified, analysed and displayed on a screen as a waveform of pressure vs. time. Beat to beat blood pressure can be seen and further analysis of the pressure waveform can be made, either clinically, looking at the characteristic shape of the waveform, or with more complex systems, using the shape of the waveform to calculate cardiac output and other cardiovascular parameters.

Fig:2 transducer

PHYSICAL PRINCIPLES INVOLVED:

Sinewave:

A wave is a disturbance that travels through a medium, transferring energy but not matter. One of the simplest waveforms is the sine wave (fig:3) . These may be thought of as the path of a point travelling round a circle at a constant speed and are defined by the function y = sin x.

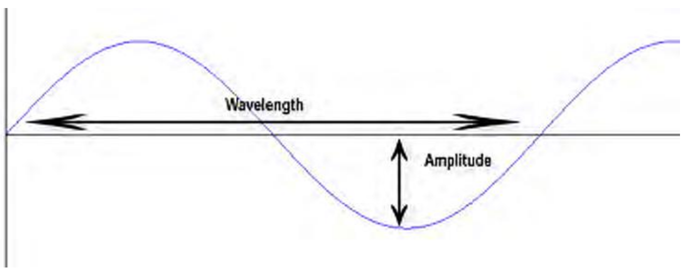


Fig:3 A sine wave

Sine waves may be described in terms of their *amplitude* – their maximal displacement from zero, their *frequency* which is the number of cycles per second (expressed as Hertz or Hz), their *wavelength*, which is the distance between two points on the wave which have the same value (e.g. two crests or troughs) and their *phase*, which is the displacement of one wave as compared with another – expressed as degrees from 0 to 360.

Sine waves are of particular importance as any waveform may be produced by combining together sine waves of differing frequency, amplitude and phase. Another way of looking at this is that any complex wave can be broken down into a number of different sine waves.

Fourier Analysis :

The arterial waveform is clearly not a simple sine wave , but it can be broken down into a series of many component sine waves. The arterial pressure wave consists of a fundamental wave (the pulse rate) and a series of harmonic waves. These are smaller waves whose frequencies are multiples of the fundamental frequency (fig 4).

The process of analyzing a complex waveform in terms of its constituent sine waves is called Fourier Analysis. In the IABP system, the complex waveform is broken down by a microprocessor into its component sine waves, then reconstructed from the fundamental and eight or more harmonic waves of higher frequency to give an accurate representation of the original waveform.

The IABP system must be able to transmit and detect the high frequency components of the arterial waveform (at least 24Hz) in order to represent the arterial pressure wave precisely. This is important when considering the natural frequency of the system.

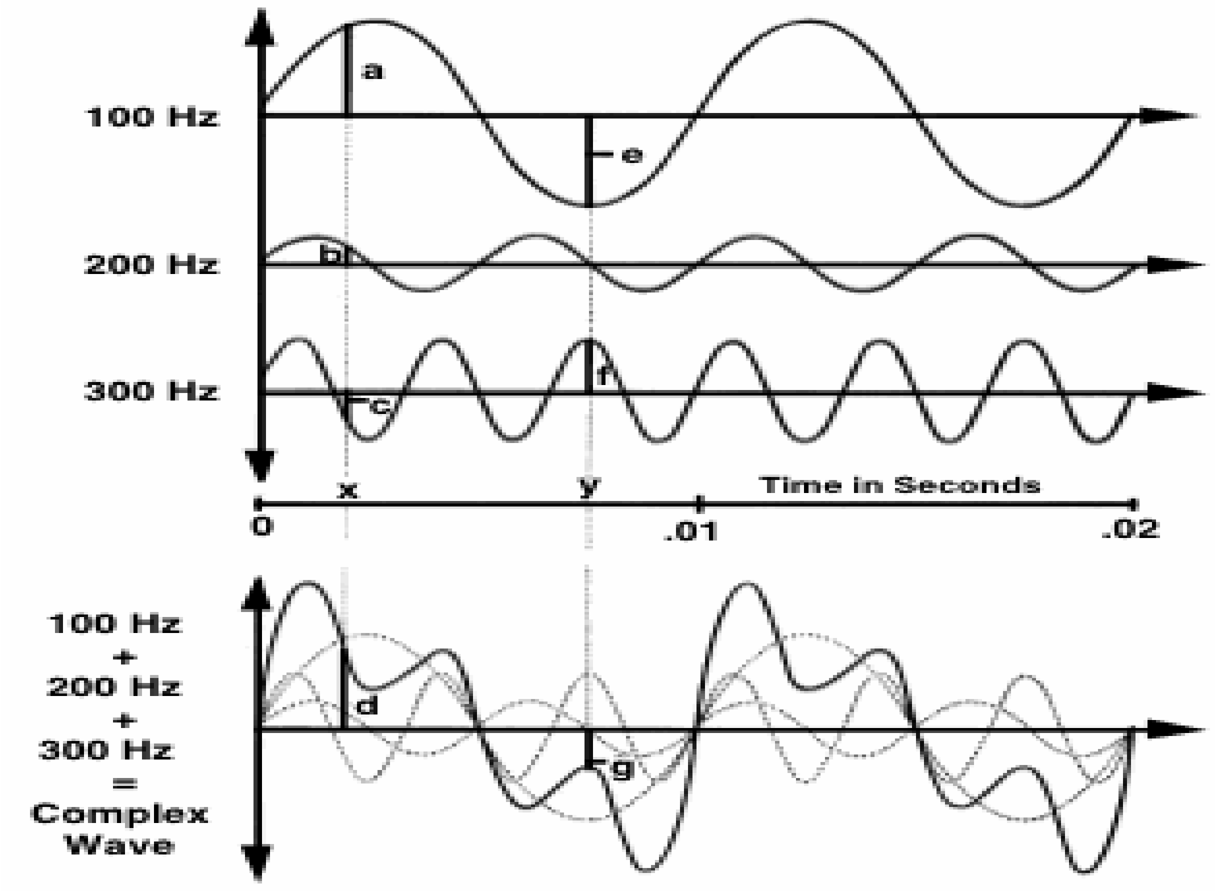


Fig:4 fourier analysis

NATURAL FREQUENCY AND RESONANCE

Every material has a frequency at which it oscillates freely. This is called its *natural frequency*. If a force with a similar frequency to the natural frequency is applied to a system, it will begin to oscillate at its maximum amplitude. This phenomenon is known as *resonance.*

Resonant systems may be very useful. The basilar membrane in the cochlear of the ear is an example of a biological system that works on the principles of natural frequency and resonance. The basilar membrane at the apex of the cochlear has a lower natural frequency than at the base. Sound waves with lower frequencies will therefore cause the basilar membrane to resonate and oscillate maximally at the base of the cochlear, whilst high frequency sound waves will cause the basilar membrane at the base of the cochlear to resonate, allowing the ear to differentiate between sounds of different pitch. However, resonant systems may also be very destructive.

In1850, a suspension bridge in France collapsed when soldiers marching across it in time with the natural frequency of the bridge caused it to resonate. The bridge began to oscillate, swinging wildly as the marching continued until eventually it collapsed.

If the natural frequency of an IABP measuring system lies close to the frequency of any of the sine wave components of the arterial waveform, then the system will resonate, causing excessive amplification, and distortion of the signal. In this case, an erroneously wide pulse pressure and elevated systolic blood pressure would result. It is thus important that the IABP system has a very high natural frequency – at least eight times the fundamental frequency of the arterial waveform (the pulse rate). Therefore, for a system to remain accurate at heart rates of up to 180bpm, its natural frequency must be at least: (180bpm x 8) / 60secs = 24Hz.

The natural frequency of a system is determined by the properties of its components. It may be increased by:

- Reducing the length of the cannula or tubing
- Reducing the compliance of the cannula or diaphragm
- Reducing the density of the fluid used in the tubing
- Increasing the diameter of the cannula or tubing

Most commercially available systems have a natural frequency of around 200Hz but this is reduced by the addition of three-way taps, bubbles, clots and additional lengths of tubing.

The natural frequency of a system may be measured in the clinical setting using the ‘fast flush’ test(fig:5). The system is flushed with high-pressure saline via the flush system. This generates an undershoot and overshoot of waves, resonating at the natural frequency of the system. This frequency may be calculated by dividing the paper or screen speed by the wavelength.

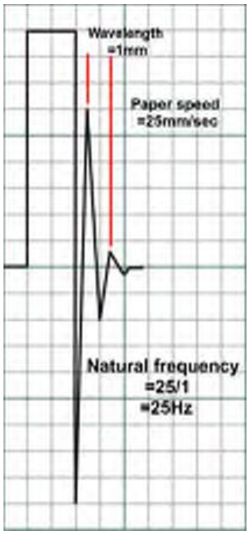


Fig:5 Finding out the natural frequency by a fast flush test

Transducer:

A transducer is any device that converts energy from one form into another and are usually used for measurement or monitoring.

Pressure transducers are used in IABP systems. These convert the arterial pressure waveform into an electrical signal that can then be measured, processed and displayed.

The arterial pulse pressure is transmitted via the column of fluid in the tubing to a flexible diaphragm, displacing it. This displacement can then be measured in a number of different ways. The commonest method is with a *strain gauge*. Strain gauges are based on the principle that the electrical resistance of wire or silicone increases with increasing stretch. The flexible diagram is attached to wire or silicone strain gauges and then incorporated into a Wheatstone bridge circuit in such a way that with movement of the diaphragm the gauges are stretched or compressed, altering their resistance.

Strain gauges have now evolved into such tiny devices that they can be used within cannula tips – such as in some ICP monitors. These systems are, however, prone to fibrin deposition and baseline drift. They cannot be calibrated after insertion and so become less accurate with time.

The Wheatstone Bridge:

The Wheatstone bridge is a circuit designed to measure unknown electrical resistance. Classically, these were arranged with three resistors of known resistance and one of variable resistance (the strain gauge). When the ratio of the resistors on the known side of the circuit (R2/R1) equals the ratio on the other side of the circuit (R3/Rx) the bridge is balanced, no current will flow and no potential difference will be measured by the galvanometer (VG). When the resistance of the strain gauge (Rx) changes due to pressure applied to the attached diaphragm, the two sides of the bridge become unbalanced and a current flows. The resulting potential difference is measured by the galvanometer and is proportional to the magnitude of the pressure applied.

Newer Wheatstone bridge setups use strain gauges in all four positions. The diaphragm is attached in such a way that when pressure is applied to it, gauges on one side of the Wheatstone bridge become compressed, reducing their resistance, whilst the gauges on the other side are stretched, increasing their resistance. The bridge then becomes unbalanced and the potential difference generated is proportional to the pressure applied. This setup of four strain gauges has the advantage that it is four times more sensitive than a single gauge Wheatstone bridge (fig 6). It also compensates for any temperature change as all of the strain gauges are affected equally (temperature will affect the resistance of a strain gauge so in the single gauge setup, a change in temperature will skew readings).

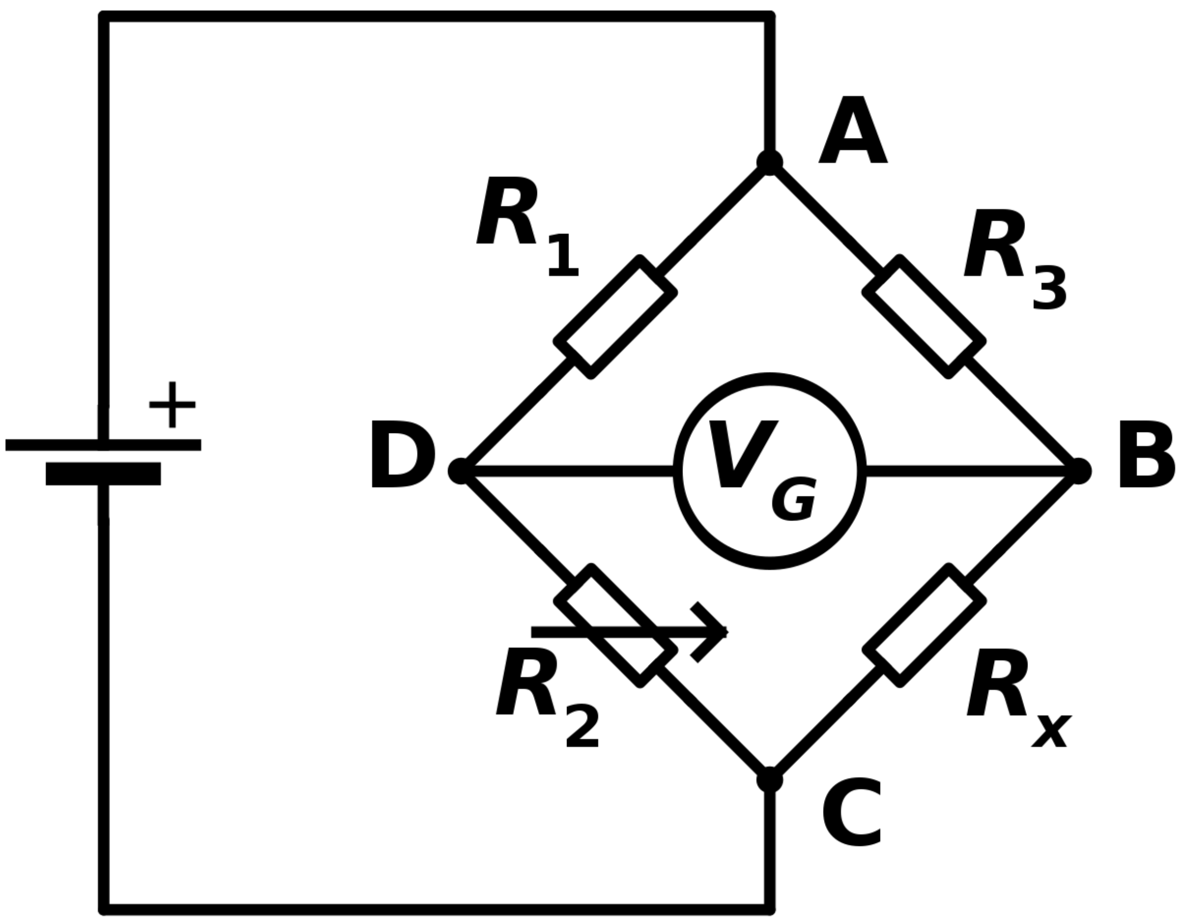


Fig:6 The wheatstone bridge

Damping :

Anything that reduces energy in an oscillating system will reduce the amplitude of the oscillations. This is termed damping. Some degree of damping is required in all systems (critical damping), but if excessive (overdamping) or insufficient (underdamping) the output will be adversely effected (fig 7). In an IABP measuring system, most damping is from friction in the fluid pathway. There are however, a number of other factors that will cause overdamping including:

- Three way taps
- Bubbles and clots
- Vasospasm
- Narrow, long or compliant tubing
- Kinks in the cannula or tubing

These may be a major source of error, causing an under-reading of systolic blood pressure (SBP) and overreading of diastolic blood pressure (DBP) although the mean blood pressure is relatively unaffected. In an underdamped system, one sees an overshoot of the pressure waves – with excessively high SBP and low DBP, as in a resonant signal. A compromise between over and under-damping must be therefore be found.

If a brief burst of energy is applied to a critically damped system, for example quickly flushing an IABP system, after displacement, the wave returns to the baseline, without any overshoot. Critical damping is therefore defined as the minimal amount of damping required to prevent any overshoot. The damping co-efficient in a critically damped system is 1. However, this does result in a system that is relatively slow to respond.

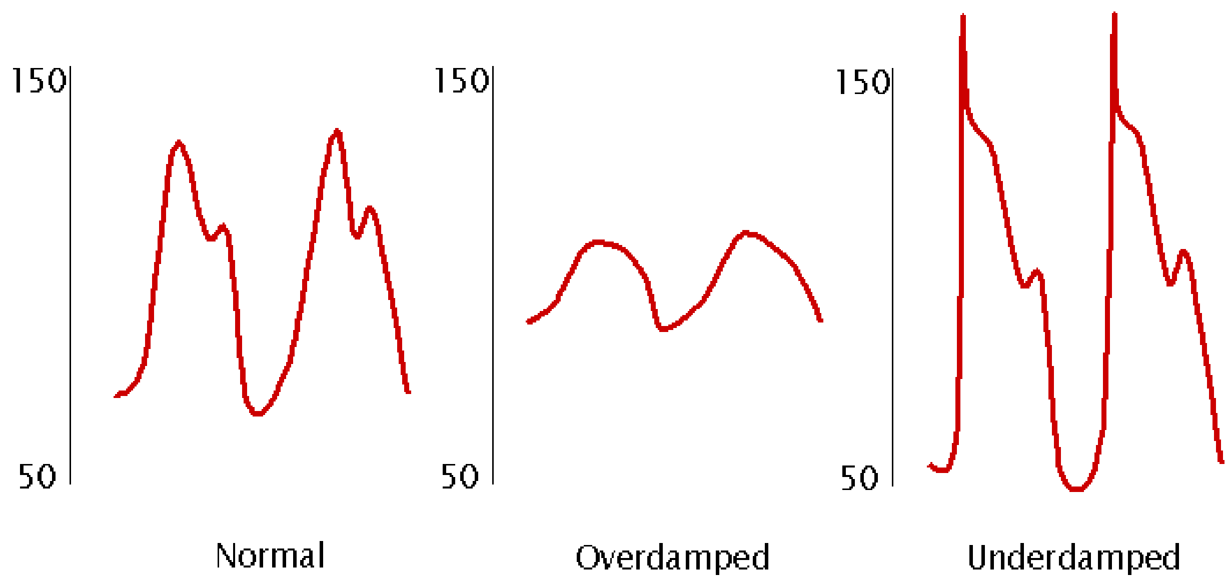


Fig:7 effects of damping on the pulse wave contour

Levelling and zeroing:

Zeroing:

For a pressure transducer to read accurately, atmospheric pressure must be discounted from the pressure measurement. This is done by exposing the transducer to atmospheric pressure and calibrating the pressure reading to zero. Note that at this point, the level of the transducer is not important. A transducer should be zeroed several times per day to eliminate any baseline drift.

Levelling:

The pressure transducer must be set at the appropriate level in relation to the patient in order to measure blood pressure correctly. This is usually taken to be level with the patient's heart, at the 4^{th} intercostal space, in the mid-axillary line. Failure to do this results in an error due to hydrostatic pressure (the pressure exerted by a column of fluid – in this case, blood) being measured in addition to blood pressure. This can be significant – every 10cm error in levelling will result in a 7.4mmHg error in the pressure measured; a transducer too low over reads, a transducer too high under reads.

PRINCIPLES INVOLVED IN THE ULTRASONOGRAM:

Ultrasound waves are generated by piezoelectric crystals in the handheld probe. These crystals generate an electrical current when a mechanical stress is applied to them. This is called the piezoelectric effect. The ultrasound probe acts as both a transmitter and receiver . The probe cycles between generating ultrasound waves 1% of the time and “listening” for the return of ultrasound waves or “echoes” 99% of the time. Using the piezoelectric effect, the piezoelectric crystals in the handheld probe convert the mechanical energy of the returning echoes into an electrical current, which is processed by the machine to produce a two-dimensional grayscale image that is seen on the screen. The image on the screen can range from black to white. The greater the energy from the returning echoes from an area, the whiter the image will appear.

Hyperechoic areas have a great amount of energy from returning echoes and are seen as white. Hypoechoic areas have less energy from returning echoes and are seen as gray. Anechoic areas without returning echoes are seen as black

Acoustic impedance is the resistance to the passage of ultrasound waves, the greater the acoustic impedance, the more resistant that tissue is to the passage of ultrasound waves. The greatest reflection of echoes back to the probe comes from interfaces of tissues with the greatest difference in acoustic impedance.

The ultrasound transducer:

Ultrasound transducers, can be categorized based on their frequency range, low frequency vs. high frequency, and the shape of the probe, curved vs. linear. The high-frequency probes are linear array probes(fig 8). They have less tissue penetration but good near-field image resolution. low-frequency probes. Low-frequency probes are curved array .

Fig: 8 different types of Ultrasound transducers

The ultrasound machine controls:

Depth :

The depth of tissue imaged can be adjusted on the machine. Low-frequency probes will be able to image deeper tissue depths than high-frequency probes. With a linear array probe, as the depth is increased, the image on the screen will appear narrower and structures will appear smaller, but the width of the field of view is relatively constant.

Frequency:

Variable-frequency probes allow changes in frequency within a narrow range. An 8 to 13 MHz probe allows selection of frequency between 8 and 13 MHz. The lower frequencies are used for deeper structures and the higher frequencies are used for more superficial structures.

Gain:

Ultrasound probes transmit ultrasound waves 1% of the time and spend the remaining 99% of the time listening for the returning echoes. Increasing the gain, increases signal amplification of the returning ultrasound waves. Returning ultrasound waves are referred to as “signal” while background artifact is referred to as “noise”. Increasing the gain, increases the signal-to-noise ratio. However, if the gain is increased too much, the screen will have a “white out” appearance and all useful information is lost.

Time gain compensation (TGC):

This allows selective control of gain at different depths. Ultrasound waves returning from deeper structures have undergone greater attenuation. To compensate for the loss of signal intensity, TGC allows for stepwise increase in gain to compensate for greater attenuation of ultrasound waves returning from deeper structures. Time gain compensation controls should be moved to the right in a stepwise fashion to "amplify" the returning signal from the deeper structures.

Color-flow Doppler:

Color-flow Doppler allows for detection of flow within vascular structures. Moving objects, such as red blood cells (RBCs), affect returning ultrasound waves differently than stationary objects. Color-flow Doppler can differentiate between RBCs moving away from the probe and RBCs moving towards the probe. Red blood cells moving towards the probe will return ultrasound waves at a higher frequency and are displayed as red, RBCs moving away from the probe will return ultrasound waves at a lower frequency and are displayed as blue . By changing the angle of the probe to the skin, the flow can be seen as either red or blue. When the probe is perpendicular to the skin, detection of flow is difficult . Therefore, the color displayed is not a reliable indicator of arterial vs. venous flow.

The more parallel the probe is to the direction of flow, the easier it is for the ultrasound machine to detect flow.

Pulse-wave Doppler:

Pulse-wave Doppler provides flow data from a small area along the ultrasound beam. The area to be sampled can be selected by the operator. Once pulse-wave Doppler is selected, the image is frozen and the operator selects the area to be sampled. The pulse-wave information is displayed graphically at the bottom of the screen as well as heard.

Resolution:

Resolution is the ability to distinguish two close objects as separate and this is very important in ultrasound. There are two types of resolution – axial and lateral.

Axial resolution:

Axial resolution is the ability to distinguish two objects that lie in a plane parallel to the direction of the ultrasound beam. Axial resolution is equal to half of the pulse length. Higher frequency probes have shorter pulse lengths, which allows for better axial resolution. The ultrasound probe emits ultrasound waves in pulses, not continuously. These pulses of ultrasound waves are emitted intermittently as the probe has to wait and listen for the returning echoes.

Pulse: a few sound waves of similar frequency.

Pulse length: the distance a pulse travels.

Pulse repetition frequency: the rate at which pulses are emitted per unit of time.

Lateral resolution:

Lateral resolution is the ability to distinguish two objects that lie in a plane perpendicular to the direction of the ultrasound beam. Lateral resolution is related to the ultrasound beam width. The more narrow (focused) the ultrasound beam width, the greater the lateral resolution. Higher frequency probes have narrower beam widths, which allows for better lateral resolution. Poor lateral resolution means that two objects lying side by side may be seen as one object. The position of the narrowest part of the beam can be adjusted by changing the focal zone. The near field is the non-diverging part of the ultrasound beam and as the name suggests is close to the ultrasound probe. The far field is the diverging portion of the ultrasound beam that is farther away from the transducer. The focal zone is the narrowest.

Artifacts:

Reverberation artifact:

The processing unit in the ultrasound machine assumes echoes return directly to the processor from the point of reflection. Depth is calculated as D¼VT, where V is the speed of sound in biological tissue and assumed to be 1,540 m/sec, and T is time. In a reverberation artifact, the ultrasound waves bounce back and forth between two interfaces (in this case the lumen of the needle) before returning to the transducer. Since velocity is assumed to be constant at 1,540 m/sec by the processor, the delay in the return of these echoes is interpreted as another structure deep to the needle and hence the multiple hyperechoic lines beneath the block needle.

Mirror artifact:

A mirror artifact is a type of reverberation artifact. The ultrasound waves bounce back and forth in the lumen of a large vessel (subclavian artery). The delay in time of returning waves to the processor is interpreted by the machine as another vessel distal to the actual vessel.

Bayonet artifact:

The processor assumes that the ultrasound waves travel at 1,540 m/sec through biological tissue. However, we know that there are slight differences in the speed of ultrasound through different biological tissues. The delay in return of echoes from tissue that has slower transmission speed, coupled with the processor's assumption that the speed of ultrasound is constant, causes the processor to interpret these later returning echoes from the tip of the needle traveling in tissue with slower transmission speed as being from a deeper structure and thus giving a bayoneted appearance. If the tip is traveling through tissue that has faster transmission speed, then the bayoneted portion will appear closer to the transducer.

Acoustic enhancement artifact:

Acoustic enhancement artifacts occur distal to areas where ultrasound waves have traveled through a medium that is a weak attenuator, such as a large blood vessel. Enhancement artifacts are typically seen distal to the femoral and the axillary artery.

Absent blood flow:

The color-flow Doppler may not detect flow when the ultrasound probe is perpendicular to the direction of flow. A small tilt of the probe away from the perpendicular should visualize the flow. Alternatively, for deep vascular structures, signal may be lost due to attenuation. Increasing gain, while in Doppler color-flow mode, will increase the intensity of the returning signals, which may detect flow that was not previously detected.

Acoustic shadowing:

Tissues with high attenuation coefficients, such as bone, do not allow passage of ultrasound waves. Therefore any structure lying behind tissue with a high attenuation coefficient cannot be imaged and will be seen as an anechoic region.

NEEDLE INSERTION:

In plane technique:

The needle is inserted in the same plane as the ultrasound beam. The path of the needle should be entirely within the beam of ultrasound(fig 9). The more parallel is the needle to the (shallower the angle of insertion) probe, the more easily it will be visualized. Inserting the needle right next to the probe will make the angle of insertion steep and will lead to poor visualization of the needle.

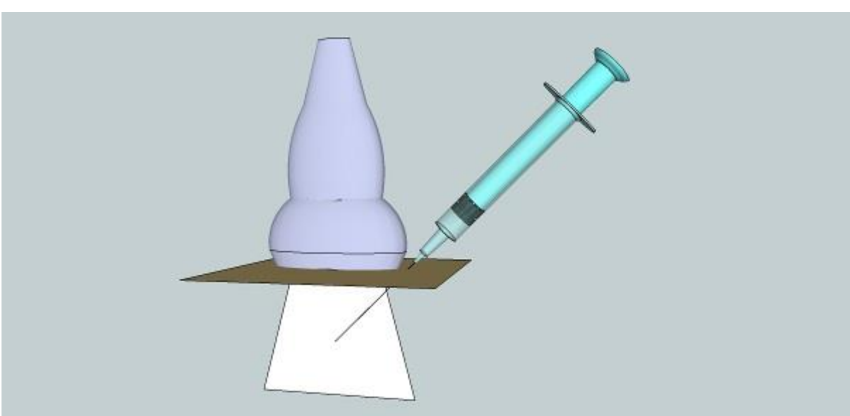


Fig:9 in plane technique

The width of the ultrasound beam can be compared to the width of the credit card. When the needle is partially within the beam and partially outside it is said to be partial plane. The part of the needle at the edge of the beam appears as the tip which can lead to dangerous events. Hence this technique must be avoided.

<u>Out of plane technique:</u>

Here the needle is perpendicular to the beam of ultrasound (fig 10). The needle is seen as a small hyperechoeic dot on the screen. The steeper the angle of insertion the easier it is to find the tip of the needle.

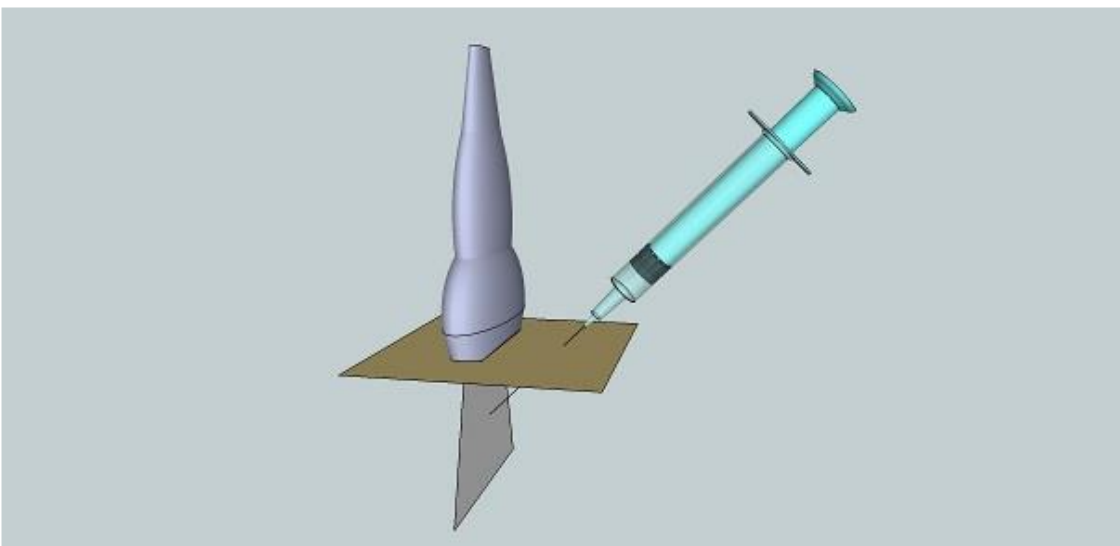


Fig:10 out of plane technique

ANATOMY OF THE RADIAL ARTERY:

The radial artery originates just below the elbow as a branch of brachial artery. It then courses along the lateral margin of the forearm until it reaches the wrist. In the upper forearm the artery is deep to the body of the supinator longus muscle. In the mid forearm, down to the level of the wrist[4], the artery lies between the tendons of supinator longus and flexor carpi radialis. Variations in both the origin and course are well described. The most common one being the artery originating just superior to the elbow, but also it may originate much higher in the arm. High origination from the brachial artery is reported in up to 12% of cases while 5% of people have its origination within the axilla.

The radial artery is usually smaller than the ulnar artery at their origins, but is equal to or larger at the wrist[5]. This is because the ulnar artery gives off numerous branches in the forearm.

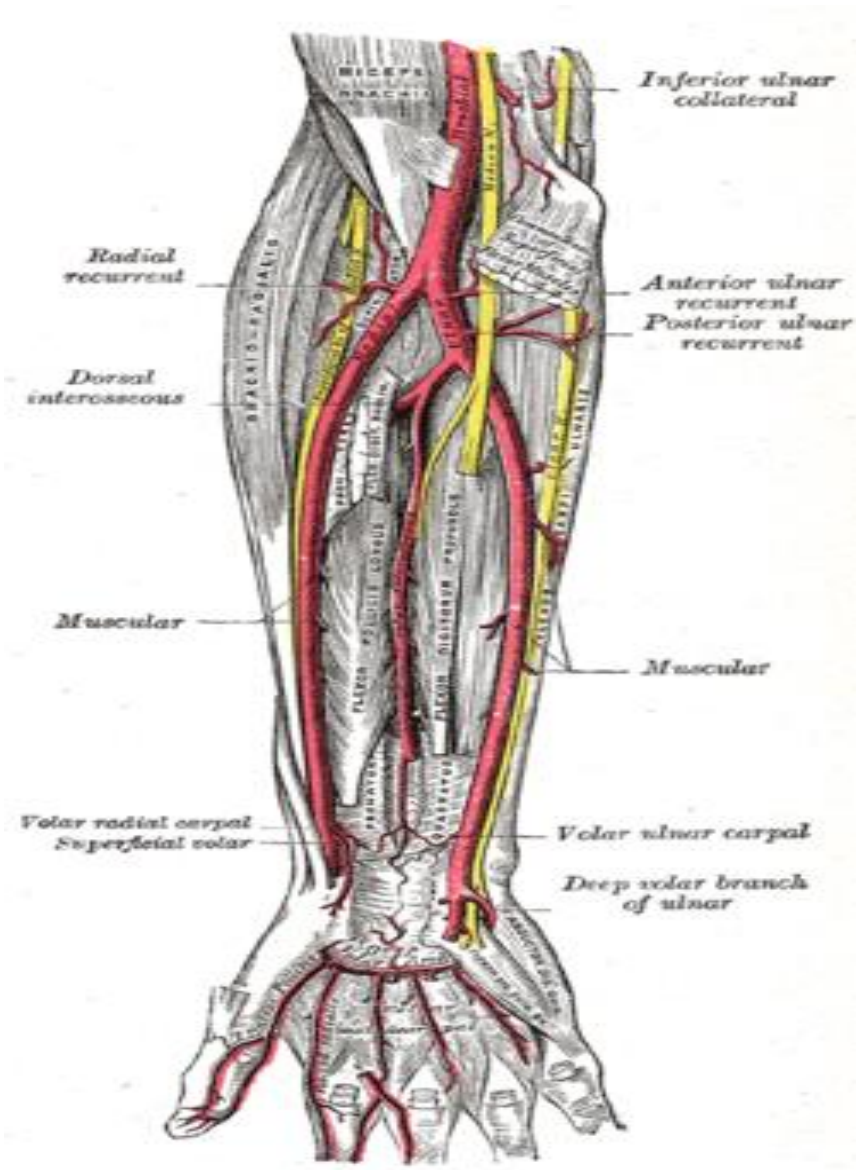
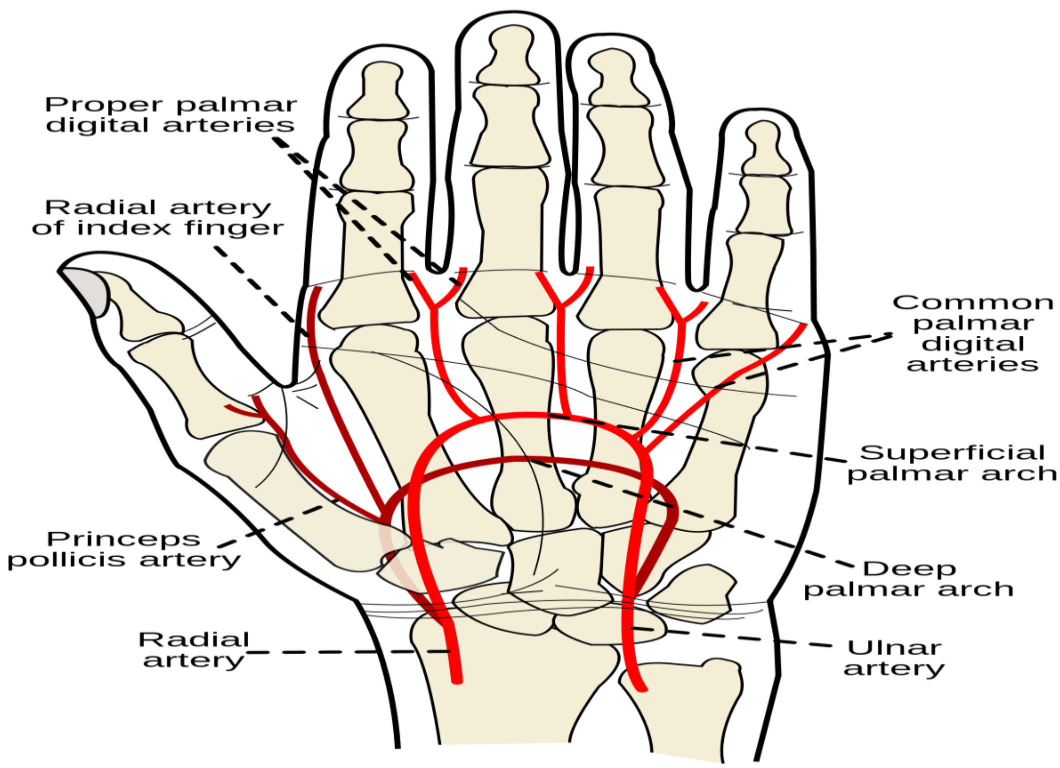


fig:11 course of the radial artery in forearm

Together the two arteries create a dense anastomotic network of 4 arches, providing arterial blood flow to the hand. Three of these arches are found on the palmar side of the hand and they include the palmar carpal arch, the deep palmar arch, and the superficial palmar arch. The arterial network on the dorsal side consists of the dorsal palmar rete[6].

The palmar arches can be divided into 2 types: complete and incomplete. The superficial palmar arch that is formed from the terminal part of ulnar artery and deep palmar arch that is formed from the terminal part of radial artery are the most clinically significant arches as they provide blood flow to all the digits of our hand. The majority of individuals have either a complete superficial or a deep palmar arch, making radial artery occlusion well tolerated. When radial artery is occluded in patients with two incomplete arches the risk for digital ischemia is substantially increased.



INDICATIONS FOR RADIAL ARTERY CANNULATION:

1) Surgeries where severe bloods loss is anticipated[7]
2) In patients where beat to beat monitoring of blood pressure is essential e.g. patients with arrhythmias, ischemic heart disease
3) Places where noninvasive method fails e.g. morbidly obese, severe burns
4) Surgeries where serial ABGs are needed e.g. neurosurgery, cardiothoracic surgery, prolonged duration
5) Patients in the intensive care requiring ionotropic support

CONTRAINDICATIONS FOR RADIAL ARTERY CANNULATION[8,9]:

Absolute:

1) Diseases that cause inadequate circulation to the extremities e.g. raynauds syndrome, thrombo angitis obliterans, buergers disease
2) Infections over the site of cannulation

Relative:

1) Uncontrolled coagulopathy
2) Atherosclerosis

COMPLICATIONS

Infection:

Infection is a potential complication common to all of the invasive monitoring[10]. It is caused by infected skin site, bad aseptic technique during insertion, poor maintenance of the indwelling catheter, prolonged duration of cannulation, non-disposable transducer domes, contaminated arterial blood gas syringes, dextrose flush solution[11,12].

The catheter is to be removed only when infection at the cannulation site or catheter-related bloodstream infection is confirmed. Lymphangitis streaks or cellulitis due to catheter infection require systemic antibiotic therapy.

Skin necrosis:

Skin necrosis is probably caused by thrombosis of radial artery with proximal advancement of thrombosis to its cutaneous branches.

Thrombosis and distal ischemia :

Temporary occlusion of the radial artery leading to thrombosis of the artery is the most common complication of radial cannulation[13,14]. Factors associated are larger catheters, smaller artery size and prolonged duration of cannulation. The incidence of thrombosis is not affected by the technique of cannulation. It is found that pretreatment with aspirin can reduce this complication.

Embolization:

This is caused by flushing forcefully the particulate matter or air into the arterial catheter. Cerebral embolization most commonly arises from axillary catheters but can also arise from brachial and radial artery catheter. Factors associated with increased risk of embolization are speed of injection, volume of the flush solution and proximity of intraluminal tip of catheter to central circulation[16,17,18].

Hematoma and neurologic injury:

Formation of hematoma at the arterial puncture site can be prevented by applying direct pressure after puncture or correction of the underlying coagulopathy. Posterior puncture in iliac or femoral arteries can lead to massive hemorrhage in the retroperitoneal area. Surgical consult might rarely become necessary[19,20].

Nerve damage:

Nerve damage occurs if the nerve lies with the artery in a fibrous or direct injury occurs from needle trauma. They are uncommon.

IMPORTANCE OF PERFORMANCE OF MODIFIED ALLENS TEST

The modified allens test measures the arterial competency and is performed before radial artery cannulation.

Procedure:

Ask the patient to clench their fist. If they are not able to do it we can close their hand tightly. Using our fingers occlusive pressure is applied to the ulnar and radial arteries to obstruct the blood flow to the hand. Complete occlusion is evidenced by the blanching of the palms. If not, then the arteries are completely occluded. Now the pressure over the ulnar artery is released and the test is interpreted as follows.

Positive modified allens test:

If the ulnar artery has good blood flow, then the hand will flush within 5 to 15 seconds[21]. This is considered a positive test.

Negative modified allens test:

When the ulnar circulation is inadequate or non-existent then the hand will not flush within 5 to 15 seconds. In this situation, the radial artery supplying that hand should not be punctured.

TECHNIQUES OF RADIAL ARTERY CANNULATION

Conventional technique:

The distal portion of the forearm is the area of maximal pulsation for radial artery. Here it is palpated between the radius and the tendon of the flexor carpi radialis. The catheter is directed towards the artery at an 30-45° angle, with the bevel of the needle upwards. Once pulsatile flow appears within the cannula, the needle is brought closer to the hand to an angle of approximately 15° - 30° and advanced 0.5 mm farther into the lumen of the artery, and the catheter threaded into the artery(fig 12). Successful placement of the catheter is confirmed by observing a transduced arterial blood pressure waveform. Since the artery is not visible on the skin surface carrying out a correct puncture is challenging. Further more advancement of the catheter requires greater technical skill than making a puncture. Thus these difficulties has led to different aides and modifications for radial artery cannulation.

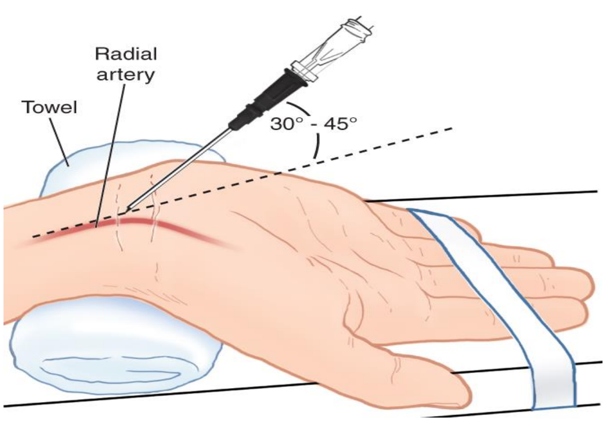


fig 12:radial artery cannulation by palpation

Aid for radial artery cannulation:

1) Radial artery cannulation has been performed by a guidewire-assisted technique in which after the artery is punctured and confirmed by a flashback of blood, a guidewire is advanced into the arterial lumen. Then the needle is removed and the arterial catheter is advanced over the guidewire. Once the catheter enters into the artery, the guidewire is removed and the catheter fixed to the forearm. This method of a guidewire-assisted radial artery cannulation technique has been preferred than a direct technique mainly in pediatric patients. This technique is easy and safe.

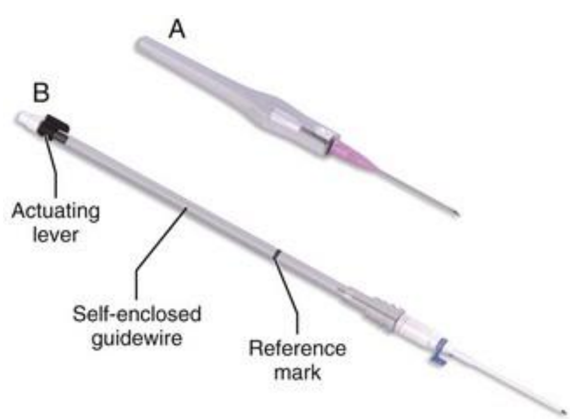


Fig:13

2) Identification of vessel using trans illumination technique has also been used for radial artery cannulation in children.

3) Another method is the localization of radial artery with a 26G hypodermic needle attached to a syringe barrel and puncturing skin at

2mm intervals until backflow is observed has been described. The radial artery cannula is then inserted just distal to hypodermic needle. The hypodermic needle is removed from the artery as the catheter is being placed.

4) Pressure curve directed technique has also been described. The radial artery cannula attached to pressure transducer after flushing it. This assembly is then inserted for radial artery cannulation in conventional technique. The arterial waveform suggests successful arterial cannulation.

5) The ultrasound-guided technique has also been used. The radial artery is localized by ultrasound and the cannula is advanced to perforate the skin slightly distally to the transducer. It is then directed towards the vessel in an angle of approximately 45°. The further advancement is guided by minimal ultrasound scanning of the artery and its close vicinity. When the cannula appeared to be within the vessel, the transducer is removed and catheterization is done.

6) Doppler has been used during radial artery cannulation. Apart from pre-insertion localization of the radial artery, the Doppler probe can be held over the artery throughout the cannula insertion. The exact position of the artery is identified by a change or loss of Doppler tones as the cannula contacts and compresses the artery.

Fig:14 ultrasound Doppler probe

7)‘Liquid stylet' for percutaneous radial artery cannulation has been reported. A syringe with 3 ml saline is attached tightly to a 20gauge cannula whose distal end is located in the radial artery. When pulsatile backflow of blood is present 1-2 ml of blood is aspirated without moving the cannula, confirming location of the cannula in the vessel lumen. Slowly and steadily 1-3ml of fluid is injected from the syringe with one hand while the other slowly advances the catheter into the vessel lumen behind the “liquid stylet” created by the injection. When the hub of the catheter reaches the surface of the skin, 1-2 ml of blood is again aspirated to confirm location of the catheter tip in the artery.

8) A surgical exposure is done when other methods fail.

Modified techniques:

The radial artery can also be cannulated in the dorsum of the hand where it emerges from the anatomical snuff box instead of usual volar aspect. The advantage of this method is the preservation of the palmer branch of radial artery and thus sparing the collateral vessels and so less chance of digital ischemia.

Antegrade radial arterial cannulation has been used for pressure monitoring successfully after the cut down approach. This was attempted after failed retrograde cannulation of the radial artery. During this, pressure measurement was of ulnar artery via palmer arch. antegrade arterial cannulation can be successfully used when radial arteries are obstructed and retrograde blood flow is observed during failed cut down attempts at standard retrograde arterial cannulation.

REVIEW OF LITERATURE

RANDOMIZED CONTROL TRIALS:

A meta-analysis conducted by xiang-dong et all reviewed 13 trials with 2402 patients[22]. Their findings were as follows; the dynamic 2D ultrasound compared with traditional palpation technique significantly reduced the first attempt failure. Using a 2D ultrasound further reduced mean attempts to success, mean time to success and complications. Doppler ultrasound has no benefit on first attempt failure compared with traditional palpation. Compared with palpatory method, USG guided radial artery cannulation was associated with a 84% improvement in first attempt success. They summarized that ultrasound guidance is superior to traditional palpatory method for radial artery cannulation even in small children and infants.

Study by Levin et al showed the first attempt success rate with USG to be 62% compared to the 34% using palpatory method alone in 69 adult patients who underwent elective surgery[23].

Shiver et al[24] studied 60 patients in the emergency setting requiring arterial cannulation randomized to USG guided or palpatory method. They showed a first pass success rate of 87% in the USG group compared to only 50% in the palpatory group.

Schwemmer et al[25], studied infants posted for major neurosurgery. They reported a success rate of 100% in the USG group, compared to 80% in the palpation group. The first-pass success rate was 67% in the USG group and 20% in the palpation group. The higher success rate of USG group may be due to the ability to visualize even small vessels by ultra sound.

However, there are some randomized controlled trials that have produced equivocal results. USG did not help in faster catheterization of radial artery in 152 pediatric patients by anesthesiologists who were inexperienced in both palpation and USG techniques. Also, the percentage of successful catheterization, total number of attempts and number of catheters used did not differ significantly between the groups. But in many instances where an inexperienced operator failed to cannulate by palpation method, an experienced ultrasound operator could successfully place it with USG. (Ganesh et al[26])

In 112 patients undergoing puncture of femoral artery for interventional investigations, Dudeck et all[27] found that USG should be used to access the femoral artery in patients with leg circumference of 60 cm or more, or in patients with weak arterial pulse. In those patients, procedure time was reduced compared to traditional palpation techniques.

Overall attempts were fewer with USG, though statistically insignificant.

CASE SERIES:

Techniques of USG have progressed from initial phase of Doppler ultrasound to advanced modalities like B-mode and color duplex US.

Xiuyan li et all[28] conducted a study in 88 ICU shock patients. They were randomized into a palpation group and the ultrasound group for the radial artery cannulation. Here the out of plane approach was first used to observe the diameter, depth, trajectory and the surrounding tissues. Then the in-plane approach was used for arterial cannulation. The dose of vasopressors and the mean arterial pressure were not statistically significant in both the groups. Even in hemodynamically compromised patients the success rate of first puncture was significantly higher in the ultrasound group than in the palpatory group. The failure rate and puncture duration were shorter in the ultrasound group. Incidence of hematoma were significantly lower in the ultrasound group. This study concluded that radial artery cannulation with out of plane orientation an in-plane guidance tends to combine the advantages of both the methods that significantly improved the success rate for first puncture and reduced the incidence of complications.

Amna et all[29] compared the ultrasound guided radial artery cannulation with conventional technique on 60 patients. They reported no statistically significant difference in mean time for cannulation and number of cannulas used in both groups. They concluded by saying more expertise was needed to obtain improved results.

Nagabhushan et all[30], showed an enhanced cannulation of radial artery and a reduced need for arterial cut-down in patients who were hypotensive or with absent or barely palpable pulses[26].

CASE REPORTS:

There are several case reports of the usage of USG for arterial cannulation.

Kannan et all[31] described a case report of USG guided brachial artery catheterization when traditional attempts failed. Catheterization was possible in a single attempt and arterial pulsations were well visualized despite the presence of extensive interstitial fluid.

White et all[32] found high level of evidence for significant benefits with ultrasound guidance for radial artery cannulation with regard to first attempt success rate and the number of attempts in adult population. They also concluded that ultrasound guidance may also produce cost savings in adult population with limited evidence for nonsignificant reduction in the number of cannula used on each patient.

Berk et all[33] concluded that the cannulation time was shorter in long axis in plane group compared to short axis out of plane group.

The arterial cannulation by long axis in plane approach increase the rate of cannula insertion success in the first attempt (76%) compared to short axis out of plane approach (57%). They also found that the long axis in pane approach results in shorter cannulation time and decreased incidence of complications.

Ganesh et all[34] conducted a study to compare ultrasound guided radial artery cannulation with traditional palpation technique in pediatric population. The operator was successful at the first attempt cannulation in only 66% and 69% in the palpation and ultrasound groups respectively. There were no statistically significant differences between the groups with respect to time, number of attempts and no of cannula used for catheterization.

Zhe feng et all conducted a study to compare modified short axis out of plane with long axis in plane technique. The cannula insertion success on the first attempt in the modified group is statistically significantly higher than the long axis group. They observed no statistically significant difference in hematoma between two treatment groups.

METHODOLOGY

STUDY DESIGN:

Prospective, randomized study

INCLUSION CRITERIA:

1. Age 20 to 80 years
2. ASA I – III PS in all consented patients posted for surgical procedures requiring arterial cannulation for continuous blood pressure measurement

EXCLUSION CRITERIA:

1.Peripheral vascular disease

2.Haemorrhagic shock

3.Coagulation disorders

4.obesity(BMI>30Kg/m^2)

5. negative modified Allen's test

GROUPS

GROUP L

Radial artery cannulation done by long axis (in plane) approach

GROUP S

Radial artery cannulation done by modified short axis (out of plane) approach

RECRUITMENT:

Patients were recruited from the operation

procedure list. Randomization was done using a computer-generated table.

INFORMED CONSENT: In English and vernacular language(tamil)

PROPOSED DURATION OF THE STUDY: six months

DATA COLLECTION PROCEDURES:

After institutional Ethics Committee approval and informed written consent, 120 ASA I-IV patients were selected for the study based on the inclusion and exclusion criteria. Patients were randomized into two groups i.e. group L & group S using computerized random number.

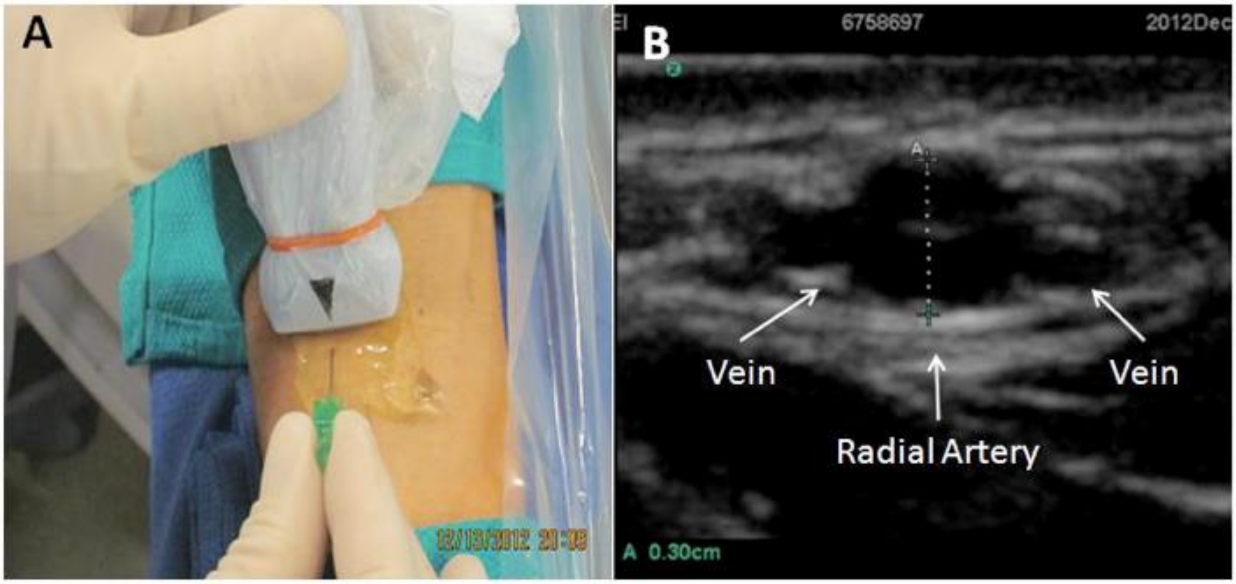
On arrival of the patient in the operating room monitors like pulse oximeter, non-invasive BP and ECG were connected and baseline values (values taken just before the start of the procedure) recorded. An IV access was obtained in the arm using a 18G cannula.

Patients then underwent induction of general anaesthesia. The left hand of all patients were chosen for the puncture. The wrist was extended over a roll of 10 cm and the hand positioned in dorsiflexion and fixed to the roll. Sterile preparation was performed over the skin insertion site and local anaesthesia given using 1ml of 2%ligncaine. The ultrasonic probe with disposable sterile covers of 18MHZ frequency was used to identify the radial artery.

MODIFIED SHORT AXIS OUT OF PLANE APPROACH:

A silk suture of size 1-0 was tied on the midpoint of the ultrasound probe and perpendicular to its long axis as a guide. This created a visible mark on the USG screen which was directed at the beating radial artery on the ultrasound view. The inner diameter of the radial artery and the depth of artery from the skin was measured. The arterial cannula needle(18G) was placed on the contact point of the suture line and skin and inserted steeply downward at an angle of 30 to 45 degree. Entry into the artery was confirmed by visualizing the backflow of blood into the needle. Then the angle of needle was lowered to 15 degrees and pushed proximally for 2 to 3mm. The needle core was then extracted and the cannula pushed into the radial artery and fixed to the skin.

The arterial transducer with the extension was flushed with heparin saline and kept ready. once the artery was cannulated, we connected it immediately to the extension tubing and the waveform was observed.



The probe is held perpendicular to the long axis of the radial artery to achieve a short axis view (A). Cross-section of a 3-mm radial artery and two veins on ultrasound, with the artery diameter measurement in the left lower corner (B). Republished with permission from Cardiac Interventions Today.

Fig: 15 short axis out of plane approach

Fig;16 modified short axis out of plane approach

LONG AXIS IN PLANE APPROACH:

After identifying the artery in the long axis view and measuring its inner diameter and the depth of artery from skin, the arterial cannula needle(18G) was inserted steeply downward at the midpoint of the short axis of the ultrasonic probe. Entry into the artery was confirmed by visualizing the backflow of blood into the needle. Then the angle of needle was lowered to 15 degrees and pushed proximally for 2 to 3mm.The needle core was then extracted and the cannula pushed into the radial artery and fixed to the skin.

The arterial transducer with the extension was flushed with heparin saline and kept ready. once the artery was cannulated, we connected it immediately to the extension tubing and the waveform was observed.

Fig:17 long axis in plane approach

OBSERVATIONS:

DEPTH OF ARTERY FROM SKIN: The ultrasonic depth of the radial artery from skin was measured in cm.

CANNULATION TIME: The start of skin puncture to the display of arterial waveform on the monitor was measured in seconds

ULTRASONIC LOCATION TIME: contact of the USG probe with the skin to the start of skin puncture was measured in seconds

ATTEMPT: The Cannula withdrawn till skin and punctured at a different site was considered one attempt

REDIRECTION: The cannula directed at a different angle at the same puncture site was considered redirection

COMPLICATIONS:

VASOSPASM: when there was > 30% reduction in the inner diameter of the radial artery

HAEMATOMA: when a visible swelling appears over the puncture site

POSTERIOR WALL PUNCTURE: After the appearance of flash of blood in the chamber when continuous backflow was not present.

VITAL PARAMETERS: heart rate, ECG, NIBP and pulse oximetry were measured before and after the procedure

RESULTS AND ANALYSIS

DATA ANALYSIS:

The collected data were analysed with IBM.SPSS statistics software 23.0 Version. To describe about the data descriptive statistics frequency analysis, percentage analysis was used for categorical variables and the mean & S.D were used for continuous variables. To find the significant difference between the bivariate samples in the Independent groups the Unpaired sample t-test was used. To find the significance in categorical data Chi-Square test was used. In all the above statistical tools the probability value .05 is considered as significant level.

THE GROUP DISTRIBUTION:

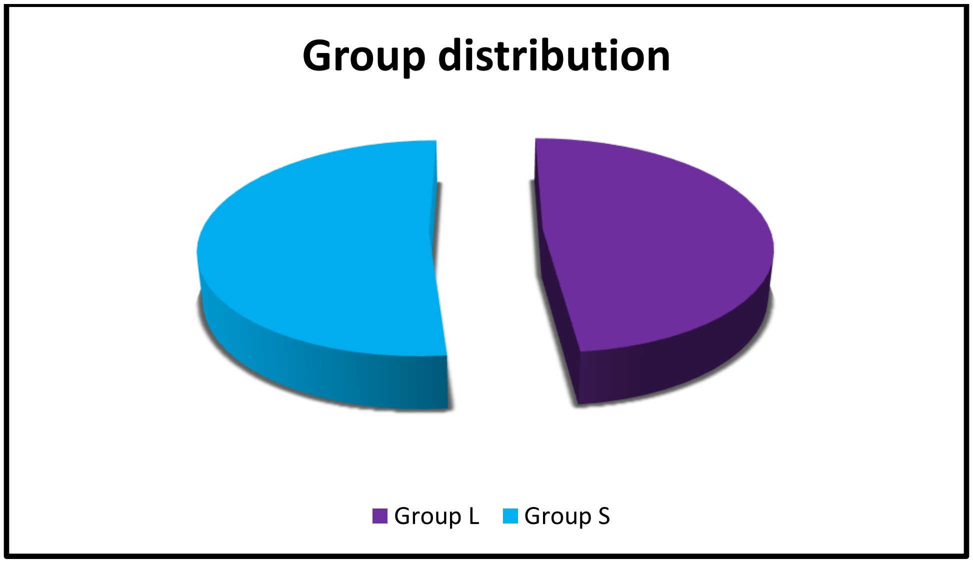


Fig:18

COMPARISON OF DEMOGRAPHIC PROFILE BETWEEN THE TWO GROUPS:

AGE:

AGE	GROUP L	GROUP S
<50YEARS	47	40
>50 YEARS	11	22

P value is 0.206 (not significant)

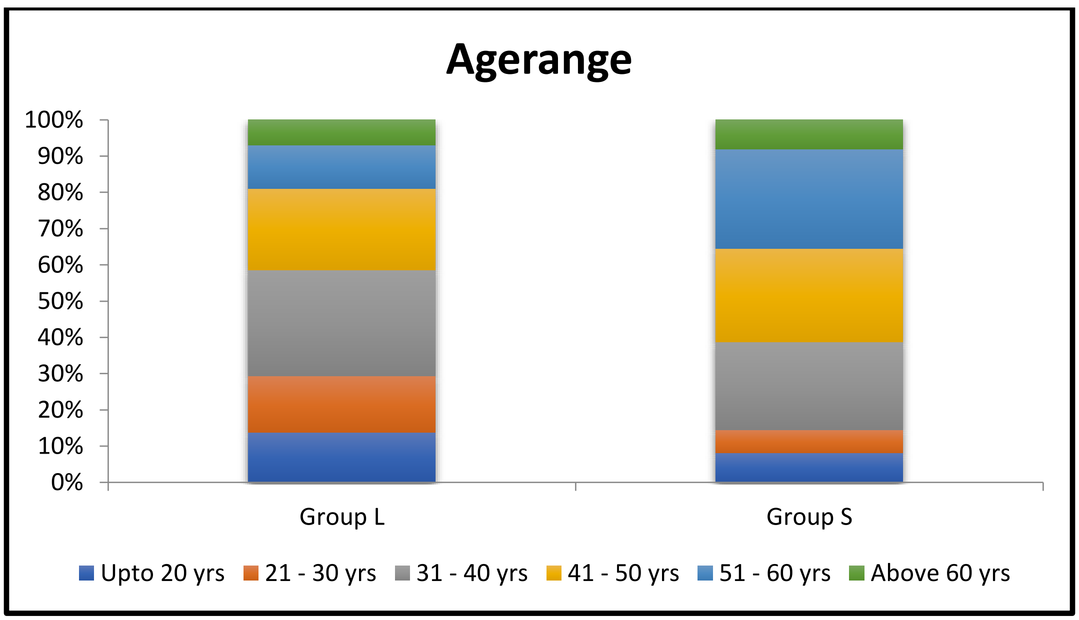


Fig:19

SEX:

SEX	GROUP L	GROUP S
MALE	21	22
FEMALE	37	40

P VALUE IS 0.934(NOT SIGNIFICANT)

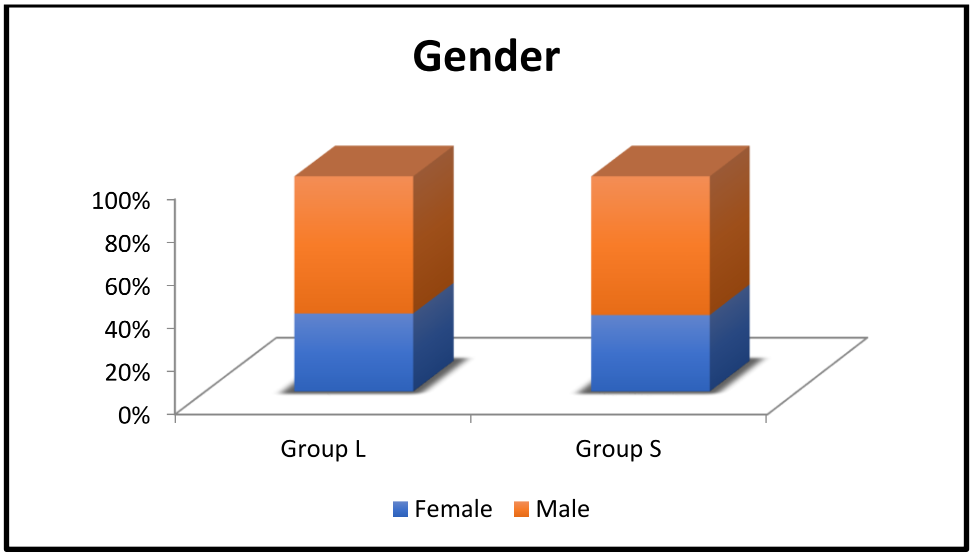


Fig: 20

THE OVERALL GENDER DISTRIBUTION BETWEEN THE TWO GROUPS:

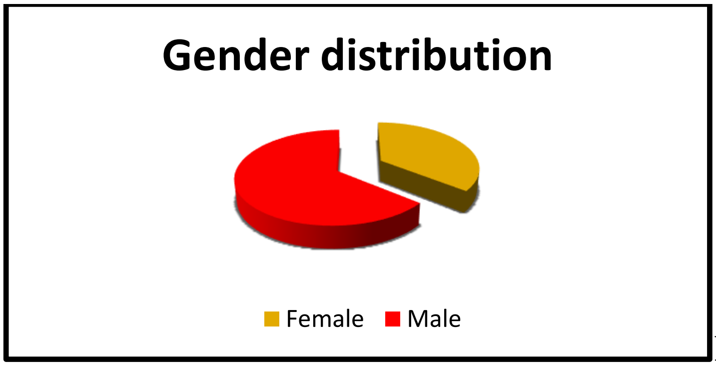


Fig: 21

COMPARISON OF BASELINE HEMODYNAMIC PARAMETERS BETWEEN THE TWO GROUPS:

PARAMETER	GROUP L (mean)	GROUP S (mean)	P VALUE
PULSE	78.86	79.56	0.657
SBP	124.14	125.16	0.502
DBP	78.62	79.84	0.297

PULSE RATE:

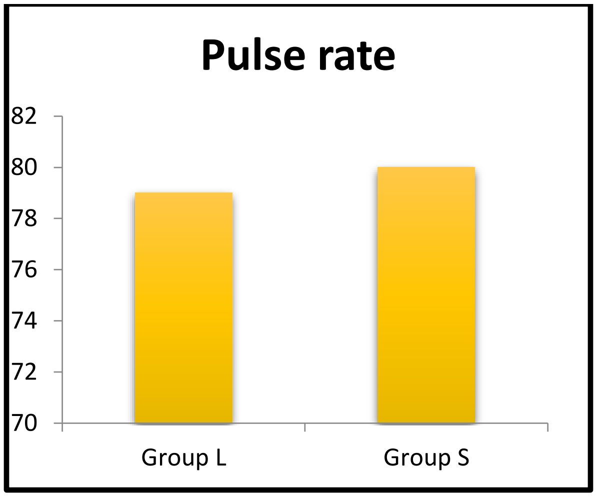


Fig:22

<u>NON- INVASIVE BLOOD PRESSURE:</u>

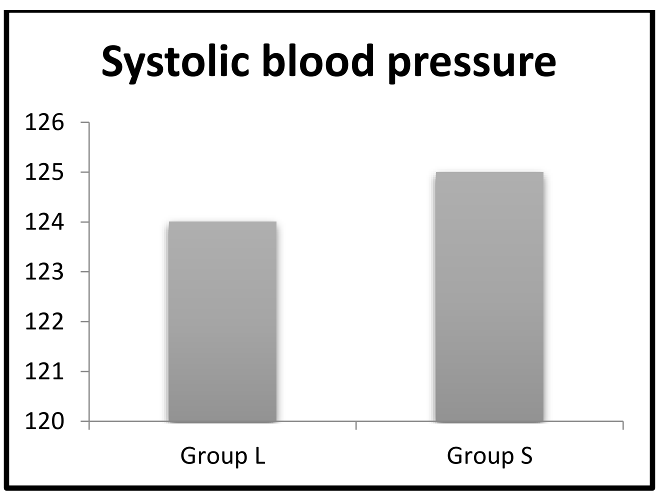


Fig:23

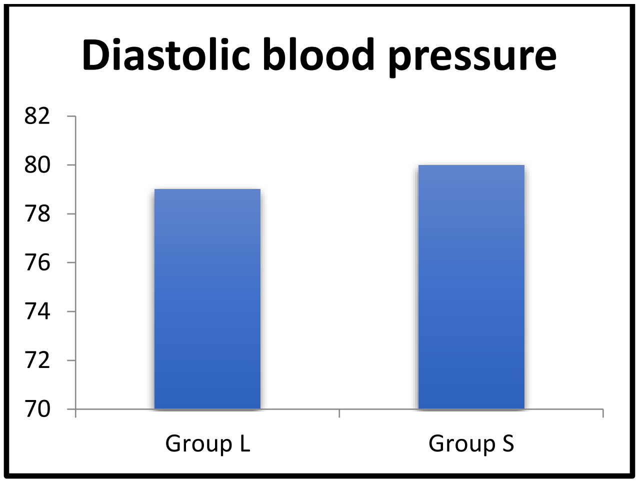


Fig:24

Thus, the baseline parameters like pulse rate, the systolic and diastolic blood pressure are comparable between the two groups and there is no statistically significant difference. P value is >0.05.

COMPARISON OF INNER DIAMETER OF RADIAL ARTERY:

PARAMETER	GROUPS	MEAN	Std.DEVIATION	P VALUE
INNER DIAMETER OF RADIAL ARTERY	GROUP L	2.6672	±0.34	0.455
	GROUP S	2.6642	±0.28	

Thus, there is no statistically significant difference between the two groups in terms of inner diameter of radial artery. P value is >0.05

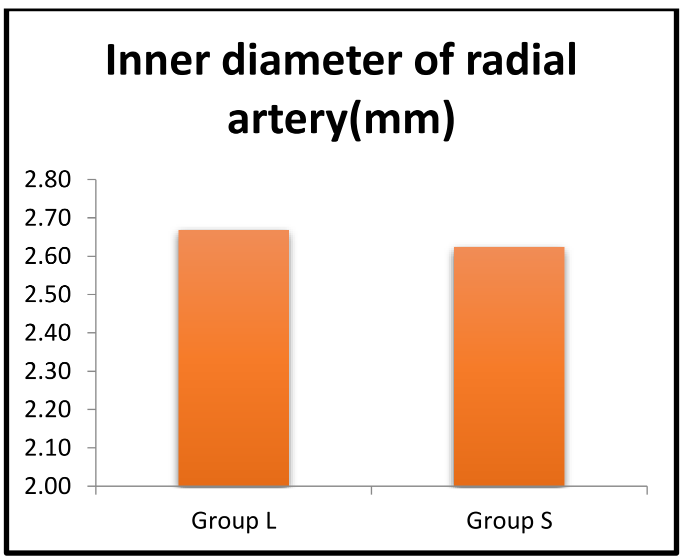


Fig:25

COMPARISON OF DEPTH FROM SKIN TO THE RADIAL ARTERY:

PARAMETER	MODIFIED SA-OOP GROUPMean (SD)	LA-IP approach Mean(SD)	P value	Mean difference
Depth from skin to radial artery (n cm)	0.6323±0.1696	0.6371±0.2157	0.893	0.00481

The results were not statistically significant for the difference of depth from skin to artery when comparing the modified SA-OOP and LA-IP groups. P value is 0.893.

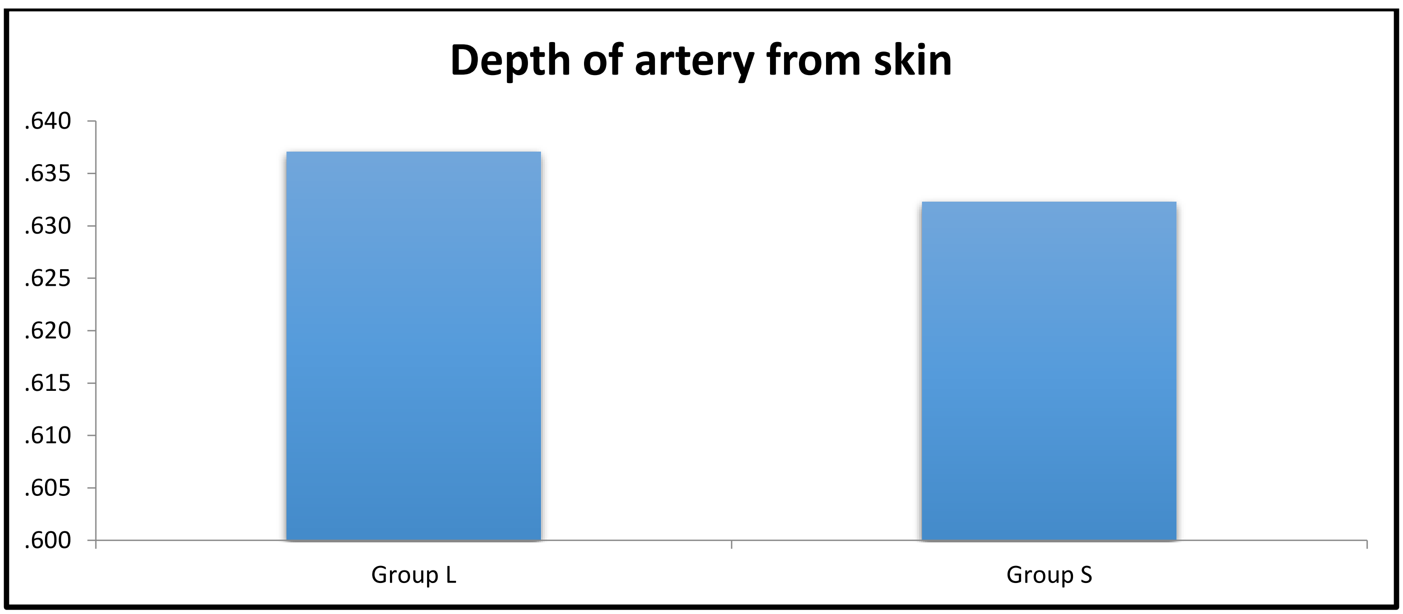


Fig: 26

COMPARISON OF ULTRASONIC LOCATION TIME AND CANNULATION TIME BETWEEN THE TWO TREATMENT GROUPS:

PARAMETER	MODIFIED SA-OOP GROUP Mean ± SD	LA-IP group Mean ± SD	P VALUE
ULTRASONIC LOCATION TIME (SECONDS)	4.34 ± 0.809	8.41 ±1.109	0.000
CANNULATION TIME(SECONDS)	10.06±1.266	14.59±2.649	0.000

The mean values of ultrasonic location time in the modified SA-OOP approach and LA-IP approach were 4.34s and 8.41s respectively. Thus there is a mean decrease of 4.075s. P value for ultrasonic location time is 0.000. Hence it is statistically significant.

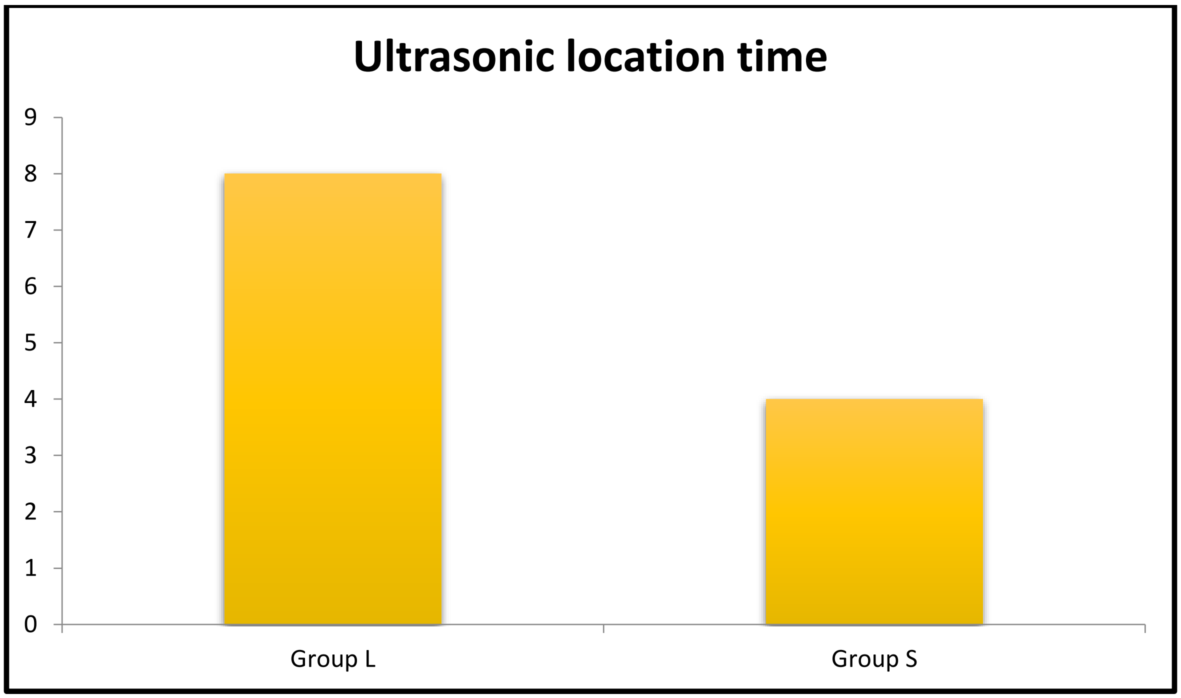


Fig:27

The mean values of cannulation time in the SA-OOP approach and LA-IP approach is 10.06s and 14.59s respectively there is a mean difference of 4.522s. the P value for cannulation time is 0.000 which is statistically significant.

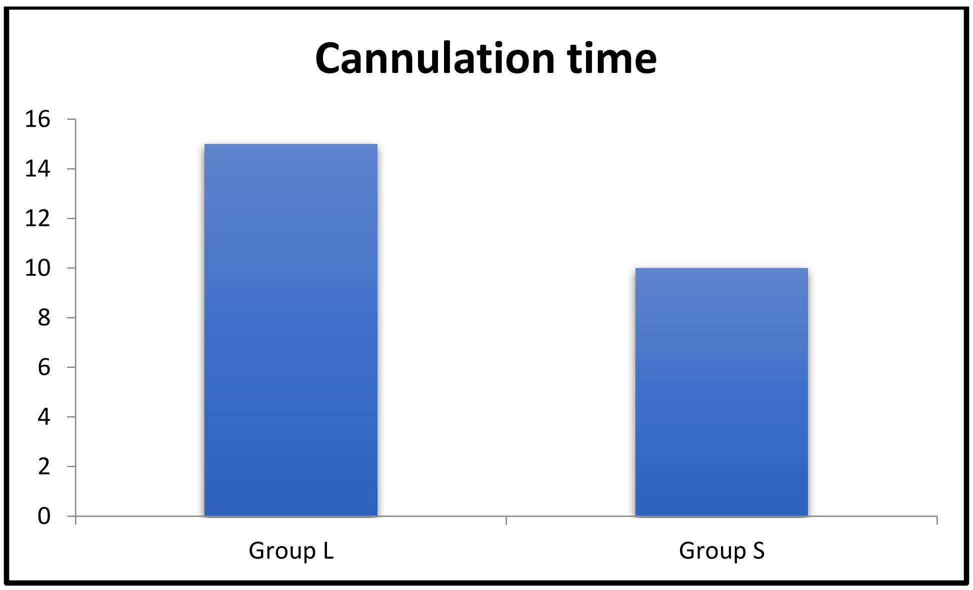


Fig:28

COMPARISON OF NUMBER OF ATTEMPTS BETWEEN THE TWO GROUPS:

NO OF ATTEMPTS	Modified SA-OOP group n (%)	La-IP GROUP n (%)	P value
1	95.2	87.9	0.294
2	4.2	10.3	
3	0.0	1.7	

Compared to LA-IP approach the SA-OOP approach tends to have higher rate of attempt one and lower rate of attempt two. The P value is 0.294 which is >0.05 and hence it is statistically not significant.

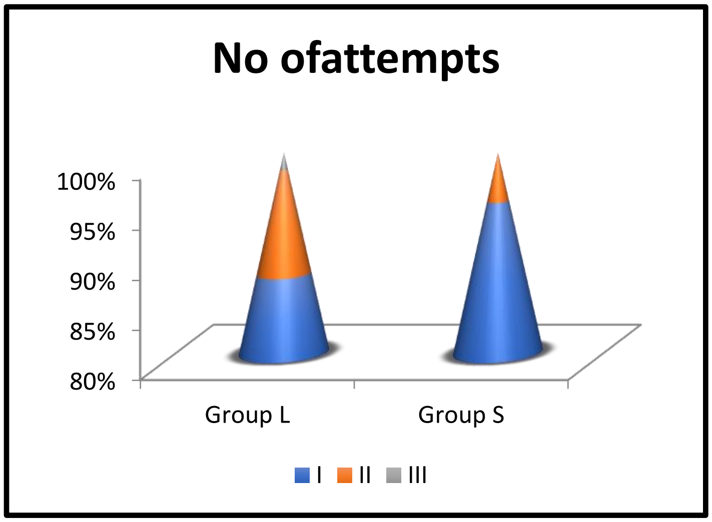
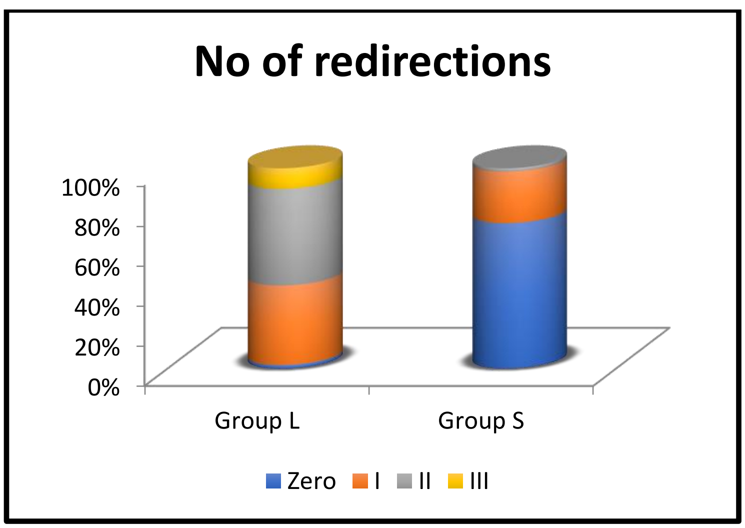


Fig: 29

COMPARISON OF NUMBER OF REDIRECTIONS IN BOTH THE GROUPS:

Number of redirections	MODIFIED SA-OOP APPROACH n (%)	LA-IP APPROACH n (%)	P value
0	1.7	72.6	0.000
1	39.7	25.8	
2	48.3	1.6	
3	10.3	0	

The number of redirections in modified SA-OOP approach is significantly lower when compared to LA-IP approach. The P value is 0.000 and hence it is statistically significant.



COMPARISON OF COMPLICATIONS BETWEEN THE TWO GROUPS

VASOSPASM:

VASOSPASM	MODIFIED SA-OOP GROUP n (%)	LA-IP GROUP n (%)	P value
PRESENT	0	3.4	0.232
ABSENT	100	96.6	

There is no statistically significant difference in the formation of vasospasm between the two groups. P value is 0.0232.

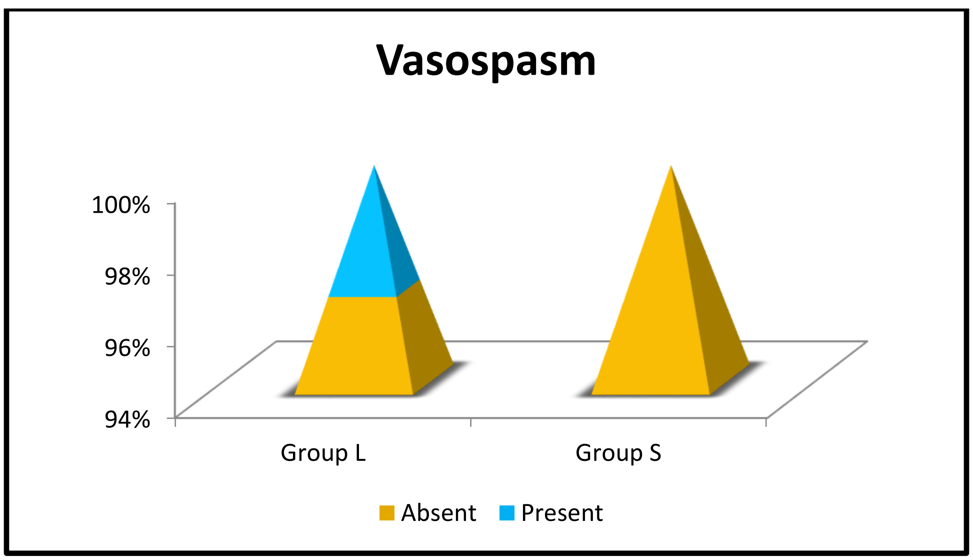
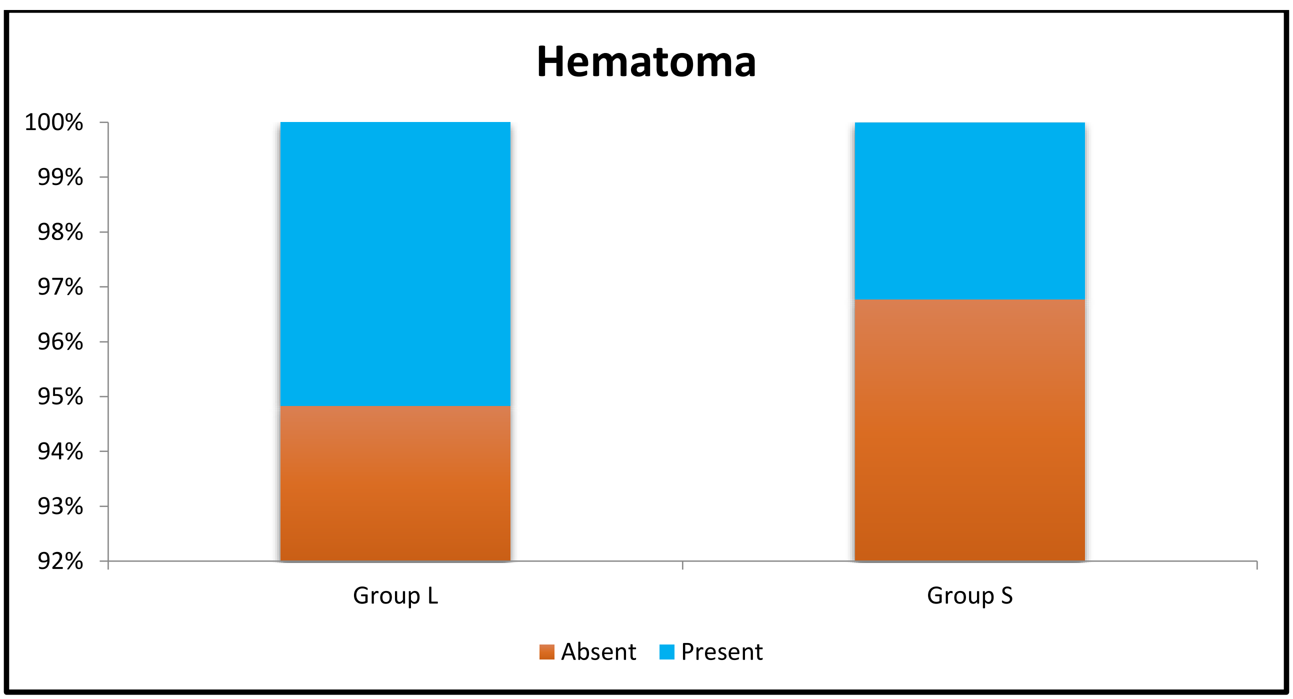


Fig:31

HAEMATOMA FORMATION:

HAEMATOMA	MODIFIED SA-OOP APPROACH n (%)	LA-IP APPROACH n (%)	P VALUE
PRESENT	3.2	5.2	0.672
ABSENT	96.8	94.8	

There is no statistically significant difference between the two groups with respect to hematoma formation. P value is 0.672.



POSTERIOR WALL PUNCTURE:

POSTERIR WALL PUNCTURE	MODIFIED SA-OOP APPROACH n (%)	LA-IP APPROACH n (%)	P value
PRESENT	8.1	0	0.058
ABSENT	91.9	100	

There is no statistically significant difference between the two groups with respect to posterior wall puncture. P value is 0.058.

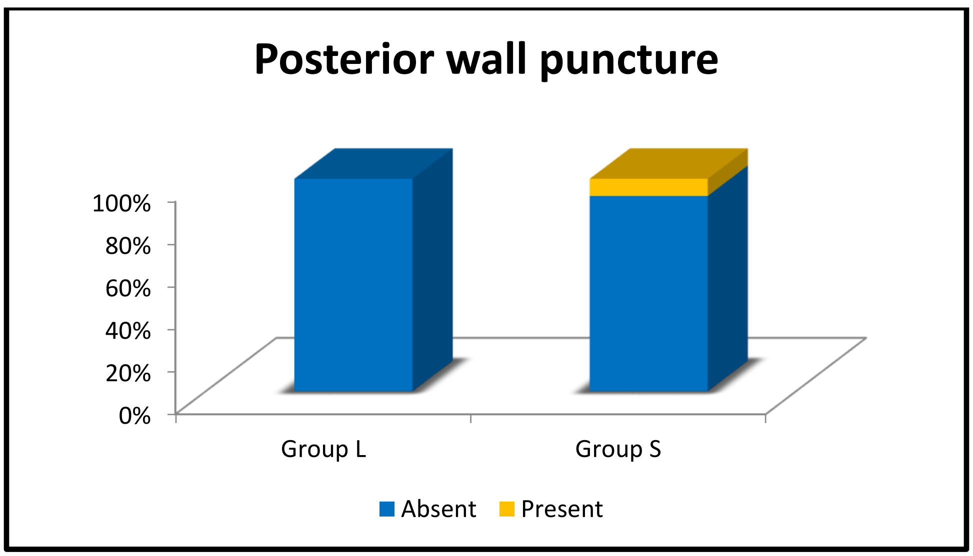


Fig:33

OVERALL PERCENT OF COMPLICATIONS USING ULTRASOUND GUIDED RADDIAL ARTERY CANNULATION

VASASPASM:

In this study, the total number of cases (including group L and group S) that presented with vasospasm were 1.7%

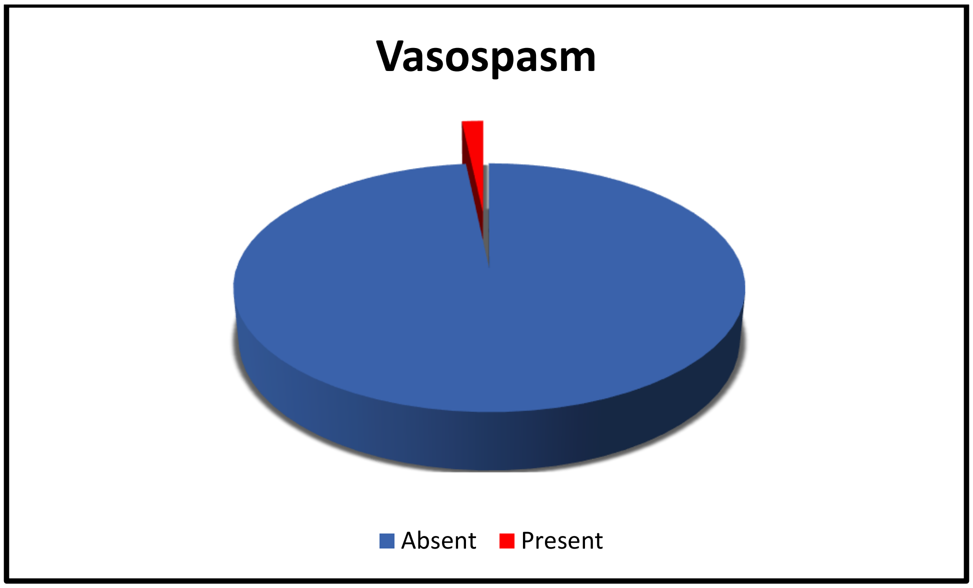


Fig:34

HEMATOMA FORMATION:

In this study the total number of cases (including group L and group S) that presented with hematoma formation were 4.2%

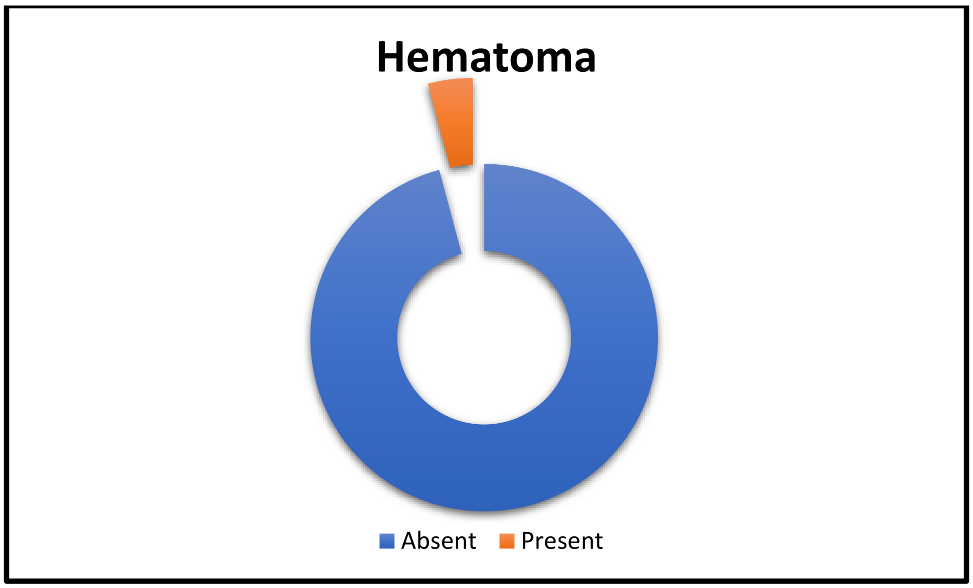


Fig:35

POSTERIOR WALL PUNCTURE:

In this study the presence of total number of cases (including group L and group S) that presented with posterior wall puncture were 4.2%

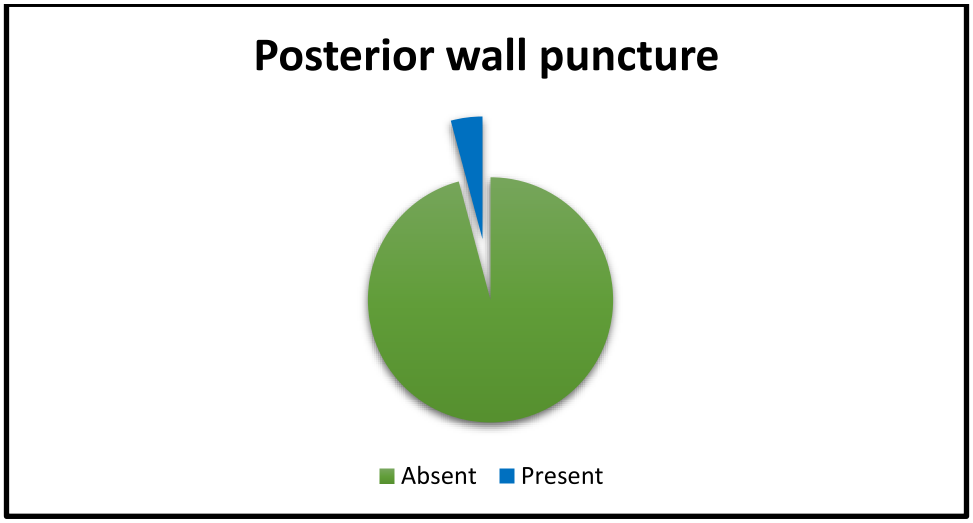


Fig:36

DISCUSSION:

Arterial cannulation is the gold standard for continuous invasive blood pressure monitoring. Radial artery is the most commonly chosen site for this purpose. Ultrasound in this setting is commonly used to increase the success rate of needle placement and to reduce the complications. Ultrasound has become the ‘third eye’ of the clinicians. With the emergence of high resolution ultrasonic apparatus and improvement in ultrasonic probes the ultrasound guided procedures are on the rise.

As discussed earlier there are two basic needling approaches using ultrasound- the short axis out of plane approach and the long axis in plane approach both of which have their own merits and demerits.

Successfully cannulating the artery means accurately puncturing the blood vessel and advancement of the catheter into the artery. Several factors affect both these steps. if the diameter of the radial artery is small, puncturing accurately becomes difficult. when the artery is deeper, it might warrant multiple attempts. When the needle is placed only inside the part of the vessel or on the vessel wall catheter advancement results in failure.

There are several studies that showed the superiority of ultrasound guidance over the Doppler assisted techniques and the traditional palpatory methods. Though few, studies comparing the advantages and disadvantages of the different needling techniques were conducted.

In this study the demographic profile (age and sex) and the baseline vital parameters (pulse and blood pressure) before cannulation had no statistically significant difference.

The diameter of the radial artery and the depth of the artery from skin were also not statistically significant. These parameters can affect the ultrasonic location time and cannulation time.

Berk et all compared the LA IP and SA-OOP approach. They reported that the LA-IP approach resulted in increased first attempt success (76%) compared to SA-OOP approach (51%). In our study, the modified SA-OOP approach was compared with the LA-IP approach. the first attempt success was 95.2% for modified SA-OOP approach compared to 87.9% for the LA-IP approach. Thus, the modified SA-OOP approach reduces the number of subjects requiring two or more attempts.

Since the modified SA-OOP approach is a new procedure testing for failure rate is also important. There were no cannula insertion failure in both the groups. This was in conjunction with other studies that compared both the approaches.

Kyung song et ell conducted a study that compared short axis and long axis approach in children. The imaging time in long axis group was significantly longer because the transducer was rotated, from the short axis to the long axis view to capture the whole artery. Zhe feng quan et all concluded that the modified short axis OOP approach significantly decreases the mean ultrasonic location time. In our study, Ultrasonic location time was lesser with the SA-OOP group when compared with the LA-IP group. The results were statistically significant. When performing an ultrasound guided radial artery cannulation, the artery is placed in the center of the screen. Technically, the modified SA-OOP approach has an advantage over the LA-IP approach in finding the artery more easily. This is by ascertaining the location of the artery using the developing line on the screen.

The other primary end point of the study is the cannulation time. Kyung song et all concluded that there was no statistically significant difference in the total time to cannulate between the two groups. The cannulation time was longer in the short axis group than in the long axis group. Zhe Feng quan et all concluded that the cannulation time between the two groups is not significantly different. In our study, the cannulation time in modified SA-OOP group is lower than the LA-IP group and it is statistically significant. The cannulation time involves the number of redirections and number of attempts. Compared to the LA-IP approach, the modified SA-OOP approach has higher rate of success in attempt one. The number of redirections is also significantly lower in the modified SA-OOP group. Thus the decrease in ultrasonic location time and cannulation time are direct results of the modification made to the SA-OOP approach. Due to the thickness of the ultrasound beam when the needle travels outside the vessels while still in section range of ultrasound probe overlapping images appear giving a illusion that the needle is inside the vessel in LA-IP approach, thus increasing the number of redirections and attempts.

As with the successful arterial cannulation preventing complications is also equally important. Studies by moon et all showed a 34% incidence of posterior wall puncture in both LA-IP and SA-OOP groups. In our study though there was no statistically significant difference between the two groups, the incidence of posterior wall puncture is slightly higher in the modified S-OOP group. In the LA-IP approach the overall path of the needle and its tip is clearly seen and hence penetration of the posterior wall is prevented.

Zhen feng et all concluded that the presence common complications like hematoma, vasospasm and thrombosis were not statistically significant between the short axis and the long axis group. But there was a slightly lower incidence of hematoma in the modified short axis approach. In our study, Other complications like hematoma formation and vasospasm were not statistically significant between the two groups.

Thus with this modification to the SA-OOP approach, puncturing of artery is done with greater accuracy. This reduces multiple attempts and redirections, increases the first attempt success rate and reduces the rate of complications.

LIMITATIONS

This is a single study and so the sample size was kept small (120 patients). Probably a multicenter study with a greater sample size can better establish the superiority or inferiority of one method over another.

The learning curve for the techniques like ultrasound sound guided procedures is slow. The cannulations were done by anaesthesiologists with less experience.

Morbidly obese or patients with acute hemodynamic disturbances were excluded from this study. If those cases were included, the effectiveness of the USG could have been more widely evaluated.

CONCLUSION

In our prospective randomized comparative study of USG guided radial artery cannulation by long axis and modified short axis technique, we conclude that the decrease in ultrasonic location time and cannulation time for the modified SA-OOP technique are the direct results of the modifications.

The incidence of success in the first attempt was higher in the modified SA-OOP approach with decrease in the incidence of complications compared to the LA-IP approach.

ANNEXURES

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PROFORMA:

NAME: AGE/SEX: IP NO.:

DATE: Wt.: GROUP:

DIAGNOSIS:

SURGERY:

BRIEF HISTORY:

COEXISTING ILLNESS:

EXAMINATION:

PR: CVS:

BP: RS:

INVESTIGATIONS:

Hb: BLOOD UREA: SUGAR: Sr. CREATININE:

ASSESSMENT: ASA I / ASA II /ASA PS III

PARAMETERS OBSERVED:

The inner diameter of radial artery:

Depth from skin to artery:

ultrasonic location time:

Number of redirections:

Number of attempts:

Cannulation time:

Vasospasm: (present/absent)

Hematoma: (present / absent)

Posterior wall puncture:(present/ absent)

INFORMED CONSENT

PLACE OF STUDY: Govt Stanley medical college, chennai

NAME AND ADDRESS OF THE PATIENT:

I,---------------------------------- have been informed about the details of the study in my own language.

I have completely understood the details of the study.

I'm aware of the possible risks and benefits, while taking part in the study.

I understand that I can withdraw from the study at any point of time and even then, I will continue to receive the medical treatment as usual.

I understand that I will not get any payment for taking part in this study

I will not object if the results of this study are getting published in any medical journal, provided my personal identity is not revealed.

I know what i'm supposed to do by taking part in this study and I assure that I would extend

my full co-operation for this study.

Signature/ thumb impression of the volunteer
Date:

Witnesses:
(Signature, name and address)
Date:

Name and signature of the investigator: