EFFECT OF LEFT STELLATE GANGLION BLOCK ON LEFT INTERNAL MAMMARY ARTERY BLOOD FLOW AND POST BYPASS RADIO-FEMORAL PRESSURE DIFFERENCE IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFT

DISSERTATION

Submitted in partial fulfillment of the requirement for the degree of

D.M. (Cardiothoracic and Vascular Anesthesiology)

Of

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY,

Thiruvananthapuram, India

December 2015

Dr. Roshith Chandran

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DECLARATION

I hereby declare that this thesis titled, **"EFFECT OF LEFT STELLATE GANGLION BLOCK ON LEFT INTERNAL MAMMARY ARTERY BLOOD FLOW AND POST BYPASS RADIO-FEMORAL PRESSURE DIFFERENCE IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFT"** has been prepared by me under the capable supervision and guidance of **Dr. Rupa Sreedhar**, Professor and Head, Department of Cardiothoracic and Vascular Anesthesiology , **Dr. Shrinivas Gadhinglajkar**, Professor, Department of Cardiothoracic and Vascular Anesthesiology and **Dr. K Jayakumar**, Professor and Head, Department of Cardiothoracic and Vascular Surgery, at Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram.

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Date:
Place: Thiruvananthapuram

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Thiruvananthapuram, India

CERTIFICATE

This is to certify that the work incorporated in this dissertation entitled **"EFFECT OF LEFT STELLATE GANGLION BLOCK ON LEFT INTERNAL MAMMARY ARTERY BLOOD FLOW AND POST BYPASS RADIO-FEMORAL PRESSURE DIFFERENCE IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFT"** for the degree of D.M. (CARDIOTHORACIC AND VASCULAR ANESTHESIOLOGY) has been carried out by Dr. Roshith Chandran under our direct supervision and guidance.

The work done in connection with this dissertation has been carried out by the candidate himself and is genuine.

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Dedicated to,

The Almighty, who gave me life,

My beloved parents, who helped to nurture it,

My teachers, who helped to shape it,

And my wife, who helped to make it all, worthwhile!

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Last but not the least, I express my heartiest gratitude to my loving parents, my wife, Deepika and my in-laws, who have been a constant source of motivation and encouragement.

CONTENTS:

INTRODUCTION

Coronary artery disease (CAD) is the biggest cause of mortality in the developed countries and is one of the leading causes of morbidity in developing countries. In 2001, coronary artery disease caused 7.3 million deaths worldwide. [1]

In India, coronary heart diseases caused 1.17 million deaths in 1990 and by 2000 the mortality rose to 1.59 million. In India presently it is estimated that there are 31.8 million people living with coronary heart disease. [2]

Coronary artery disease is chiefly managed medically worldwide. Patients are sent for coronary artery bypass grafting (CABG) when the lesion is severe and the symptoms are unresponsive to medical management.

Since its inception in 1962 when Dr. Sabiston performed the first CABG, using a saphenous venous graft as a conduit from ascending aorta to distal right coronary artery, this modality of treatment has developed by leaps and bounds. Multiple variations of the grafting technique have been attempted and use of internal mammary artery (IMA) as a conduit for revascularization of left anterior descending (LAD) branch of left coronary artery (LCA) is now a firmly established benchmark. Multiple studies have suggested that the use of the left internal mammary artery (LIMA) graft to the left anterior descending coronary artery is the most important factor for survival and reduction of late cardiac events after CABG [3], [4], [5]. The CABG operation has become the most completely studied operation in the history of surgery and has been shown to be highly effective for the relief of severe angina. [6]

Sarabu MR *et al.* first reported spasm of left internal mammary artery (LIMA), when they cited two incidences of early post-operative vasospasm, which could be relieved only by re-exploration, and local application of vasodilators. Though the cause of LIMA spasm was only speculative, they had raised concern about the profound hemodynamic repercussions of the eventuality. [7]

Over the years, multiple case reports of early LIMA spasm emerged, and surgeons started using pharmacological vasodilators to tackle the problem. Various vasodilators

that have been tried included various organic nitrates, calcium channel blockers, sodium nitroprusside (SNP) and papaverine. [8]

In last few years, there have been some studies, which investigated the effect of regional anesthesia techniques such as thoracic epidural anesthesia (TEA) [9] and stellate ganglion block (SGB) [10] for sympatholysis and studied its effects on internal mammary artery diameter. These studies demonstrated vasodilation in the internal mammary artery via angiography and extrapolated an increase in blood flow through it.

Invasive blood pressure monitoring via preoperative radial artery cannulation is routinely performed in cardiac surgery. Baba T *et al.* [11] demonstrated that there is a significant femoral to radial arterial pressure gradient in patients undergoing surgery with cardiopulmonary bypass (CPB), which is especially evident during rewarming and weaning patients from bypass, and it persisted from 10 to 60 minutes post bypass. [12] Gravlee GP *et al.* [13] observed gradual increase in central to peripheral pressure gradient during rewarming post CPB.

The sympathetic nervous system plays an important role in ventricular arrhythmogenesis. Post cardiac surgery patients are especially vulnerable to this condition due to handling of cardiac structures, tissue oedema, post CPB systemic inflammatory response and inotropic infusions for supporting cardiac function. Left cardiac sympathetic denervation (LCSD) has shown to decrease the incidence of ventricular arrhythmias and sudden cardiac death in patients with recurrent and intractable ventricular arrhythmias. [14]

In our study, we have compared the internal mammary artery blood flow, by measuring it directly during LIMA harvesting, in two groups of patients (those who have received SGB and those who have not). We also noted whether upper limb sympatholysis has any effect on radio-femoral pressure difference during various stages of the surgery. We noted whether stellate ganglion block had any effect on incidence arrhythmias in the intraoperative and post-operative period

AIMS AND OBJECTIVES

1) To compare the effect of left stellate ganglion block versus topically applied papaverine on left internal mammary artery blood flow in patients undergoing coronary artery bypass grafting.

2) To compare the post cardiopulmonary bypass Radio – Femoral blood pressure difference in the group receiving the block versus the group not receiving it.

3) To compare hemodynamic parameters (heart rate, systolic, diastolic and mean blood pressure) and incidence of arrhythmias in the two groups.

4) To assess success rate of SGB, when administered under ultrasound guidance.

5) To assess the safety of SGB in patients anticoagulated with large doses of heparin.

6) To evaluate the effect of SGB on the incidence of ventricular arrhythmias and atrial fibrillation

REVIEW OF LITERATURE:

Stellate ganglion anatomy:

The stellate ganglion, named after its star-shaped appearance, results from the union of the inferior cervical ganglion with the first and second thoracic ganglion. [15]

Anatomically, the stellate ganglion is bordered laterally by the scalene muscles, medially by the longus colli muscle, posteriorly by the transverse processes and pre-vertebral fascia, anteriorly by the subclavian artery, and inferiorly by the posterior aspect of the pleura. The vertebral artery originates from the subclavian artery in the proximity of the stellate ganglion and commonly is found anterior to it. Though there is considerable variation in the size of the ganglion, it usually measures 2.5 cm in length (cranio-caudal), 1.0 cm in width (medial to lateral) and 0.5 cm in height (antero-posterior).

Sympathetic innervation to the upper extremity is provided by the stellate ganglion through gray communicating rami of C7, C8, T1 and occasionally C5 and C6. Some efferent fibers from the stellate ganglion travel with the major vascular structures, predominately the subclavian and common carotid arteries.

Block of the stellate ganglion should successfully denervate the sympathetic component to the head and neck because all pre-ganglionic nerves either synapse here or pass through on their way to more cephalad ganglia. Horner's syndrome may be produced by the block of the middle or superior cervical ganglia but there is a likelihood that it can miss the lower distribution of sympathetic fibers traveling from the stellate ganglion to the vertebral plexus and subclavian plexus. [16], [17]

Postganglionic sympathetic nerves destined for the upper extremity leave the stellate ganglion as gray communicating rami to join the anterior divisions of C5 through T1. Some postganglionic nerves pass directly from the sympathetic chain to form a subclavian perivascular plexus and innervate the subclavian, axillary, and upper part of the brachial arteries. [18]

The stellate ganglion is present in only 80% of the population, [19], [20] so a more correct term for stellate ganglion block should be either lower cervical sympathetic block or upper thoracic sympathetic block (cervico-thoracic sympathetic trunk block)

Methods of delivering stellate ganglion block:

a) Landmark guided/Surface anatomy/Blind
   - Anterior: C6 level or the classical method
     C7 level
   - Posterior: T1 level
   - Interpleural technique
b) Radiologically (CT) guided
c) MRI guided
d) Ultrasound guided

Classical (Landmark guided) technique of SGB:

The classical para-tracheal method of delivering stellate ganglion block relied on anatomical landmarks such as cricoid cartilage to identify the level of C6 vertebra and palpating Chassaignac's tubercle (C6 tubercle). The carotid artery pulsation is felt and the artery is retracted laterally followed by vertical placement and advancement of the needle till it hits the bony prominence. The needle is then retracted 2-4 mm and drug is delivered after confirming negative aspiration of blood or CSF.

Hogan QH *et al.* [21] performed stellate ganglion block in 8 healthy volunteers by the blind para-tracheal method and studied the spread of the drug using MRI. They noted that the drug spread anterior to the ganglion.

Guntmukkala M *et al.* [22] performed stellate ganglion block with methylene blue in 20 cadavers to study the distribution of the injectate. They noted that the solution spread into the posterior mediastinum and along the apical pleura. There was no spread onto the thoracic sympathetic chain. Both these studies demonstrate the unreliability of the blind technique of stellate ganglion block.

Stellate ganglion block under radiological guidance:

Janik JE *et al.* [23] acquired computed tomography (CT) images to study the cervical spine of 70 adult patients and observed that there was large variability observed in the location and size of the landmarks used for guiding needle placement during stellate ganglion block. Fluoroscopy guided techniques help localizing the transverse process of the C6 and C7 vertebrae and use them as surrogate markers for the cervical sympathetic trunk. Though visualization of the spread of the drug, by mixing radio-opaque dye with the injectate helps improve the accuracy of drug delivery, it cannot guarantee blockade of the ganglia. Fluoroscopy cannot identify soft tissue or vascular structures along the path of the needle. Exposure to high amount of radiation is another drawback of the procedure.

Tip of the needle should ideally be placed anterolateral to the Longus colli muscle, deep to the pre-vertebral fascia (to avoid spread along the carotid sheath) but superficial to the fascia covering the longus colli muscle (to avoid injecting into the muscle substance).

Ultrasound guided Stellate ganglion block:

Kapral *et al.* [24] in 1995, published the first case series on ultrasound technique for SGB, but this technique has only recently gained popularity.

Ultrasound guidance helps to identify the correct fascial plane, thus facilitating caudal spread of the injectate to reach the stellate ganglion at C7-T1 level, even with the needle placement at the level of C6. Thus more effective and precise sympathetic block can be achieved with even small injectate volume. Ultrasound-guided SGB may also improve the safety of the procedure by direct visualization of vascular structures (inferior thyroidal, vertebral, and carotid arteries) and soft tissue structures (esophagus, thyroid and nerve roots). The risk of vascular and soft tissue injury may thus be minimized.

Shibata Y *et al.* [25] performed stellate ganglion block under USG guidance and noted that the method helps deposit the drug deep to the pre-vertebral fascia more

consistently. It was associated with more reliable caudal spread of the drug and thus higher efficacy. Injectate deposited anterior to the pre-vertebral fascia, tends to spread around the carotid sheath, blocking the RLN (Recurrent laryngeal nerve) causing increased risk of hoarseness of voice.

The esophagus is deviated to the left of the trachea in about 50–70 % of the population, as shown by different imaging modalities. [26] This is particularly important when left sided stellate ganglion block is intended. Mediastinitis can be caused due to esophageal injury, particularly if the patient has an unrecognized diverticulum. Narouze S *et al.* [27] reported a case where ultrasound guided stellate ganglion block helped avoid an injection into an esophageal diverticulum.

Siegenthaler A *et al.* [28] performed USG of the neck to delineate the sono-anatomy of the stellate ganglion. They noted that esophagus and inferior thyroidal, vertebral and carotid arteries were in the needle path in most of the patients. They performed routine retraction maneuvers customary to performance of the block and noted that these maneuvers had only partial impact on moving these structures away from the target and in some cases may increase left-sided esophageal puncture risk in certain individuals. They concluded that direct ultrasound imaging will improve the safety of SGB.

The inferior thyroid vessels in some patients can be large and can run a tortuous and variable course, and thus can cause retropharyngeal hematoma after SGB. In some variants, it can cross the carotid artery from lateral to medial at C6-C7 level and can thus be vulnerable to injury during the procedure. [29]

Precise administration of the SGB, using ultrasound allows the use of a small volume of injectate while maintaining the same degree of efficacy and thus improves patient safety. Wulf *et al.* [30] reported toxic plasma levels in 30 % of patients undergoing SGB using 10 ml of 0.5 % bupivacaine, by the blind technique. Two studies have recently been conducted on investigating the optimal volume of local anesthetic necessary for successful ultrasound-guided SGB as compared to the traditional approach. Lee MH *et al.* showed that 2 ml of 0.5 % Mepivacaine was sufficient for a successful block, [31] while Jung G *et al.* showed the optimal volume was 4 ml of 0.2 % Ropivacaine [32].

In his pilot study, Kapral *et al.* [24] found that ultrasound-guided SGB, required a lower volume of local anesthetics (5 ml rather than 8 ml) and there was a more rapid onset of Horner's syndrome, as compared with the blind technique.

Success of stellate ganglion block:

Successful sympathetic blockade to the head and neck structures is easy to recognize clinically and is documented by the presence of Horner's syndrome, which includes miosis, ptosis, enophthalmos; also associated with that are conjunctival congestion, nasal stuffiness and facial anhydrosis. Presence of Horner's syndrome however, does not indicate complete blockade of the sympathetic flow to the upper extremity. [33] The most commonly used test is measurement of the temperature of the skin. Elevation of the temperature by 1 to 3°C typically indicates sympathetic blockade [34], [35] and is usually measured by thermography or contact thermometry. [36]

Malmqvist *et al.* [37] recommended that successful sympathetic blockade should satisfy five criteria,

1. Horner's syndrome within 300 seconds
2. Final skin temperature of more than 34° C, assuming a pre-block temperature of 32° C or lower (1 to 3° C temperature increase)
3. Increase in blood flow by 50% or more from the pre-block status
4. Abolition of skin-resistant response (sympatho-galvanic response) on the radial and ulnar side following the block
5. Increase in the skin-resistant response of up to 13% or more of the pre-block value on the radial and ulnar side of the extremity where block has been delivered [34], [37], [38]

Other methods used to predict success of sympathectomy include pulse-amplitude changes, which are is subject to variations. [39] Lindberg and Wallin [40] used microneurography, which is a direct but invasive test requiring expensive equipment and extensive experience. [34], [36] The sweat test (ninhydrin, cobalt blue and iodine-starch test) [36] is cumbersome and time consuming and not well accepted by a fair amount of patients and therefore not widely used. Other methods used to measure blood flow include plethysmography (muscle and skin), xenon-133 and sodium-24

clearance (by the skin and muscle). [36] Electromagnetic flow meters have been used for whole limb blood flow. [36]

Temperature measurement is probably the most widely used technique, among the above mentioned tests, to assess complete sympathectomy of the affected site.

Left internal mammary artery spasm post CABG:

Sarabu MR *et al.* in 1987 described 2 cases of early post operative IMA spasm which could be relieved only by re exploration and local application of vasodilators. Though the reason for the same was unknown, they had raised concern about the profound hemodynamic repercussions of the eventuality. [7]

One year later, Kong *et al.* [41] described the angiographic presentation of IMA spasm in a patient who underwent CABG

Ziadinov, E. *et al.* [42] noted that vaso-reactivity was a complex process, where in a homeostatic equilibrium between constriction and dilation is established, which is modulated by a number of different neurotransmitters, cascades and receptors. Internal mammary artery is histo-anatomical similar to a somatic artery and is capable of undergoing severe spasm. They also noted that the actual incidence of this entity remains unknown and under reported; as any post operative myocardial ischemia gets empirically treated with NTG (Nitroglycerine) and tapering of vasopressors. Also timely angiographic data is unavailable as patients undergo aggressive medical management and with the risk of hemodynamic instability, are not shifted to a catheterization laboratory.

Endothelial dysfunction and increased sensitivity for endogenous vasoconstrictors is commonly noted in patients with comorbidities such as hypertension, diabetes, and dyslipidemia. [43], [44] Turoni *et al.* demonstrated that hypertension increases the basal arterial tone, reducing the response to passive stretching of the IMA and impairs nitric oxide release. [45]

Metabolic factors like hypokalemia, hypercalcemia, hypomagnesemia, hypoglycemia and increased serum lactates have all been implicated for contributing to IMA spasm as noted by G.W. He *et al.* [46]

Pharmacological methods for treating LIMA spasm:

In view of serious complications occuring due to IMA spasm, surgeons have traditionally been using pharmacological measures to prevent it. Commonly used drugs include SNP, organic nitrates like NTG, papaverine and calcium channel blockers.

Multiple agents have been compared with each other over the years for their potency and safety. Several authors reported that sodium nitroprusside is more potent than nicardipine, nicorandil, fenoldopam, hydralazine, adenosine, and labetalol. [47], [48]

Some authors have also tried using combination therapy of dilators to investigate if the effect is super-additive. Harskamp R.E. *et al.* [49] compared various combination regimen and noted that they were nearly as effective as sodium nitroprusside alone.

Multiple authors have tried comparing various routes of administration of these drugs to identify the most effective method. Intraluminal route gives maximum vasodilation followed by topical or in-pedicle injection. Intraluminal injection carries the risk of dissection of the vessel. Intraluminal papaverine adversely affects the endothelium because of low pH and thus is not recommended.

Yildiz O *et al.* noted that the distal segment of IMA is usually more involved in spasm as vasoconstrictive receptors are more expressed in a distal direction. [43] They suggested that of the length of IMA allows, it should be shortened to note if flow improves.

Tarhan A *et al.* [50] conducted a study comparing warm saline to topical papaverine as a method to prevent IMA spasm. They noted no difference in the blood flow in IMA between both the groups. This study demonstrated the importance of maintaining the temperature of the administered fluids at 37°C.

Choi *et al.* [51] compared the response of skeletonized graft versus pedicled IMA graft to sympathetic stimulus and to local application of nor-adrenaline. They noted that skeletonization of the IMA completely abolishes sympathetic nervous system influence; causing arterial dilation and increased blood flow through it. This was proven by measuring flow before and after skeletonization, as well as demonstrating

insensitivity of free IMA grafts to nor-adrenaline. [52]

Gaudiani V.A. [53], Jeanmart H. [54], and Abad C. [55] have all reported using various atraumatic mechanical devices like angiography balloon catheter and Fogarty catheter for routine dilation of the IMA. Presently, they are not widely used due to the high risk of injury to the endothelium and thereby reducing the long-term graft patency. Introduction of coronary steel probe into IMA is a rough procedure and its use is not recommended.

Sivalingam S *et al.* [8] conducted a meta-analysis of 200 articles indexed in Pubmed to identify the optimal vasodilator for preventing spasm of the internal mammary artery in coronary artery bypass surgery. They concluded that mammary arteries often have low flow initially due to handling, but in around 15-20 minutes, the flow invariably doubles even with no treatment. They noted that strongest evidence for safe prevention of spasm was for papaverine administered topically and peri-arterially. Many studies have also shown no benefit with vasodilator therapy and thus no treatment at all can also be an entirely acceptable strategy.

Regional anesthesia for preventing LIMA spasm:

Use of regional anesthesia techniques in CABG began with thoracic epidural as a supplement for general anesthesia and has progressed over the years to CABG being performed under thoracic epidural anesthesia alone. The use of thoracic epidural anesthesia has proven benefits in patients undergoing cardiac surgery as shown by multiple large trials and meta analysis. [56], [57], [58], [59], [60]

Donmez A *et al.* [61] administered stellate ganglion block in patients undergoing CABG and demonstrated increased diameter of the proximal and distal radial arteries as well as the internal mammary artery by transthoracic echocardiography. They also demonstrated the effect in vitro, though the cause for the same remains unknown.

Gopal D *et al.* [10] administered stellate ganglion block in 30 patients undergoing coronary angiography. The IMA diameter before and 20 minutes after the block was noted via angiography. They demonstrated significant increase in the vessel diameter without any hemodynamic compromise.

Yildrim Y *et al.* [62] administered stellate ganglion block in 50 patients undergoing CABG with radial arterial grafts and compared the flow through the arterial graft against patients not undergoing stellate ganglion block. They demonstrated vasodilation and increased flow across the arterial conduit using Doppler ultrasound techniques.

Onan IS *et al.* [9] investigated the effects of thoracic epidural in patients undergoing CABG on IMA blood flow. They randomized 30 patients into 2 groups, one that received thoracic epidural and the other being given general anesthesia for the surgery. They found that IMA blood flow in patients of the group, which received thoracic epidural, was significantly more as compared to the patients who received general anesthesia. They biopsied a sample of the vessel and demonstrated increased adenosine A2B receptors, VEGF (Vascular Endothelial Growth Factor) and iNOS (Inducible nitric oxide synthase) on the endothelium and smooth muscle cells of the IMA wall by immunocytochemistry. All these secondary mediators are produced by IMA and are known to mediate vasodilation by inducing endothelial nitric oxide release. The authors thus suggested that TEA might be useful to prevent perioperative ischemia and associated major cardiac events because of graft failure.

Radio-femoral pressure difference after institution of CPB:

Stern *et al.* [63] first reported the phenomenon of pressure differences between the aorta and the radial artery which appeared after cardiopulmonary bypass (CPB). Over the years many investigators have reported an aortic and/or femoral-to-radial artery pressure gradient after CPB.

Many authors have attempted to postulate the reason for this radio-femoral pressure difference. Pauca AL *et al.* [12] suggested a decrease in vascular resistance of the upper extremity or the hand while Maruyama *et al.* suggested that vasodilators may be responsible for the pressure gradient.

In contrast, Baba *et al.* [11] and Nakayama *et al.* [64] reported that peripheral vasoconstriction or vasospasm was responsible for the pressure gradient. Gravlee *et*

al. [13] cannulated multiple sites (aorta or femoral artery and radial artery), measured the pressure gradient between them under limited clinical conditions, and postulated that peripheral vasoconstriction was responsible for the gradient.

Although Rich *et al.* [65] and De Hert *et al.* [66] demonstrated that appearance of the pressure gradient was associated with the initiation of CPB, the etiology of the pressure gradient remains controversial.

Kanazawa *et al.* [67] introduced a miniature pressure transducer tipped catheter via the radial artery and studied the pulse wave velocity from the aorta to the peripheries. They noticed that there is a linear decrease in the pulse wave velocity along the vascular tree which implies a decrease in arterial elasticity. They postulated that decrease in arterial elastance at onset of CPB was responsible for the radio-femoral pressure difference.

Treatment of arrhythmias using Stellate ganglion block:

The sympathetic nervous system plays an important role in ventricular arrhythmogenesis. Various factors including acute myocardial ischaemia, heart failure, electrolyte imbalance (potassium and magnesium), inotropic drug infusions, hyperthyroidism, infection and fever are all known to precipitate arrhythmias. [68]

Han S *et al.* [14] demonstrated that post myocardial infarction, there is increase in synaptic density as well as electrical activity in the stellate ganglion. This indicated significant electro-anatomical and extra-cardiac autonomical nerve activity remodeling occurring post myocardial infarction.

Nademanee *et al.* [69] conducted a study in 49 patients suffering from electrical storm post myocardial infarction. They separated the patients into two comparable groups. One group was administered sympathectomy (pharmacological and regional) while the other was treated with anti-arrhythmic medications alone. They maintained a follow up of the patients for 1 year and noted lower mortality in the group in whom sympathetic block was administered.

Bourke *et al.* [70] administered sympathetic block in the form of thoracic epidural anesthesia and left cardiac sympathetic denervation via video-assisted thoracoscopic surgery (VATS) to select group of retrospectively identified patients with recurrent ventricular arrhythmias and noted a significant reduction in the number of ventricular arrhythmias.

There have been multiple case reports of use of SGB for treatment of electrical storms. [71], [72] Various mechanisms of action of SGB against arrhythmias have been proposed. Reduction in adrenergic outflow has been proposed as the most important factor reducing the arrhythmia potential. [72] LSGB also been shown to be effective in controlling arrhythmias by shortening the QTc interval. [73]

MATERIALS AND METHODS

A. Institutional ethics committee and technical advisory committee approval was obtained before this study was initiated.

B. Design:

Prospective, interventional, randomized controlled trial

C. Subject/participant selection:

1. Number: 100 Consecutive patients who underwent elective coronary artery bypass grafting under cardiopulmonary bypass were enrolled into the study, if they fulfilled inclusion criteria and gave written consent for the study, after study details were explained to them.

   This was in conjunction with a study conducted by Yildrim et al [62] who administered stellate ganglion block in 50 patients and compared them to a similarly sized control group to study the effect of the block on the radial artery diameter.

2. Inclusion criteria:
   a. Age – 18 to 80 years
   b. Patients who were slated to undergo elective coronary artery bypass graft surgery under Cardiopulmonary bypass in The Department of Cardiothoracic Surgery, SCTIMST

3. Exclusion criteria:
   a. Patient not willing to participate in the study
   b. Age more than 80 years
   c. Ejection fraction < 45%
   d. History of strokes / Transient ischaemic attacks in past
   e. History of Glaucoma.
   f. History of allergy to local anesthetic drugs
   g. Emergency coronary artery bypass graft or reoperations.

h. Presence of Chronic obstructive pulmonary disease (COPD)
i. Patients with renal dysfunction (Serum Creatinine > 1.5)

4. Recruitment: The investigators recruited the patients during the pre-anesthetic checkup on the day prior to the slated surgery. Patients were provided complete details of the study in the presence of a witness. All procedure related questions were addressed and written informed consent obtained from them.

D. Informed consent: in English and Malayalam

E. Duration of study: 18 months

F. Funding: Nil

G. Study protocol:

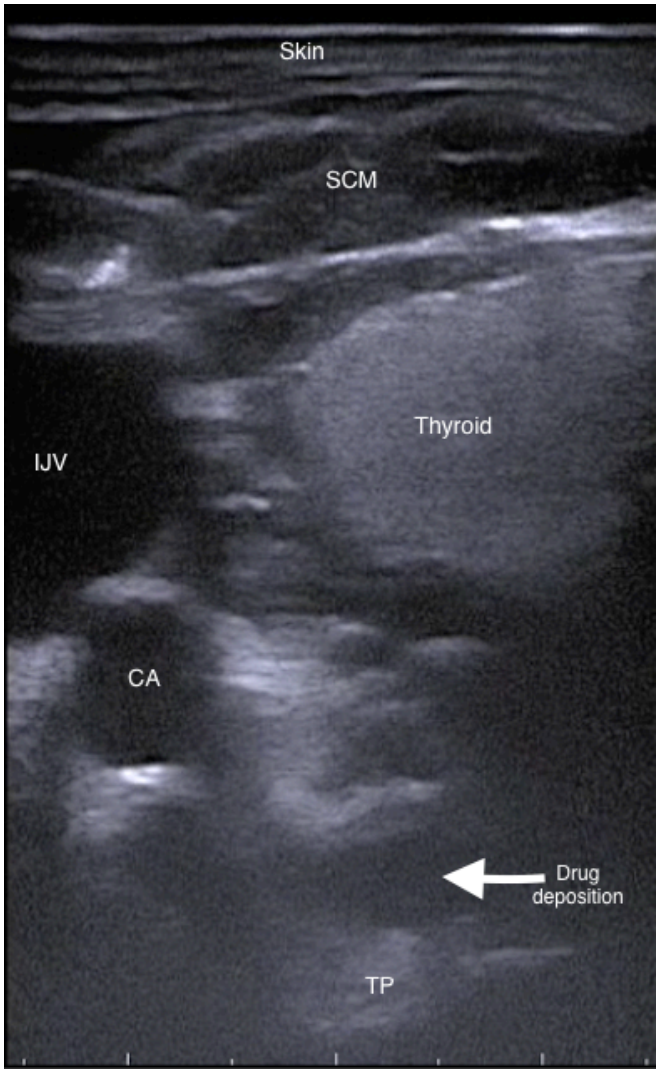
Study groups: The patients were randomized into 2 groups by computerized randomized table as follows

I. Group S – Patients receiving stellate ganglion block
II. Group C – Patients in the control group

Patients underwent anesthesia induction with Inj Midazolam 0.1mg/kg IV, Inj Fentanyl 10mcg/kg IV and Inj Pancuronium 0.1mg/kg IV after securing an IV access and a left radial arterial access. Anesthesia was maintained with Sevoflurane or Isoflurane at 1 MAC, infusion Morphine 40 mcg/kg/hour and intermittent Pancuronium doses, titrating it to a BIS value of 40. Supplemental doses of midazolam and fentanyl were administered as per requirement. After anesthesia was induced, the internal jugular vein and femoral artery were cannulated.

After internal jugular vein cannulation, patients were positioned with head in midline position and mild extension of the neck. Cricoid cartilage was identified by midline palpation of the neck. Esaote MyLab One (Esaote Europe, Maastricht, The Netherlands) with 12Mhz ultrasound probe was used to identify the structures of the

neck. The airway was identified by the shadow of the cricoid cartilage at the level of C6 vertebrae. With the probe being moved laterally, internal jugular vein, carotid artery and thyroid was identified. Depth of ultrasound field was adjusted to include transverse process of the C6 vertebra, which is identified by its typical bright echo-luminance. Color Doppler was used to make sure that there are no vascular structures along intended the needle track. Following complete aseptic precautions, a 22 G, 10 cm long needle was inserted under ultrasound guidance and directed towards the transverse process of the C6 vertebra, passing between the medial border of carotid artery and the lateral margins of the thyroid gland. After the needle tip makes contact with the transverse process, it is withdrawn 2 mm and 8 ml of 0.25% Bupivacaine was injected, visualizing the drug deposition into the longus colli compartment.



Labels:

IJV: Internal Jugular Vein

CA: Carotid artery

TP: Transverse process of vertebrae

SCM: Sternocleidomastoid

Picture 1: Sono-Anatomy of the stellate ganglion block

Block was considered a success if the skin temperature on the index finger of the left upper limb increased by more than 1.5 degree Celsius as compared to the baseline values.

Vitals of the patient (Heart rate, blood pressure) were intensively monitored throughout the duration of surgery as well as in the post-operative period in the Cardiac Surgery ICU.

After dissection of LIMA, administration of adequate dose (400 IU/kg body weight) of heparin and confirmation of adequate anticoagulation, the blood flow through the vessel was noted for 15 seconds, keeping mean pressures in the narrow range between 70-75 mmHg. The vessel was allowed to bleed freely into a measuring chamber for 15 seconds and the volume was noted. The process was repeated twice and mean of the two values were taken as the LIMA flow after extrapolating it for 1 minute. The collected blood was delivered back to the patient through the cardiopulmonary bypass machine.

Both radial and the femoral arterial pressures were monitored and the values compared at specified intervals as mentioned below.

Patients, in whom no difference in the skin temperature between the index fingers is noted even after 20 minutes of performance of block, were treated as failure of block and were excluded from the study.

Any complications occurring due to the administration of the block was recorded.

H. Observations:

The following observations were made in all patients

i. Pulse: (Baseline, every 5 minutes after the block for 20 minutes, just before measuring internal mammary artery blood flow, at 10 minutes post aortic cross clamp, during rewarming, and at every 10-minute interval after the patient was weaned off bypass till shifting to ICU)

ii. Blood pressure: Systolic and Diastolic (Baseline, every 5 minutes after the block for 20 minutes, just before measuring internal mammary artery blood flow, at 10 minutes post aortic cross clamp, during rewarming, and at every 10 minute interval after the patient was weaned off bypass till being transferred to ICU)

iii. Left internal mammary artery blood flow: (After dissection, with MAP maintained between 70 to 75 mmHg)

iv. Complications: (if any)

v. Incidence of arrhythmias: in the ICU in immediate 24 hours post block

OBSERVATION AND RESULTS

Our study is a prospective single center randomized control trial carried out in 100 patients undergoing elective CABG between the age of 18 to 80 to study the effect of stellate ganglion block on left internal mammary artery blood flow. The study population of 100 patients were randomized into study (S) and control (C) groups of 50 patients each.

Group S: This group of patients were administered left sided stellate ganglion block after induction of anesthesia as per standardized protocol.

Group C: This group of patients underwent induction of general anesthesia as per standardized protocol and did not receive stellate ganglion block.

The data obtained was subjected to statistical analysis using Student's Unpaired T-Test and Fisher's exact test to find out significant difference between the groups. For statistical comparison, difference was considered significant when the P value was found to be less than 0.05.

Table 1: Comparison of demographic data between the two groups

Parameter	SGB	Control	Test applied	P Value	Significance
Age (Years)					
Mean	60.42	56.7	Unpaired T	0.27	Not
S.D.	8.09	8.57	Test		significant
Range	42-76	40-78			
Weight (Kg)					
Mean	64.75	64.5	Unpaired T	0.87	Not
S.D.	8.38	7.3	Test		significant
Range	45-89.8	50.1-83.3			
Sex (%)					
Male	41	42	Fisher's	0.69	Not
Female	9	8	Exact test		significant

BSA Mean S.D. Range	 1.7 0.14 1.36-2.07	 1.7 0.12 1.43-2.06	 Unpaired T Test	 0.79	 Not significant
EF (%) Mean S.D. Range	 58.6 6.08 45-70	 60.18 6.68 45-72	 Unpaired T Test	 0.22	 Not significant
Number of Grafts Mean S.D. Range	 4.26 0.75 2-5	 4.44 0.58 3-5	 Unpaired T Test	 0.18	 Not significant

The patients were demographically similar in study and control groups. (Table1) The above table shows that age of the patients was ranging from 40 – 78 years with mean age of 60.4 ± 8.09 years in study group and 56.7 ± 8.57 years in control group which is statistically not significant.

In the study 82% of patients in stellate ganglion group and 84% of patients in papaverine group were males. (Figure 1)

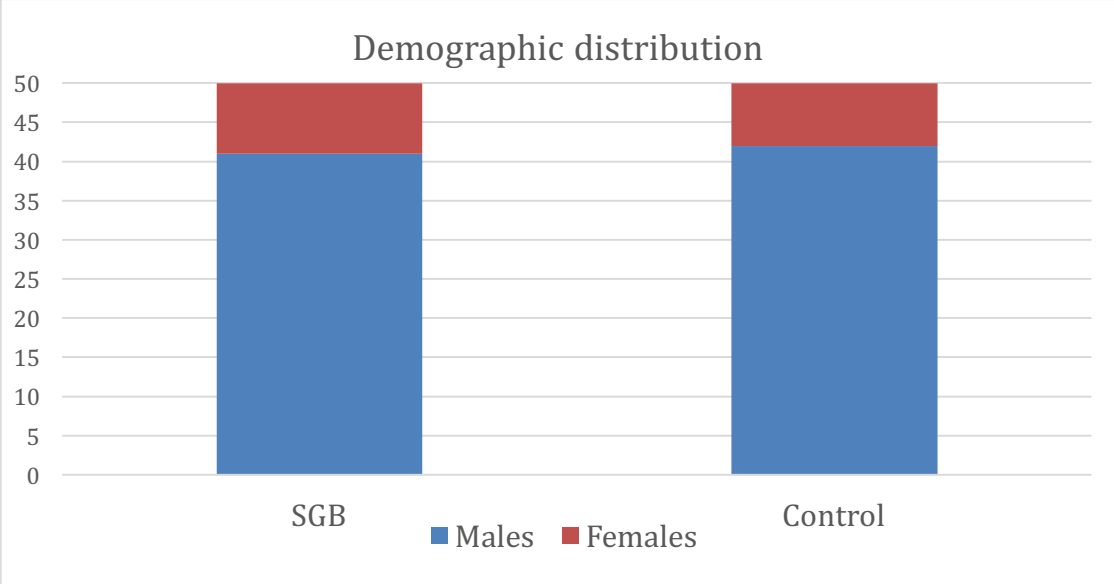


Figure 1: Demographic distribution between the groups

The mean weight was 64.75 ± 8.38 kg in the study group as compared to 64.5 ± 7.3 kg in the control group. Body surface area (BSA) of the patients was comparable in both the groups. The other demographic parameters that were compared include the ejection fraction and number of grafts which were placed. These parameters too were similar in both the groups. (Table 1)

Presence of comorbidities like hypertension, diabetes mellitus, smoking and dyslipidemia were noted in all patients taking part in the trial. These comorbidities could have directly or indirectly (in the form of medications for treatment of these illnesses) confounded and influenced the results of the study. These were found to be distributed equally among the two groups. (Table 2)

Table 2: Distribution of comorbidities between the groups

Parameter	SGB	Control	Test applied	P Value	Significance
Hypertension					
Positive	41	40	Fisher's	0.72	Not significant
Negative	9	10	exact test		
Diabetes Mellitus					
Positive	26	30	Fisher's	0.24	Not significant
Negative	24	20	exact test		
COPD					
Positive	2	3	Fisher's	0.55	Not significant
Negative	48	47	exact test		
Smoking					
Positive	24	22	Fisher's	0.56	Not significant
Negative	26	28	exact test		
Dyslipidemia					
Positive	46	44	Fisher's	0.38	Not significant
Negative	4	6	exact test		

We noted the hemodynamic parameters (heart rate, systolic, diastolic and mean pressures, both in radial and femoral arteries) of the patient from the time they were shifted into the operation theatre

The variations in the hemodynamics were charted and there was no significant difference noted between the patients in the study group as compared to the control group (Table 3)

Table 3: Comparison of pre CPB mean pulse rate between the groups

Duration in minutes	Mean pulse rate (beats/minute)			Significance
	SGB	Control	P Value	
Baseline	67.3 ± 10.6	66.5 ± 12.9	0.93	Not significant
5 mins	63.5 ± 10.8	64.7 ± 13.0	0.63	Not significant
10 mins	63.9 ± 10.9	64.0 ± 13.1	0.95	Not significant
15 mins	63.9 ± 10.1	63.0 ± 11.7	0.66	Not significant
20 mins	63.8 ± 10.2	63.6 ± 9.4	0.94	Not significant
Prior to LIMA flow reading	63.5 ± 9.6	64.3 ± 8.9	0.65	Not significant

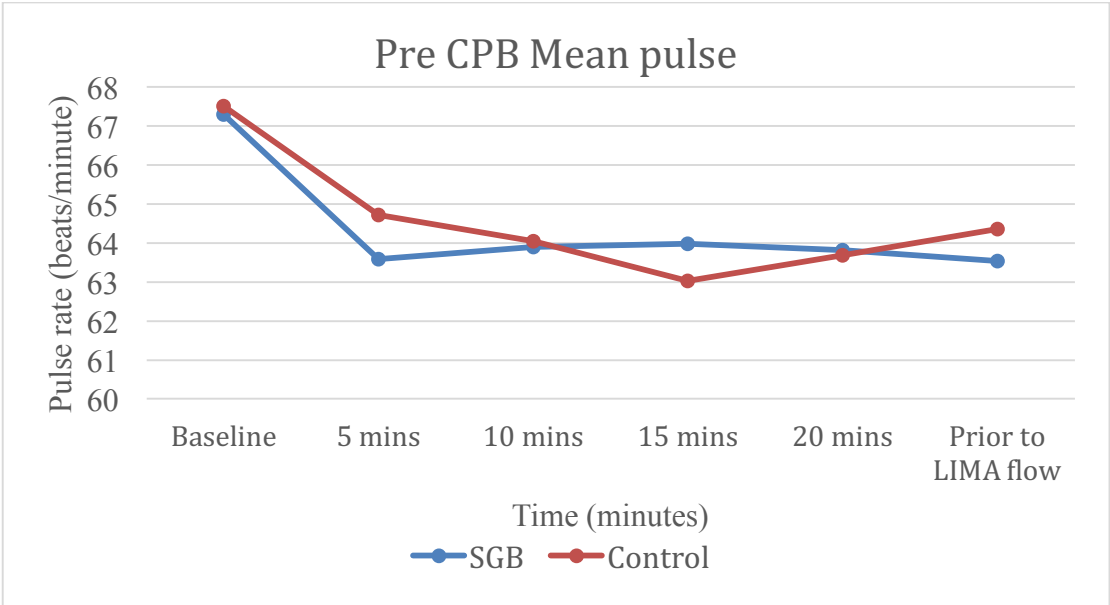


Figure 2: Comparison of pre CPB mean pulse rate between the groups

The difference in mean pressures between the left radial and femoral pressures was calculated in the pre bypass period and charted. It was noted that the radio-femoral arterial pressure difference was positive, which meant that the mean radial arterial pressures was consistently higher than the mean femoral arterial pressures in both the groups. The difference though was only minor and the trend in the difference between the upper and lower limb pressures was largely statistically non significant except at the 10th and 20th minute post induction. (Table 4)

Table 4 : Comparison of Pre operative mean radio femoral pressure difference between the groups

Duration in minutes after induction	Mean Radio-Femoral pressure difference (mmHg)		
	SGB	Control	P Value
Baseline (Pre-induction)	1.51 ± 2.25	1.91 ± 2.15	0.37
5 mins	1.00 ± 1.65	1.05 ± 1.97	0.88
10 mins	0.47 ± 2.11	1.21 ± 1.52	0.05
15 mins	1.03 ± 2.29	1.49 ± 1.66	0.25
20 mins	0.60 ± 2.14	1.44 ± 1.94	0.04
Prior to LIMA flow reading	0.61 ± 1.73	1.00 ± 2.3	0.34

After the left internal mammary artery dissection and with the the blood pressure kept steady between the MAP of 70 to 75 mmHg, the blood flow in the LIMA was measured by letting it to flow feely into a container for 15 seconds. The readings were obtained and the reading was repeated within 5 minutes again. Mean of both the readings were extrapolated as blood flow per minute and the readings were compared. It was noted that the LIMA flow in the stellate ganglion group was 49.28 ± 7.88 ml/minute as compared to 47.12 ± 7.24 ml/minute in the control arm of the study. The difference in the blood flow was found to be statistically non significant. (Table 5)

Table 5 : Comparison between LIMA flows between the two groups (ml/min)

Groups	LIMA blood flow	Test Applied	"P" Value	Significance
SGB	49.28 ± 7.88	Unpaired T Test	0.15	Not significant
Control	47.12 ± 7.24			

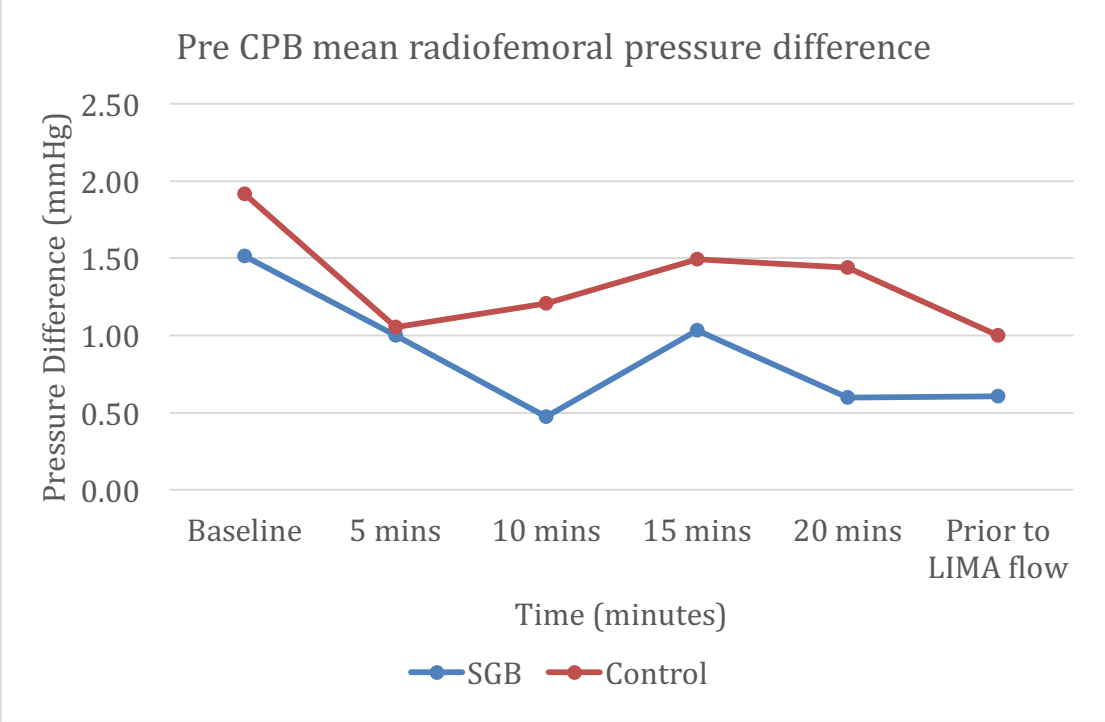


Figure 3: Comparison of pre CPB mean radio-femoral mean arterial pressure (MAP) difference between the groups

After adequate heparin administration and confirmation of anticoagulation, patient underwent aortic and right atrial cannulation and CPB was initiated. The MAP of the patients at 10 minutes into the CPB run and at onset of rewarming was noted, both in the radial and the femoral arteries in both the groups and they were compared. The femoral pressures were noted to be higher than the radial pressures in most of the instances. The radio-femoral pressure difference in the SGB group was -1.26 ± 1.79 and -1.3 ± 2.72 as compared to -0.48 ± 1.88 and -2.96 ± 3.66 in the control groups at 10 minutes of initiation of CPB and at rewarming respectively. There was significant radio-femoral pressure difference (>5mmHg) in 28% of the patients in the entire

study population. The radial-femoral pressure difference was significantly lesser in the SGB group as compared to the control group. (Table 6)

Table 6: Comparison of Intraoperative mean radio-femoral pressure difference between the groups

Duration in minutes	Mean Radio-Femoral pressure difference (mmHg)			Significance
	SGB	Control	P Value	
10 mins	-1.26 ± 1.79	-0.48 ± 1.88	0.03	Significant
Rewarming	-1.3 ± 2.72	-2.96 ± 3.66	0.01	Significant

Hemodynamic parameters (pulse rate, systolic, diastolic and mean blood pressures in the radial and femoral arteries) of all the patients were noted at 10 minutes interval after discontinuation of CPB till patient was transferred to the post operative care ICU.

The mean pulse rate in both the groups was tabulated in the patients post separation from the CPB and there was no significant difference between the groups (except at 30 minutes). (Table 7)

Table 7: Comparison of post CPB mean pulse rate between the groups

Duration in minutes	Mean pulse rate (beats/minute)			Significance
	SGB	Control	P Value	
10 mins	84.84 ± 12.77	81.86 ± 11.45	0.22	Not significant
20 mins	86.52 ± 10.31	83.38 ± 12.01	0.16	Not significant
30 mins	88.04 ± 12.8	82.98 ± 12.24	0.04	Significant
40 mins	89.14 ± 11.96	84.40 ± 12.98	0.06	Not significant
50 mins	88.88 ± 11.93	87.48 ± 13.23	0.57	Not significant
60 mins	90.16 ± 12.18	87.72 ± 11.86	0.31	Not significant
Shifting	89.12 ± 9.82	86.86 ± 10.47	0.26	Not significant

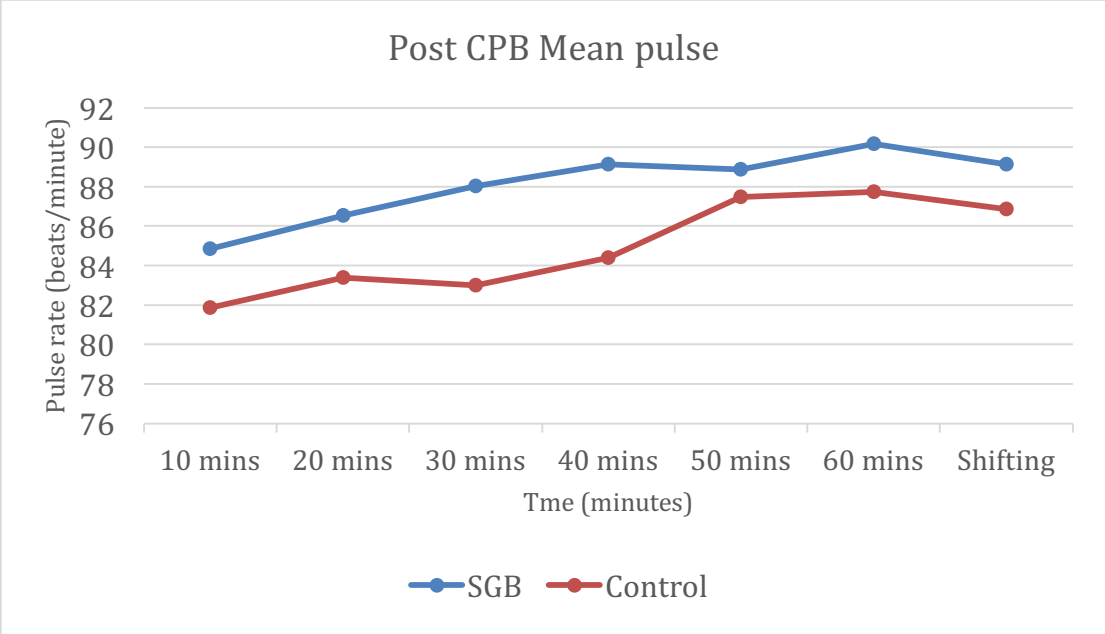


Figure 4: Comparison of post CPB mean pulse rate between the groups

Some patients required temporary pacing post the CPB, but there was no difference in the incidence of pacing requirement in patients of either groups. (Table 8)

Table 8: Post CPB pacing requirement (n = number of patients)

Parameter	SGB (n)	Control (n)	Test applied	P Value	Significance
Post op Pacing					
Positive	5	7	Fisher's	0.34	Not significant
Negative	45	43	exact test		

The difference in mean pressures between the left radial and femoral pressures was calculated in the post bypass period in both the groups and charted. It was noted that the radio-femoral pressure difference was negative, which meant that the mean radial arterial pressures was consistently lower than the mean femoral arterial pressures in both the groups. The trend in the difference between the upper and lower limb pressures is remained statistically significant for the 40 minutes post weaning off CPB. After 40 minutes, the radio-femoral pressure difference diminished and was statistically non significant. (Table 9)

Table 9 : Comparison of Post operative mean radio femoral pressure difference between the groups

Duration in minutes	Mean Radio-Femoral pressure difference (mmHg)			Significance
	SGB	Papaverine	P Value	
10 mins	-0.99 ± 1.85	-1.92 ± 2.26	0.03	Significant
20 mins	-1.01 ± 1.68	-1.90 ± 1.93	0.02	Significant
30 mins	-0.24 ± 2.3	-1.51 ± 1.84	0.0003	Significant
40 mins	-0.94 ± 1.83	-1.70 ± 2.0	0.05	Significant
50 mins	-1.05 ± 2.34	-1.53 ± 1.86	0.25	Not significant
60 mins	-1.29 ± 1.4	-1.12 ± 1.68	0.58	Not significant
Shifting	-0.32 ± 1.54	-0.79 ± 1.56	0.13	Not significant

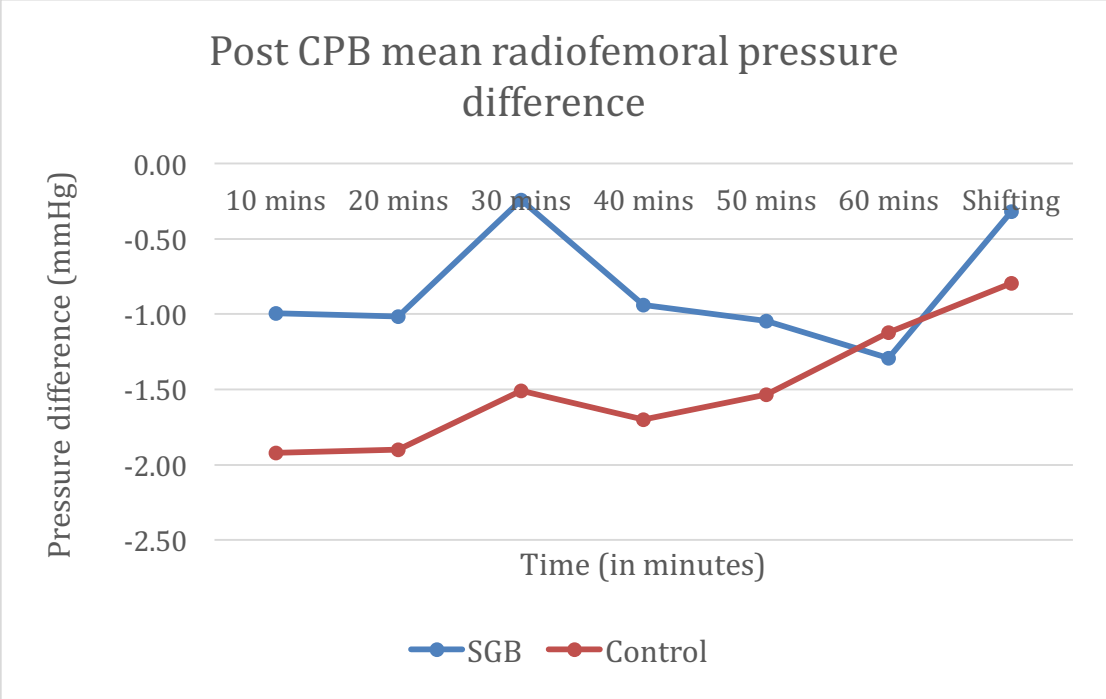


Figure 5: Comparison of post CPB mean radio-femoral mean arterial pressure (MAP) difference between the groups

After shifting to the post operative care ICU, the patients were followed up for 24 hours to note the incidence of arrhythmias (atrial or ventricular). 21% of patients suffered from arrhythmias in the post operative period. All were transient and was easily controlled with antiarrhythmic medications, pH correction and correction of electrolyte abnormalities.

It was noted that the incidence of arrhythmias was 10% in the SGB group as compared to 32% in the control group, which was statistically highly significant. (Table 10)

Table 10: Incidence of post operative arrhythmias (n = number of patients)

Parameter	SGB (n)	Control (n)	Test applied	P Value	Significance
Post operative arrhythmias					
Positive	5	16	Fisher's exact test	0.0008	Highly significant
Negative	45	34			

Patients were monitored for any complications of the block, like vascular injury, hematoma formation, injury to nerves, neuro-deficit or drug toxicity. None of the patients in our study who underwent stellate ganglion block suffered from any side effects or complications.

DISCUSSION

The challenges in the surgical management of patients with CAD presenting for CABG has increased as more and more high risk subsets of patients survive due to advances in medical science and are thus referred for surgery.

Since the first CABG was performed by Dr. Sabiston in 1962, this modality of treatment has undergone major refinements and improvements in technique as well as level of skill. This has led to improved survival in the patients who undergo this complicated and delicate surgery.

Use of internal mammary artery as a bypass conduit for left anterior descending artery grafting was a major step in improving post surgery outcomes. Multiple excellent meta-analysis and reviews over the years, on the subject have shown that the use of the left internal mammary artery (IMA) graft to the left anterior descending coronary artery is the most important factor for survival and reduction of late cardiac events after CABG. [3],[4],[5]

Though arterial grafts have the advantage of release of intrinsic vasodilator substances which helps maintain long term graft patency, there are also some disadvantages involved with use of these grafts. The tunica media of the arterial grafts contain smooth muscle fibers which can undergo vasospasm due to surgical handling, especially in the immediate post bypass period. This problem was first identified and reported by Subaru MR *et al.* [7] in 1987. The catastrophic consequences of this eventuality was soon identified by the surgeons and that lead to the practice of routine application of pharmacological vasodilators for prevention of LIMA spasm.

There have been multiple studies conducted comparing the various vasodilators. The more commonly used ones include various organic nitrates, calcium channel blockers, sodium nitroprusside and papaverine. In a meta-analysis conducted by Sivalingam S *et al.* [8] to to identify the optimal vasodilator for preventing spasm of the internal mammary artery in coronary artery bypass surgery, it was noted that papaverine administered topically or peri-arterially had the strongest evidence in favor of safe prevention of spasm. They also noted that there were multiple studies which had shown no benefit with vasodilator therapy and thus no treatment at all can also be an

entirely acceptable strategy.

Use of thoracic epidural in cardiac surgery was initially of interest for its superior post operative pain relief and reduction in stress response to the surgery. The use of thoracic epidural anesthesia has proven benefits in patients undergoing cardiac surgery as shown by multiple large trials and meta analysis. [56], [57], [58]

Onan IS *et al.* [9] were the first to investigate the effects of thoracic epidural in patients undergoing CABG on IMA blood flow. They noted that IMA blood flow in patients of the group, which received thoracic epidural, was significantly more as compared to the patients who received general anesthesia alone. They thus suggested that thoracic epidural anesthesia induced thoracic sympathectomy might be useful in prevention of perioperative ischemia and associated major cardiac events because of graft failure.

Another method of thoracic sympathetic blockade was attempted by Gopal D *et al.* [10], by administering stellate ganglion block to patients undergoing routine coronary angiography. They injected radio opaque dye into the internal mammary artery prior to the block and 20 minutes post successful block shown by onset of Horner's syndrome. They showed that there was a dilation in the internal mammary artery which could be demonstrated by angiography. Though the IMA diameters were measured, they did not measure the LIMA flows and the study population was limited to 30 patients. This study encouraged us to initiate a larger randomized controlled trial to investigate the effect of this novel technique on LIMA blood flow as well as its effect on post CPB radio-femoral pressure difference and the incidence of post operative arrhythmias.

100 patients undergoing elective CABG surgery, who satisfied the inclusion criteria and gave consent for the study were recruited and randomized into 2 groups. One group (SGB) received the block while the other acted as control. In the SGB group, we administered stellate ganglion block using 8 cc of 0.25% Bupivacaine, under ultrasound guidance.

Kapral *et al.* [24] were the first to administer SGB under ultrasound guidance and the chief advantage they proposed was more accurate delivery of the drug and lower drug

volume requirement. They demonstrated that successful SGB block can be administered using 5cc of 0.5% Bupivacaine. Other authors like Lee MH *et al.* [31] and Jung G *et al.* [32] used 2ml of 0.5% Mepivacaine and 4ml of 0,2% Ropivacaine respectively for demonstrating successful blockade of the stellate ganglion. All these authors administered the drug for treatment of chronic pain syndromes and used the onset of Horner's syndrome as a sign of successful block. The innervation of the facial structures originates from the cervical (higher) portion of the stellate ganglion and thus require minimal drug volumes to block it when needle placement is precise.

The sympathetic innervation of the vessels of the arm and chest arise from the thoracic (lower) portion of the stellate ganglion. Bonica JJ *et al.* [33] showed that, while presence of Horner's syndrome indicates successful block of the cervical segments, it may not indicate complete blockade of the sympathetic flow to the upper extremity. We chose to administer a total volume of 8 ml of 0.25% Bupivacaine for the block to account for higher volume necessary to reach the thoracic segments.

Malmqvist *et al.* [37] proposed that successful sympathetic blockade should satisfy the five criteria which included onset of Horner's syndrome, skin temperature difference, blood flow to limb and assessment of skin resistance response. and conducted a study to check its feasibility. They noted that all 5 criteria could be met in only 15 of the 54 patients. Difference in skin temperature, pre-block as compared to post-block was the sign which could be elicited most easily. Sympatho-galvanic response or skin resistance response involves measuring the conductance through the skin after delivery of the block. Sympathectomy causes reduction in the sweat gland activity, thus increasing the resistance to flow of electric current. This is used as an objective method for quantification of activity of the sympathetic system. Malmqvist et al. could elicit an increase of sympatho-galvanic response of more than 13% in only 12% of their study subjects.

We decided to base success of block on the rise in skin temperature of more than 1.5°C as compared to the baseline. Monitoring the blood flow in the limb or checking the sympatho-galvanic response were both not feasible in the operation theatre setting.

All the studies we could come across involved administering stellate ganglion block in awake patients and thus Horner's syndrome could be easily demonstrated. We chose to not base success of block on basis of Horner's syndrome as our subset of patients had high cardiac morbidity due to coronary artery disease and thus we decided to administer the block after induction of anesthesia. We administer high doses of opioids as part of our routine induction protocol to reduce stress response to intubation and incision. Ptosis and enophthalmos cannot be demonstrated after administration of muscle relaxants while miosis is a known effect of high opioid administration. We were not able to demonstrate Horner's syndrome in most of our patients. The skin temperature difference and flushing of the extremity could be demonstrated in all the cases where we administered the block with the exception of two cases where the temperature difference could not be recorded due to failure of monitoring equipment.

The haemodynamic parameters i.e. pulse, SBP (Systolic blood pressure), DBP (Diastolic blood pressure) and MAP (Mean arterial pressure) of all the patients were noted from the time of shifting into the OT till end of surgery. We compared the changes in hemodynamic pattern between both the groups as well as difference in the pressures in the radial and femoral arterial pressures.

The baseline mean pulse rate was 67.3 ± 10.68 bests/min in the SGB group as compared to 67.5 ± 12.93 beats/min in the control group. The pulse rate increased during intubation, skin incision and sternal retraction and returned to baseline during LIMA harvesting. Similar trends were seen in SBP, DBP and MAP and no statistically significant difference was noted between both the groups. Thus we observed that SGB does not cause significant fall in the systemic mean and diastolic arterial pressures which are crucial for maintaining coronary perfusion in a patient with triple vessel disease.

Gopal D *et al.* [10] administered the SGB in awake patients undergoing coronary angiogram. They noted no difference in hemodynamic parameters (pulse, SBP, DBP and MAP) after administration of SGB.

Chen YQ *et al.* [74] studied the hemodynamic effect of stellate ganglion block on

elderly patients during induction of anesthesia and intubation. They noted no difference in the heart rate and blood pressure of patients after administration of stellate ganglion block, but they noted that the stress response to intubation is markedly blunted in patients in whom stellate ganglion block was administered. They concluded that SGB helps attenuate stress response to anesthesia induction and intubation and thus may be protective to the myocardium.

We noted LIMA flows of 49.28 ± 7.88 ml/minute in the SBG group as compared to 47.12 ± 7.24 ml/minute in the control group. Though the flow rate is higher in the SGB group, the difference was found to be not statistically significant.

LIMA flow can vary with the sex, race, habitus of the person and the blood pressure at which the readings is taken. Readings also may vary with the operating skill of the surgeon who dissects the LIMA. In our study LIMA dissection was done by 3 surgeons of comparable experience and expertise.

Influence of sympathetic innervation on LIMA flow also depends on the technique of LIMA dissection. Choi *et al.* [51] compared the response of skeletonized graft versus pedicled IMA graft to sympathetic stimulus and noted that a skeletonized IMA acts more like a passive conduit and there is no effect of sympathetic nervous system influence on it. We use pedicled LIMA graft at our center and thus were anticipating some residual influence of sympathetic innervation.

Gopal D *et al.* [10] demonstrated dilation of the IMA, by angiography, in response to SGB in patients who have a completely intact sympathetic innervation to the entire vessel and thus postulated a higher flow through LIMA. From our results we note that a similar degree of vasodilation and increased blood flow may not be achievable in a partially denervated pedicled graft.

We are not certain why SGB does not result in increasing LIMA flow under anesthesia in a patient with CABG. Most of the patients operated for coronary revascularization receive vasodilator drugs like anti-hypertensives, anti-anginals and diuretics. Probably the LIMA in these patients may be undergoing vasodilation to some extent. This vasodilation may be further augmented by administration of intravenous and inhalational anesthetics which reduce the sympathetic tone. In addition, partial denervation of LIMA during surgical dissection may further result in

loss of sympathetic response to some extent. Hence LIMA flow could not increase further despite sympatholysis achieved due to SGB.

We noted blood pressure in the radial and femoral arteries all through the duration of the surgery. In the pre CPB period, radial arterial pressures (MAP) remained marginally higher than the femoral pressures (MAP), but the difference was clinically and statistically not significant.

At initiation of CPB, the radio-femoral arterial pressure difference widened, (femoral greater than radial pressures) being -0.48 ± 1.88 in the SGB group as compared to -1.26 ± 1.79 mmHg in the control group (10 minutes into CPB). The difference on rewarming (32 °C) was -1.3 ± 2.72 mmHg in the SGB group as compared to -2.96 ± 3.66 mmHg in the control group. Both these values were found to be statistically significant.

In the post CPB period, we observed statistically significant radio-femoral pressure difference (femoral more than radial pressures) in our study group until 40 minutes post weaning the patients off bypass, after which the pressure difference dropped.

The pressure difference (femoral pressures greater than radial) was noted to be clinically significant (>5mmHg) in 28% of the study subjects. 20 of these patients belonged to the control group as compared to 8 patients in the SGB group, yielding clinically and statistically significant results.

Gravlee *et al.* [13] noted that the pressure difference was observed after the initiation of CPB and became especially evident on rewarming and weaning patients off bypass, during which the radial pressures remained lower than the femoral pressures. The pressure difference was abolished within an hour of weaning patients off bypass. Chauhan S *et al.* [75] also reported on this pressure difference and suggested favoring routine femoral arterial cannulation against radial cannulation for patients undergoing CPB. Our results are similar to previously reported literature on observed radio-femoral pressure difference after initiation of CPB. In addition to this, we noted that the magnitude of radio-femoral pressure difference is lesser in the group receiving SGB as compared to controls.

The cause for this pressure difference is still a matter of controversy as multiple

studies have given contradictory theories about its origin. Pauca AL *et al.* [12] suggested a decrease in vascular resistance of the upper extremity or the hand while Maruyama *et al.* suggested that vasodilators may be responsible for the pressure gradient. In contrast, Baba *et al.* [11] and Nakayama *et al.* [64] reported that peripheral vasoconstriction or vasospasm was responsible for the pressure gradient.

We have noted that sympathectomy of the upper limb by administering SBG lowers the incidence of radio-femoral pressure difference during and in the immediate post CPB period.

SGB abolished the radio-femoral arterial pressure difference probably by producing vasodilation of radial artery. Therefore, we postulate that radial artery vasoconstriction may be the mechanism behind the generation of radial-femoral pressure difference on and after CPB. As the radial artery pressure equalled femoral arterial pressure in majority of patients who received stellate ganglion block, there may not be a need for femoral artery cannulation in those who receive the block.

Cardiac sympathetic innervation arises from the cervical sympathetic ganglion and there has been multiple reports on the efficacy of SBG on abolishing ventricular arrhythmias by reducing the sympathetic stimulation to the myocardium.

Han S *et al.* [14] demonstrated that post myocardial infarction, there is increase in synaptic density as well as electrical activity in the stellate ganglion. This indicated significant electro-anatomical and extra-cardiac autonomical nerve activity remodeling occurring post myocardial infarction. This finding is particular relevant to our patient subset, all of whom have clinically significant coronary artery disease. Post operative arrhythmias were noted in 21% of our patients. Out of these, 5 patients belonged to the SGB group while 16 belonged to the control group. The difference in incidence of arrhythmias between the two groups were statistically highly significant.

The success rate of stellate ganglion blockade under ultrasound guidance was 100% in our patients. The ganglion blockade could be completed within 5-6 minutes in all cases.

In the entire course of our study, we did not have even a single episode of neurological or vascular complication, attesting the safety of this procedure under

ultrasound guidance. Bleeding and dissecting hematoma may be life threatening complications of accidental carotid artery puncture. These complications could be prevented by use of ultrasound.

Benefits of sympatholysis in controlling ventricular arrhythmias are well known, Intractable ventricular arrhythmias and atrial fibrillation may be troublesome complications in the post operative period after CABG. These arrhythmias may be encountered despite adequate revascularization. Excessive sympathetic drive may be one of the underlying mechanisms behind these arrhythmias. Left SGB is considered one of the treatment modalities for these patients. [72]

Limitations of our study:

Most convincing evidence of increase in left internal mammary artery blood flow is demonstration of the increase in flow after administration of the block. This would have meant administering the block after sternotomy and administration of heparin. Administering the block to the patient after heparin administration increases procedural risk. It would also introduce a minimum mandatory waiting period of 10 minutes for peak action of the block to be achieved in a completely anticoagulated patient. We did not pursue this endeavor due to ethical and time constraints.

There are presently no studies we could come across that compared internal mammary blood flow among patients of different sizes. IMA flow varies with sex, race and build of the person. Indexing the IMA blood flow to BSA (Body surface area) was proposed as one of the methods to facilitate comparison between patients of varying sizes. BSA may be similar in patients of widely differing body habitus and build. It therefore cannot be relied on as an accurate measure for comparison of IMA flow between patients. In our research, we could have not come across any study that could validate this method.

IMA spasm depends on the skill of the surgeon handling the vessel. In our series, IMA harvesting was performed by 3 different surgeons, with nearly same level of expertise in the procedure and they were blinded to the study.

SUMMARY AND CONCLUSIONS

1. Stellate ganglion blockade was not found to increase LIMA blood flow in CABG patients as compared to patients who received only topically applied papaverine.

2. Stellate ganglion block under ultrasound guidance is a very safe procedure, even in patients who are slated to undergo systemic anticoagulation.

3. Statistically significant radio-femoral pressure difference (femoral greater than radial) was noted in patients of both the groups at 10 minutes from starting of CPB. The difference was sustained till 40 minutes post weaning the patients off CPB.

4. Stellate ganglion block induced sympathectomy helps reduce the radio-femoral arterial pressure difference in the post CPB period as compared the control group.

5. Stellate ganglion block does not cause any hemodynamic deterioration. There was no significant difference in the hemodynamic parameters (heart rate, systolic, diastolic and mean blood pressure) between the groups.

6. Under ultrasound guidance, SGB could be administered without any failure in all patients in our study.

7. Stellate ganglion block can be administered safely without any complications in all patients, who were anticoagulated with high dose of heparin.

8. Stellate ganglion block helps reduce the incidence of arrhythmias in post CABG patients.

BIBLIOGRAPHY

1. Gaziano TA, Bitton A, Anand S, Abrahams-Gessel S, Murphy A. Growing epidemic of coronary heart disease in low- and middle-income countries. Curr Probl Cardiol. 2010 Feb;35(2):72-115.
2. Ghaffar A, Reddy KS, Singhi M. Burden of non-communicable diseases in South Asia. BMJ. 2004 Apr 3;328(7443):807-10.
3. Loop FD, Lytle BW, Cosgrove DM, Stewart RW, Goormastic M, Williams GW, Golding LA, Gill CC, Taylor PC, Sheldon WC, et al. Influence of the internal-mammary-artery graft on 10-year survival and other cardiac events. N Engl J Med. 1986 Jan 2;314(1):1-6.
4. Yusuf S, Zucker D, Peduzzi P, Fisher LD, Takaro T, Kennedy JW, Davis K, Killip T, Passamani E, Norris R, et al. Effect of coronary artery bypass graft surgery on survival: overview of 10-year results from randomised trials by the Coronary Artery Bypass Graft Surgery Trialists Collaboration. Lancet. 1994 Aug 27;344(8922):563-70.
5. Cameron A, Davis KB, Green G, Schaff HV. Coronary bypass surgery with internal-thoracic-artery grafts--effects on survival over a 15-year period. N Engl J Med. 1996 Jan 25;334(4):216-9.
6. Hawkes AL, Nowak M, Bidstrup B, Speare R. Outcomes of coronary artery bypass graft surgery. Vascular Health and Risk Management. 2006;2(4):477-484.
7. Sarabu MR, McClung JA, Fass A, Reed GE. Early postoperative spasm in left internal mammary artery bypass grafts. Ann Thorac Surg. 1987;44(2):199-200.
8. Sivalingam S, Levine A, Dunning J. What is the optimal vasodilator for preventing spasm in the left internal mammary artery during coronary arterial bypass grafting? Interact Cardiovasc Thorac Surg. 2005 Aug;4(4):365-71.
9. Onan IS, Onan B, Korkmaz AA, Oklu L, Kilickan L, Gonca S, Dalcik H, Sanisoglu I. Effects of thoracic epidural anesthesia on flow and endothelium of internal thoracic artery in coronary artery bypass graft surgery. J Cardiothorac Vasc Anesth. 2011 Dec;25(6):1063-70.

10. Gopal D, Singh NG, Jagadeesh AM, Ture A, Thimmarayappa A. Comparison of left internal mammary artery diameter before and after left stellate ganglion block. Ann Card Anaesth. 2013 Oct-Dec;16(4):238-42
11. Baba T, Goto T, Yoshitake A, Shibata Y. Radial artery diameter decreases with increased femoral to radial arterial pressure gradient during cardiopulmonary bypass. Anesth Analg. 1997 Aug;85(2):252-8.
12. Pauca AL, Hudspeth AS, Wallenhaupt SL, Tucker WY, Kon ND, Mills SA, Cordell AR. Radial artery-to-aorta pressure difference after discontinuation of cardiopulmonary bypass. Anesthesiology. 1989 Jun;70(6):935-41.
13. Gravlee GP, Wong AB, Adkins TG, Case LD, Pauca AL. A comparison of radial, brachial, and aortic pressures after cardiopulmonary bypass. J Cardiothorac Anesth. 1989 Feb;3(1):20-6.
14. Han S, Kobayashi K, Joung B, Piccirillo G, Maruyama M, Vinters HV, March K, Lin SF, Shen C, Fishbein MC, Chen PS, Chen LS. Electroanatomic remodeling of the left stellate ganglion after myocardial infarction. J Am Coll Cardiol. 2012 Mar 6;59(10):954-61.
15. Rauck RL. Stallate Ganglion Block. Techniques in Regional Anesthesia and Pain Management. 2001;5(3): 88-93.
16. Hoffman HH: An analysis of the sympathetic trunk and rami in the cervical and upper thoracic regions in man. Ann Surg. 1957;145(1):94-103.
17. Mitchell GAG. Anatomy of the Autonomic Nervous System. E & S Livingstone, Edinburgh, Scotland, 1953:264-67
18. Moore DC: Cerebral vascular accident. In Stellate Ganglion Block. Springfield, Illinois, Charles C Thomas Co, p 158-165, 1954
19. Ellis, H., Feldman, S. Anatomy for Anesthetists. in: (ed 3). Blackwell Scientific Publications, Oxford, London; 1979:256–262.
20. Raj P. Stellate ganglion block. In: Waldman SD, Winnie AP, editors. Interventional pain management. Philadelphia, Dannemiller Education, W.B. Saunders Company; 1996. p. 269.
21. Hogan QH, Erickson SJ, Haddox JD, Abram SE. The spread of solutions during stellate ganglion block. Reg Anesth. 1992 Mar-Apr;17(2):78-83.
22. Guntamukkala M, Hardy PA. Spread of injectate after stellate ganglion block in man: an anatomical study. Br J Anaesth. 1991 Jun;66(6):643-4.

23. Janik JE, Hoeft MA, Ajar AH, Alsofrom GF, Borrello MT, Rathmell JP. Variable osteology of the sixth cervical vertebra in relation to stellate ganglion block. Reg Anesth Pain Med. 2008 Mar-Apr;33(2):102-8.
24. Kapral S, Krafft P, Gosch M, Fleischmann D, Weinstabl C. Ultrasound imaging for stellate ganglion block: direct visualization of puncture site and local anesthetic spread. A pilot study. Reg Anesth. 1995 Jul-Aug;20(4):323-8.
25. Shibata Y, Fujiwara Y, Komatsu T. A new approach of ultrasound-guided stellate ganglion block. Anesth Analg. 2007;105(2):550-1.
26. Smith KJ, Ladak S, Choi PT, Dobranowski J. The cricoid cartilage and the esophagus are not aligned in close to half of adult patients. Can J Anaesth. 2002;49(5):503-7.
27. Narouze S, Vydyanathan A, Patel N. Ultrasound-guided stellate ganglion block successfully prevented esophageal puncture. Pain Physician. 2007;10(6):747-52.
28. Siegenthaler A, Mlekusch S, Schliessbach J, Curatolo M, Eichenberger U. Ultrasound imaging to estimate risk of esophageal and vascular puncture after conventional stellate ganglion block. Reg Anesth Pain Med. 2012;37:224–7.
29. Narouze S. Beware of the “serpentine” inferior thyroid artery while performing stellate ganglion block. Anesth Analg. 2009;109:289-90.
30. Wulf H, Maier C, Schele H, Wabbel W. Plasma concentration of bupivacaine after stellate ganglion blockade. Anesth Analg. 1991;72:546–8.
31. Lee MH, Kim KY, Song JH, Jung HJ, Lim HK, Lee DI, Cha YD. Minimal volume of local anesthetic required for an ultrasound-guided SGB. Pain Med. 2012;13(11):1381-8.
32. Jung G, Kim BS, Shin K-B, Park K-B, Kim SY, Song SO. The optimal volume of 0.2% ropivacaine required for an ultrasound-guided stellate ganglion block. Korean Journal of Anesthesiology. 2011;60(3):179-184.
33. Bonica JJ. Sympathetic nerve blocks for pain diagnosis and therapy. Technical considerations vol. II. Block of stellate ganglion and cervicothoracic and thoracic chains. Published by Winthrop – Breon laboratories 1984; 61-77.
34. Hogan QH, Abram SE. Neural blockade for diagnosis and prognosis. A review. Anesthesiology. 1997;86(1):216-41.
35. Matsumoto S. Thermographic assessments of the sympathetic blockade by

stellate ganglion block - Comparison and analysis of thermographic patterns between C7-SGB and C6-SGB in 20 healthy volunteers. Masui. 1991;40(5):692-701.

36. Lofstrom B, Cousins M. Sympathetic neural blockade of the upper and lower extremity. In Neural Blockade in Clinical Anesthesia and Management of Pain, ed 2. Cousins M, Bridenbaugh PO (eds). London, J.P. Lippincot, 1988.
37. Malmqvist EL, Bengtsson M, Sörensen J. Efficacy of stellate ganglion block: a clinical study with bupivacaine. Reg Anesth. 1992;17(6):340-7.
38. Stevens RA, Stotz A, Kao TC et al. The relative increase in the skin temperature after stellate ganglion block is predictive of complete sympathectomy of the hand. Reg Anesth Pain Med 1998; 23:266-270.
39. Meijer J, de Lange JJ, Ros HH. Skin pulse wave monitoring during lumbar epidural and spinal anesthesia. Anesth Analg. 1988;67(4):356-9.
40. Lidberg L, Wallin BG. Sympathetic skin nerve discharges in relation to amplitude of skin resistance responses. Psychophysiology. 1981 May;18(3):268-70.
41. Kong B, Kopelman H, Segal BL, Iskandrian AS. Angiographic demonstration of spasm in a left internal mammary artery used as a bypass to the left anterior descending coronary artery. Am J Cardiol. 1988;61(15):1363
42. Ziadinov E, Al-Kemyani N, Al-Sabti H. Management of Internal Mammary Artery Spasm. J Cardiol Clin Res. 2014;2(2):1028.
43. Yildiz O1, Ciçek S, Ay I, Demirkiliç U, Tuncer M. Hypertension increases the contractions to sumatriptan in the human internal mammary artery. Ann Thorac Surg. 1996;62(5):1392-5
44. Grapow MT, Reineke DC, Kern T, Müller-Schweinitzer E, Carrel T, Eckstein FS. Human internal thoracic arteries from diabetic patients are resistant to endothelial dysfunction. Fundam Clin Pharmacol. 2009 Oct;23(5):567-72.
45. Turoni, C.M., de Bruno, M.P., Coviello, A., Marañón, R.O., Herrera, R.N., Muntaner, J. and Proto, V. Internal Mammary Artery Grafts Reactivity in Hypertensive Patients: Role of Stretching in Extraendothelial Nitric Oxide. Clinical and Experimental Hypertension. 2007;29:327-44.
46. He GW, Fan KY, Chiu SW, Chow WH. Injection of vasodilators into arterial grafts through cardiac catheter to relieve spasm. Ann Thorac Surg.

2000;69(2):625-8.

47. Deja MA, Gołba KS, Malinowski M, Woś S, Kolowca M, Biernat J, Kajor M, Spyt TJ. Skeletonization of internal thoracic artery affects its innervation and reactivity. Eur J Cardiothorac Surg. 2005 Oct;28(4):551-7.
48. Tanaka KA, Szlam F, Katori N, Tsuda A, Levy JH. In vitro effects of antihypertensive drugs on thromboxane agonist (U46619)-induced vasoconstriction in human internal mammary artery. Br J Anaesth. 2004;93(2):257-62.
49. Harskamp RE, McNeil JD, van Ginkel MW, Bastos RB, Baisden CE, Calhoon JH. Postoperative internal thoracic artery spasm after coronary artery bypass grafting. Ann Thorac Surg. 2008;85(2):647-9.
50. Tarhan A, Kehlibar T, Yapici F, Yilmaz M, Arslan Y, Yapici N, Ozler A. Role of physiological state 'normothermia' in internal thoracic artery spasm after harvesting. Eur J Cardiothorac Surg. 2006;30(5):749-52.
51. Choi JB, Lee SY. Skeletonized and pedicled internal thoracic artery grafts: effect on free flow during bypass. Ann Thorac Surg. 1996;61(3):909-13.
52. Massa G, Johansson S, Kimblad PO, Sjöberg T, Steen S. Might free arterial grafts fail due to spasm? Ann Thorac Surg. 1991;51(1):94-101.
53. Gaudiani VA, Buch WS, Chin AK, Ayres LJ, Fogarty TJ. An improved technique for the internal mammary artery coronary bypass graft procedure. J Card Surg. 1988;3(4):467-73.
54. Jeanmart H, Perrault LP, Desjardins N, Chavanon O, Carrier M, Fonger JD. Arterial balloon catheter: a new atraumatic device for dilating arterial grafts. Ann Thorac Surg. 2001;72:810-5.
55. Abad, C., Valerón, M.E., Cáceres, J.J. and Avalos, O. Preparation of the Internal Mammary Artery with the IMAG Fogarty Balloon Catheter. Minerva cardioangiologica, 2001;49:263-66.
56. Kessler P, Aybek T, Neidhart G, Dogan S, Lischke V, Bremerich DH, Byhahn C. Comparison of three anesthetic techniques for off-pump coronary artery bypass grafting: general anesthesia, combined general and high thoracic epidural anesthesia, or high thoracic epidural anesthesia alone. J Cardiothorac Vasc Anesth. 2005;19(1):32-39.

57. Scott NB, Turfrey DJ, Ray DA, Nzewi O, Sutcliffe NP, Lal AB, Norrie J, Nagels WJ, Ramayya GP. A prospective randomized study of the potential benefits of thoracic epidural anesthesia and analgesia in patients undergoing coronary artery bypass grafting. Anesth Analg. 2001;93(3):528-35.

58. Kiliçkan L, Solak M, Bayindir O. Thoracic epidural anesthesia preserves myocardial function during intraoperative and postoperative period in coronary artery bypass grafting operation. J Cardiovasc Surg. 2005;46(6):559-67.

59. Swenson JD, Hullander RM, Wingler K, Leivers D. Early extubation after cardiac surgery using combined intrathecal sufentanil and morphine. J Cardiothorac Vasc Anesth. 1994;8(5):509-14.

60. Gonca S, Kiliçkan L, Dalçik C, Dalçik H, Bayindir O. The cardioprotective effects of thoracal epidural anesthesia are induced by the expression of vascular endothelial growth factor and inducible nitric oxide synthase in cardiopulmonary bypass surgery. J Cardiovasc Surg. 2007;48(1):93-102.

61. Dönmez A, Tufan H, Tutar N, Araz C, Sezgin A, Karadeli E, Torgay A. In vivo and in vitro effects of stellate ganglion blockade on radial and internal mammary arteries. J Cardiothorac Vasc Anesth. 2005;19(6):729-33.

62. Yildirim V, Akay HT, Bingol H, Bolcal C, Iyem H, Doğanci S, Demirkilic U, Tatar H. Pre-emptive stellate ganglion block increases the patency of radial artery grafts in coronary artery bypass surgery. Acta Anaesthesiol Scand. 2007 Apr;51(4):434-40.

63. Stern DH, Gerson JI, Allen FB, Parker FB. Can we trust the direct radial artery pressure immediately following cardiopulmonary bypass? Anesthesiology. 1985 May;62(5):557-61.

64. Nakayama R, Goto T, Kukita I, Sakata R. Sustained effects of plasma norepinephrine levels on femoral-radial pressure gradient after cardiopulmonary bypass. J Anesth. 1993;7(1):8-16.

65. Rich GF, Lubanski RE Jr, McLoughlin TM. Differences between aortic and

radial artery pressure associated with cardiopulmonary bypass. Anesthesiology. 1992;77(1):63-6.

66. De Hert SG, Vermeyen KM, Moens MM, Hoffmann VL, Bataillie KJ. Central-to-peripheral arterial pressure gradient during cardiopulmonary bypass: relation to pre- and intra-operative data and effects of vasoactive agents. Acta Anaesthesiol Scand. 1994;38(5):479-85.
67. Kanazawa M, Fukuyama H, Kinefuchi Y, Takiguchi M, Suzuki T. Relationship between aortic-to-radial arterial pressure gradient after cardiopulmonary bypass and changes in arterial elasticity. Anesthesiology. 2003 Jul;99(1):48-53.
68. Eifling M, Razavi M, Massumi A. The evaluation and management of electrical storm. Tex Heart Inst J 2011;38:111-21.
69. Nademanee K, Taylor R, Bailey WE, Rieders DE, Kosar EM. Treating electrical storm : sympathetic blockade versus advanced cardiac life support-guided therapy. Circulation. 2000;102(7):742-7.
70. Bourke T, Vaseghi M, Michowitz Y, Sankhla V, Shah M, Swapna N, Boyle NG, Mahajan A, Narasimhan C, Lokhandwala Y, Shivkumar K. Neuraxial modulation for refractory ventricular arrhythmias: value of thoracic epidural anesthesia and surgical left cardiac sympathetic denervation. Circulation. 2010;121(21):2255-62.
71. García-Morán E, Sandín-Fuentes MG, Álvarez López JC, Duro-Aguado I, Urueña-Martínez N, Hernández-Luis C. Electrical storm secondary to acute myocardial infarction and heart failure treated with left stellate ganglion block. Rev Esp Cardiol (Engl Ed). 2013;66(7):595-7.
72. Gadhinglajkar S, Sreedhar R, Unnikrishnan M, Namboodiri N. Electrical storm: Role of stellate ganglion blockade and anesthetic implications of left cardiac sympathetic denervation. Indian J Anaesth. 2013;57(4):397-400.
73. Milne JR, Ward DE, Spurrell RA, Camm AJ. The long QT syndrome; effects of drugs and left stellate ganglion block. Am Heart J. 1982;104:194-8.
74. Chen YQ, Jin XJ, Liu ZF, Zhu MF. Effects of stellate ganglion block on cardiovascular reaction and heart rate variability in elderly patients during anesthesia induction and endotracheal intubation. J Clin Anesth. 2015;27(2):140-5.

75. Chauhan S, Saxena N, Mehrotra S, Rao BH, Sahu M. Femoral artery pressures are more reliable than radial artery pressures on initiation of cardiopulmonary bypass. J Cardiothorac Vasc Anesth. 2000 Jun;14(3):274-6.

APPENDIX

ABBREVIATIONS AND ACRONYMS

1. **SGB:** Stellate ganglion block
2. **LSGB:** Left stellate ganglion block
3. **CAD:** Coronary artery disease
4. **CABG:** Coronary artery bypass grafting
5. **LIMA:** Left internal mammary artery
6. **IMA:** Internal mammary artery
7. **SBP:** Systolic blood pressure
8. **SBP:** Diastolic blood pressure
9. **MAP:** Mean arterial pressure
10. **CPB:** Cardio-pulmonary bypass
11. **LCA:** Left coronary artery
12. **LAD:** Left anterior decending artery
13. **TEA:** Thoracic epidural anesthesia
14. **LSCD:** Left cardiac sympathetic denervation
15. **CT:** Computed tomography
16. **MRI:** Magnetic resonance indexing
17. **USG:** Ultrasonography
18. **RLN:** Recurrent laryngeal nerve
19. **NTG:** Nitrogylgerine
20. **SNP:** Sodium nitroprusside
21. **VEGF:** Vascular endothelial growth factor
22. **iNOS:** Inducible nitric oxide synthase
23. **VATS:** Video-assisted thoracoscopic surgery
24. **BSA:** Body surface area

INSTITUTIONAL ETHICS COMMITTEE CLEARANCE

श्री चित्रा तिरुनालं आयुर्विज्ञान और प्रौघोगिकी संस्थान
तिरुवनन्तपुरम - 695 011, केरल, इंडिया
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY
THIRUVANANTHAPURAM - 695 011, INDIA
(An Institute of National importance under Govt. of India)

Institutional Ethics Committee (IEC)
(IEC Regn No. ECR/189/Inst/KL/2013)

SCT / IEC-549/ FEBRUARY-2014 01-04-14

Dr. Roshith Chandran
Senior Resident
Department of Anesthesiology
SCTIMST.

Dear Dr. Roshith Chandran,

The Institutional Ethics Committee reviewed and discussed your application to conduct the study entitled "EFFECT OF LEFT STELLATE GANGLION BLOCK ON LIMA BLOOD FLOW AND POST BYPASS RADIO-FEMORAL PRESSURE DIFFERENCE IN PATIENTS UNDERGOING CABG. (IEC-549)" on 14th February, 2014.

The following documents were reviewed:

1. *Covering letter dated 18.01.2014 addressed to the Chairman of IEC regarding the submission of the documents for IEC approval.*
2. *IEC Application form.*

तार : चित्रमेट Grams : Chitramet | फोन Phone : 2443152 | फाक्स Fax : (91)471-2446433 2550728 | ई-मेइल E-mail : sct. @sctimst.ker.nic.in

INSTITUTIONAL ETHICS COMMITTEE CLEARANCE

3. *Technical Advisory Committee's Approval Letter.*
4. *Study Proposal.*
5. *Declaration form.*
6. *Consent forms in English and Malayalam.*
7. *Short CV's of the Principal Investigator and Co- Principal Investigators.*
8. *Letter addressed to Institutional Ethics Committee, SCTIMST dated 26-03-14 from Dr. Roshith Chandran, Senior Resident, Department of Cardiac Anaesthesiology, SCTIMST submitting the Modified Consent form and Declaration in English and Malayalam.*
9. *Modified consent form in English and Malayalam.*
10. *Declaration in English and Malayalam.*

The following members of the Ethics Committee were present at the meeting held on 14th February, 2014 at G. Parthasarathi Board Room, AMCHSS, SCTIMST.

Sl. No	Name	Highest Degree	Gender	Scientific / Non-scientific	Affiliation with Institution (s)
1.	Justice M.R. Hariharan Nair.	MA BL	Male	Legal Expert (Chairperson)	No
2.	Dr. J. M. Tharakan	MD	Male	Clinician (Cardiologist)	Yes
3.	Dr. K. A. Kumar	MD	Male	Clinician (Psychiatrist)	No
4.	Dr. Rema M. N	MD	Female	Pharmacologist	No
5.	Dr. Meenu Hariharan	DM	Female	Clinician (Gastro Enterologist)	No
6.	Dr. R .V. G Menon	PhD	Male	Lay Person	No

INSTITUTIONAL ETHICS COMMITTEE CLEARANCE

7.	Dr. Premila P.G.	MD	Female	Clinician (Paediatrician)	No
8.	Dr. S.Sivasankaran	MD	Male	Clinician (Cardiologist)	Yes
9.	Dr. Anoopkumar Thekkuveettil	PhD	Male	Basic Scientist (Molecular Biology) /Ethicist (Member Secretary)	Yes

IEC Decision

Approved the conduct of the study in the present form.

Remarks:

The Institutional Ethics Committee expects to be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and asks to be provided a copy of the final report.

There was no member of the study team who participated in voting / decision making process. The ethics committee is organized and operated according to the requirements of Good Clinical Practice and the requirements of the Indian Council of Medical Research (ICMR).

Yours Sincerely

Dr. Anoopkumar Thekkuveettil
Member Secretary, Ethics Committee.

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Consent form

Title of study: Effect of left stellate ganglion block on Left Internal Mammary Artery blood flow and post bypass radio-femoral pressure difference in patients undergoing Coronary artery bypass grafting.

Study numbers: We request you to participate in the study where we are planning to evaluate the effect of left sided stellate ganglion block versus topical application of papaverine on blood flow through the left internal mammary artery and post bypass radio-femoral pressure difference in 100 patients undergoing coronary artery bypass grafting under cardiopulmonary bypass.

What is a stellate ganglion?

The stellate ganglion is made up of the fused portion of the seventh cervical and first thoracic sympathetic ganglia. The sympathetic nerves are responsible for controlling the autonomic functions of our body, including our heart rate, blood pressure and skin temperature. Nerves arising from this ganglion control the size of the blood vessels, which supply the hands, part of the face, and the chest. The ganglion also contains nerves, which carry pain sensation from these areas to the brain.

What is stellate ganglion block?

A stellate ganglion block is the injection of a small amount of local anesthetic near a group of nerves in the neck area called as the stellate ganglion. A stellate ganglion block is a commonly performed procedure for relief of chronic pain syndromes in the head neck and arm. Stellate ganglion block also has been used to relieve pain from blockade of blood vessel of the heart (angina) and for control of certain abnormal rhythms of the heart, which are resistant to medications.

What is the role of vasodilators in coronary artery bypass surgery?

Left internal mammary artery is situated along the left border of the sternum and is the major vessel used to bypass the blocked coronary artery. Arterial walls have thick layer of muscles in it, which have a tendency of contracting when the artery is being dissected during the surgery. Vasospasm reduces the diameter of the vessel and thus the amount of blood flowing into the coronary arteries from the bypassed vessels.

Vasodilators like papavarine, nitroglycerine etc have been used traditionally either in the injectable form or as spray to counter this vasospasm and improve blood flow.

How is the block performed?

The block will be performed while you are unconscious. The neck will be mildly extended and the area cleaned with chlorhexidine. Stellate ganglion will be localized with ultrasound. Under strict aspetic precautions, a 22 G needle, guided by ultrasound will be used to deliver local anesthetic (0.5% Bupivacaine) medications around the stellate ganglion.

What are the risks and side-effects?

Normal effects of the block include flushing of face, slight drooping of eyelids, absence of sweating and constriction of pupils on the side of injection. These effects are temporary and last for the duration of action of the injected drug, Bupivacaine (8 hours). These effects indicate that the block is working well. You will be under the effect of anesthesia while the block is being administered and thus are unlikely to experience any of these effects.

There have been rare case reports of damage to the surrounding nerves and vascular structures when the block has been administered using surface marking. Administration of the block under direct ultrasound guidance will avoid these complications.

Why are we doing this study?

Traditionally pharmacological agents like papavarine has been used to prevent spasm of the left internal mammary artery caused by handling during the vessel dissection. All pharmacological agents have side effects like reduction in BP and heart rate changes associated with it. Stellate ganglion block has been shown to be effective in increasing the diameter of the internal mammary artery, without any change in BP and heart rate. We have not been able to identify any study which documents increase in the LIMA blood flow after stellate ganglion block. We intend to do this study to compare the LIMA blood flow after stellate ganglion block as compared to the traditionally used pharmacological method.

Can you withdraw from this study after it starts?

Your participation in this study is entirely voluntary and you are also free to decide to withdraw permission to participate in this study. If you do so, this will not affect your usual treatment at this hospital in any way.

What will happen if you develop any study related injury?

We do not expect any injury to happen to you but if you do develop any side effects or problems due to the study, these will be treated at no cost to you. We are unable to provide any monetary compensation, however.

Will you have to pay for the study?

No.

Will your personal details be kept confidential?

Your personal details will be kept confidential. The result of this study will be published in a medical journal but you will not be identified by name in any publication or presentation of results.

If you have any further questions, please feel free to contact:

Dr. Roshith Chandran, Senior Resident, Department of Anaesthesia (Tel: 9048555770) or mail me: roshith@sctimst.ac.in

Dr.Rupa Sreedhar, Professor, Department of Anaesthesia (Tel: 9446314043)

Dr. Shrinivas Gadhinglajkar, Professor, Department of Anaesthesia (Tel: 0944630404)

DECLARATION

I, _____ (Participant's name)
Date of Birth / Age _____(in years)
Declare that I have read the above information provided to me regarding the study: EFFECT OF LEFT STELLATE GANGLION BLOCK ON LIMA BLOOD FLOW AND POST BYPASS RADIO-FEMORAL PRESSURE DIFFERENCE IN PATIENTS UNDERGOING CABG

Please tick the relevant boxes

- And have clarified any doubts that I had. [ ]
- I also understand that my participation in this study is entirely voluntary and that I am free to withdraw permission to continue to participate at any time without affecting my usual treatment or my legal rights [ ]
- I understand that the study staff and institutional ethics committee members will not need my permission to look at my health records even if I withdraw from the trial. I agree to this access [ ]
- I understand that my identity will not be revealed in any information released to third parties or published [ ]
- I voluntarily agree to take part in this study [ ]
- I received a copy of this signed consent form [ ]

Name:
Signature:
Date:

Name of witness:
Relation to participant:
Date:

(Person Obtaining Consent)
I attest that the requirements for informed consent for the medical research project described in this form have been satisfied. I have discussed the research project with the participant and explained to him or her in nontechnical terms all of the information contained in this informed consent form, including any risks and adverse reactions that may reasonably be expected to occur. I further certify that I encouraged the participant to ask questions and that all questions asked were answered.

_____ _____
Name and Signature of Person Obtaining Consent

INFORMED CONSENT (MALAYALAM)

സമ്മതപത്രം

ശീർഷകം

ബൈപ്പാസ് ശസ്ത്രക്രിയയ്ക്ക് വിധേയരാകുന്ന രോഗികളിൽ ഇടതു മാമറി ധമനിയിലൂടെയുള്ള രക്തപ്രവാഹത്തിൽ സ്റ്റില്ലേറ്റ് നാഡികേന്ദ്രത്തിൽ ബ്ലോക്ക് കൊടുത്താലുള്ള ഫലവും ശസ്ത്രക്രിയ കഴിഞ്ഞതിനുശേഷമുള്ള രക്തസമ്മർദ്ദത്തിന്റെ വ്യതിയാനവും.

പഠനത്തിനുദ്ദേശിക്കുന്ന രോഗികളുടെ എണ്ണം

ഇടതുവശത്തുള്ള സ്റ്റില്ലേറ്റ് നാഡീകേന്ദ്രത്തിൽ കൊടുക്കുന്ന ബ്ലോക്കിന്റെ ഫലവും ഇടതു വശത്തുള്ള മാമറി ധമനിയിൽ "പപ്പാവെരിൻ" എന്ന മരുന്ന് കൊടുക്കുമ്പോഴുണ്ടാകുന്ന ഫലവും മനസ്സിലാക്കാനാണ് ഞങ്ങൾ ഈ പഠനത്തിൽ നിങ്ങളെ ഉൾപ്പെടുത്താൻ ഉദ്ദേശിക്കുന്നത്. കൂടാതെ ബൈപ്പാസ് ശസ്ത്രക്രിയയുടെ സമയത്ത് 100 രോഗികളുടെ റേഡിയോ ഫെമൊറൽ (Radio femoral) രക്തസമ്മർദ്ദത്തിന്റെ വ്യതിയാനം മനസ്സിലാക്കുവാനുമാണ് ഞങ്ങൾ ഈ പഠനം കൊണ്ടുദ്ദേശിക്കുന്നത്.

ഈ പഠനപദ്ധതിയിൽ ഭാഗമാകുവാൻ തിരഞ്ഞെടുക്കപ്പെടുന്ന രോഗികളെ കംപ്യൂട്ടറിന്റെ സഹായത്തോടെ രണ്ടു ഭാഗമായി വേർതിരിക്കുന്നതാണ്. അതിലെ ഒരു വിഭാഗത്തിൽപ്പെട്ട രോഗികളുടെ സ്റ്റില്ലേറ്റ് നാഡീ കേന്ദ്രം ബ്ലോക്ക് ചെയ്യിക്കുകയും രണ്ടാമത്തെ വിഭാഗത്തിൽപ്പെട്ട രോഗികൾക്ക് പപ്പാവെരിൻ മരുന്ന് നൽകുകയും ചെയ്യുന്നു. ഇതിൽ ഏതു വിഭാഗത്തിലാണ് നിങ്ങളെ ഉൾപ്പെടുത്തേണ്ടതെന്ന് കംപ്യൂട്ടർ പ്രോഗ്രാം വഴിയാണ് നിശ്ചയിക്കുന്നത്. അതിനാൽ ഏത് വിഭാഗത്തിലാണ് ഉൾപ്പെടുന്നതെന്ന് മുൻകൂട്ടി പറയുവാൻ സാധിക്കില്ല.

എന്താണ് സ്റ്റിലേറ്റ് നാഡീകേന്ദ്രം (Stellete ganglion)

കഴുത്തിലെയും നട്ടെല്ലിന്റെ മുകൾഭാഗത്തുമായുള്ള സിംപതെറ്റിക് നാഡീകേന്ദ്രം കൂടിച്ചേർന്ന ഒരു ഭാഗമാണ് സ്റ്റിലേറ്റ് നാഡീകേന്ദ്രം. ഹൃദയമിടിപ്പ്, രക്തസമ്മർദ്ദം, ശരീരഊഷ്മാവ് എന്നിവ പോലുള്ള നമ്മുടെ നിയന്ത്രണാതീത കാര്യങ്ങൾ ചെയ്യുന്നത് സിംപതെറ്റിക് ഞരമ്പുകളാണ്. കൈയ്യിലേയും നട്ടെല്ലിന്റെ ഭാഗത്തെയും മുഖത്തിന്റെയും വിവിധ രക്തക്കുഴലുകളുടെ അളവ് നിയന്ത്രിക്കുന്നത് ഈ നാഡീവ്യൂഹത്തിൽ നിന്നുണ്ടാകുന്ന ഞരമ്പുകളാണ്. കൂടാതെ ഈ ഞരമ്പുകളാണ് ഇവിടെയുണ്ടാകുന്ന വേദനകളെ തിരിച്ചറിയാനായി തലച്ചോറിലേയ്ക്ക് ആവേഗങ്ങളെ എത്തിക്കുന്നത്.

എന്താണ് സ്റ്റിലേറ്റ് നാഡീവ്യൂഹത്തിലെ ബ്ലോക്ക്?

കഴുത്തിന്റെ ഭാഗത്തുള്ള ഒരു കൂട്ടം ഞരമ്പുകളാണ് സ്റ്റിലേറ്റ് നാഡീകേന്ദ്രം. ഈ നാഡീ കേന്ദ്രത്തിൽ ഒരു ചെറിയ അളവിൽ മരുന്ന് കുത്തിവയ്ക്കുന്നു. കഴുത്തിലേയും കൈയ്യിലേയും തലയിലേയും വിട്ടുമാറാത്ത വേദന ശമിപ്പിക്കുവാനാണ് സാധാരണയായി സ്റ്റിലേറ്റ് നാഡീ കേന്ദ്രം ബ്ലോക്ക് ചെയ്യുന്നത്. കൂടാതെ ഹൃദയത്തിലെ രക്ത ക്കുഴലുകളിൽ തടസ്സമുണ്ടാകുമ്പോൾ അനുഭവപ്പെടാറുള്ള വേദന അകറ്റുവാനും ഹൃദയത്തിന്റെ അസാധാരണമായ താളക്രമത്തെ നിയന്ത്രിക്കാനും ഈ പ്രക്രിയ ഉപയോഗിക്കുന്നു.

ബൈപ്പാസ് ശസ്ത്രക്രിയ ചെയ്യുന്ന സമയത്ത് സിരകളെ വലുതാക്കുവാനുള്ള മരുന്ന് കൊടുക്കുന്നതിന്റെ പങ്ക് എന്ത്?

നട്ടെല്ലിന്റെ ഇടതുവശത്തായിട്ടാണ് ഇടത് മാമറി രക്തക്കുഴൽ കാണപ്പെടുന്നത്. ഹൃദയത്തിലെ തടസ്സമുള്ള രക്തക്കുഴലിനെ ബൈപ്പാസ് ചെയ്യുന്നതിലേയ്ക്കായി ഈ രക്തക്കുഴലാണ് ഉപയോഗിക്കുന്നത്. ശുദ്ധ രക്തക്കുഴലുകൾ (ധമനി) കട്ടിയുള്ള പേശീ

നിർമ്മിതമാണ്. ശസ്ത്രക്രിയ സമയത്ത് രക്തക്കുഴലുകൾ ഛേദിക്കുമ്പോൾ അവയ്ക്ക് ചുരുങ്ങാനുള്ള പ്രവണതയുണ്ടാകും. സിരകൾ ചുരുങ്ങുന്ന സമയത്ത് അതിന്റെ വ്യാസം കുറയുകയും ബൈപ്പാസ് ചെയ്ത സിരകളിൽ നിന്നും ഹൃദയത്തിലെ രക്തക്കുഴലുകളിലേയ്ക്കുള്ള (കൊറോണറി രക്തക്കുഴലുകൾ) രക്തപ്രവാഹം കുറയുകയും ചെയ്യും. സിരകൾ വികസിപ്പിക്കുന്നതിലേയ്ക്കായി 'പപ്പാവെരിൻ' 'നൈട്രോഗ്ലിസറിൻ' എന്നീ മരുന്നുകളാണ് പരമ്പരാഗതമായി ഉപയോഗിച്ചു വരുന്നത്. ഇത് രക്തപ്രവാഹം നല്ല രീതിയിൽ ആക്കുകയും ചെയ്യുന്നു.

എങ്ങനെയാണ് ഈ ബ്ലോക്ക് കൊടുക്കുന്നത്?

നിങ്ങൾ അബോധാവസ്ഥയിൽ ആയിരിക്കുമ്പോഴാണ് ഈ ബ്ലോക്ക് നൽകുന്നത്. കഴുത്ത് കുറച്ച് ചരിച്ചു വച്ചതിനുശേഷം ആ ഭാഗം രോഗാണുവിമുക്തമാക്കുന്ന ലായനികൊണ്ട് (Chlorhexidine) വൃത്തിയാക്കുന്നു. അൾട്രാസൗണ്ട് ഉപകരണം കൊണ്ട് 'സ്റ്റിലേറ്റ്' നാഡികേന്ദ്രം മനസിലാക്കുന്നു. കൃത്യമായ നിരീക്ഷണത്തോടെ, 22G സൂചികൊണ്ട് അൾട്രാസൗണ്ട് ഉപകരണത്തിന്റെ സഹായത്തോടെ (0.5% Bupivacaine) മരുന്ന് സ്റ്റിലേറ്റ് നാഡീകേന്ദ്രത്തിലേയ്ക്ക് കൊടുക്കുന്നു.

എന്തൊക്കെയാണ് ഇതിന്റെ ബുദ്ധിമുട്ടും പാർശ്വഫലങ്ങളും

മുഖത്ത് രക്തത്തുടിപ്പ്, കൺപോളകൾ ചെറുതായി തളരുക, കൃഷ്ണമണി ചുരുങ്ങുക എന്നിവയാണ് സാധാരണയായി കണ്ടുവരുന്ന പാർശ്വഫലങ്ങൾ. മരുന്നിന്റെ (0.5% Bupivacaine) പ്രവർത്തന സമയം വരെ മാത്രമേ ഈ പാർശ്വഫലങ്ങൾ കാണുകയുള്ളൂ (8 മണിക്കൂർ) ബ്ലോക്ക് നന്നായി പ്രവർത്തിക്കുന്നു എന്നതിനുള്ള തെളിവാണ് ഈ പാർശ്വഫലങ്ങൾ. ഈ ബ്ലോക്ക് കൊടുക്കുന്ന സമയത്ത് നിങ്ങൾ പൂർണ്ണമായും ബോധരഹിതരായിരിക്കുന്നതു കൊണ്ട് ഈ പാർശ്വഫലങ്ങൾ അനുഭവപ്പെടുകയില്ല.

സർഫസ് മാർക്കിംങ് വഴി സറ്റിലേറ്റ് നാഡീ കേന്ദ്രത്തിൽ ബ്ലോക്ക് കൊടുക്കുമ്പോൾ, അപൂർവ്വം ചില രോഗികളിലെങ്കിലും തൊട്ടടുത്തുള്ള ഞരമ്പുകൾക്കോ സിരകൾക്കോ ക്ഷതം സംഭവിച്ചതായി കാണപ്പെട്ടിട്ടുണ്ട്. എന്നാൽ അൾട്രാസൗണ്ട് ഉപകരണത്തിന്റെ സഹായത്തോടുകൂടി ഇതു ചെയ്യുമ്പോൾ മേൽപറഞ്ഞ കേടുപാടുകൾ ഒഴിവാക്കാവുന്നതാണ്.

എന്തിനാണ് ഞങ്ങൾ ഈ പഠനം ചെയ്യുന്നത് ?

രക്തക്കുഴലുകൾ ഛേദിക്കുന്ന സമയത്ത് ഇടത് മാമറി രക്തക്കുഴലിൽ ഉണ്ടായേക്കാവുന്ന ചുരുങ്ങൽ 'പപ്പാവെരിൻ' എന്ന മരുന്ന് ഉപയോഗിച്ച് നമുക്ക് ഒഴിവാക്കാം. എല്ലാ മരുന്നുകൾക്കും അതിന്റേതായ പാർശ്വഫലങ്ങൾ ഉണ്ട്. അതായത് രക്തസമ്മർദ്ദം കുറുകയോ ഹൃദയമിടിപ്പിൽ വ്യത്യാസം വരികയോ ചെയ്യാം. സ്റ്റിലേറ്റ് നാഡീകേന്ദ്രത്തിൽ ബ്ലോക്ക് കൊടുക്കുമ്പോൾ, രക്തസമ്മർദ്ദത്തിനോ ഹൃദയമിടിപ്പിനോ മാറ്റം വരാതെ തന്നെ രക്തക്കുഴലിന്റെ വ്യാസം വർദ്ധിക്കുന്നു. നാഡീകേന്ദ്രത്തിൽ ബ്ലോക്ക് കൊടുത്തതിനുശേഷമുള്ള ഇടത് മാമറി രക്തക്കുഴലിലെ രക്തപ്രവാഹവും പരമ്പരാഗതമായി ഉപയോഗിച്ചു വരുന്ന ചികിത്സാ രീതിയും തമ്മിലുള്ള താരതമ്യ പഠനമാണ് ഞങ്ങൾ ഇവിടെ ചെയ്യാനുദ്ദേശിക്കുന്നത്.

ഈ പഠനത്തിൽ പങ്കെടുത്തതിനുശേഷം ഇതിൽ നിന്നും പിന്മാറാൻ സാധിക്കുമോ?

നിങ്ങൾ ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നത് തികച്ചും നിങ്ങളുടെ താൽപര്യ പ്രകാരമായിരിക്കും. കൂടാതെ എപ്പോൾ വേണമെങ്കിലും നിങ്ങൾക്ക് ഇതിൽ നിന്നും പിന്മാറാവുന്നതാണ്. അങ്ങനെ ചെയ്യുകയാണെങ്കിൽ ഈ ആശുപത്രിയിൽ നിന്നും നിങ്ങൾക്ക് ലഭിക്കുന്ന ചികിത്സയ്ക്ക് യാതൊരുവിധ തടസ്സവും ഉണ്ടാകുന്നതല്ല.

ഈ പഠനംമൂലം നിങ്ങളുടെ ആരോഗ്യത്തിന് ദോഷകരമായ ഫലങ്ങൾ ഉണ്ടാവുക യാണെങ്കിൽ എന്തു ചെയ്യും?

ഈ പഠനം മൂലം നിങ്ങളുടെ ആരോഗ്യത്തിന് യാതൊരു ദോഷഫലങ്ങളും ഉണ്ടാകുമെന്ന് പ്രതീക്ഷിക്കുന്നില്ല. എന്നിരുന്നാലും എന്തെങ്കിലും പാർശ്വഫലങ്ങൾ ഉണ്ടായാൽ അതിനുള്ള ചികിത്സ നിങ്ങൾക്ക് ചിലവുകളൊന്നുമില്ലാതെ തന്നെ ഇവിടെ നൽകുന്നതാണ്. ധനസഹായങ്ങളൊന്നും നൽകാൻ സാധിക്കുകയില്ല.

ഈ പഠനത്തിന് നിങ്ങൾക്ക് എന്തെങ്കിലും ചിലവുകൾ വഹിക്കേണ്ടി വരുമോ?

ഇല്ല

നിങ്ങളുടെ വ്യക്തിവിവരങ്ങൾ രഹസ്യസ്വഭാവമുള്ളവയായിരിക്കുമോ?

നിങ്ങളുടെ വ്യക്തി വിവരങ്ങൾ തികച്ചും രഹസ്യമായിരിക്കും. ഈ പഠനത്തിന്റെ നിഗമനങ്ങൾ ഞങ്ങൾ പ്രസിദ്ധീകരിക്കുമെങ്കിലും അതിൽ നിങ്ങളുടെ പേരു വിവരങ്ങൾ ഒന്നും തന്നെ ഉണ്ടായിരിക്കുന്നതല്ല.

നിങ്ങൾക്ക് എന്തെങ്കിലും സംശയം ഉണ്ടെങ്കിൽ ദയവായി ചോദിക്കുക

ഡോ. റോഷിത് ചന്ദ്രൻ, സീനിയർ റസിഡന്റ്, അനസ്തേഷ്യ ഡിപ്പാർട്ട്മെന്റ് (മൊ. 9048555770) അഥവാ e-mail: roshith@sctimst.ac.in)

ഡോ. രൂപ ശ്രീധർ, പ്രൊഫസർ, അനസ്തേഷ്യ ഡിപ്പാർട്ട്മെന്റ് (മൊ.9446314043)

ഡോ. ശ്രീനിവാസ്, പ്രൊഫസർ, അനസ്തേഷ്യ ഡിപ്പാർട്ടമെന്റ് (മൊ.0944630404)

പ്രതിജ്ഞ

ഞാൻ . . . . . (പങ്കെടുക്കുന്ന ആളിന്റെ പേര്) ജനനതീയതി/ വയസ് . . . . (വർഷത്തിൽ) ഞാൻ ഈ പഠനത്തെ സംബന്ധിച്ച് മേൽപ്പറഞ്ഞ വിവരങ്ങൾ മനസ്സിലാക്കി.

''ബൈപ്പാസ് ശസ്ത്രക്രിയക്ക് വിധേയരാകുന്ന രോഗികളിൽ ഇടതു മാമറി രക്തക്കുഴലിലൂടെയുള്ള രക്തപ്രവാഹത്തിൽ സ്റ്റിലേറ്റ് നാഡീകേന്ദ്രത്തിൽ ബ്ലോക്ക് കൊടുത്താലുള്ള ഫലവും ശസ്ത്രക്രിയ കഴിഞ്ഞതിനുശേഷമുള്ള രക്തസമ്മർദ്ദത്തിന്റെ വ്യതിയാനവും''.

ദയവായി അടയാളപ്പെടുത്തുക (√).

- ഇതു വായിച്ചതിനുശേഷം എന്റെ എല്ലാ സംശയങ്ങളും മാറി ( )
- പഠനത്തിൽ പങ്കെടുക്കുന്നത് എന്റെ സ്വന്തം താല്പര്യപ്രകാരമാണെന്നും എപ്പോൾ വേണമെങ്കിലും ഇതിൽ നിന്നും പിൻമാറാവുന്നതാണെന്നും അത് എന്റെ ചികിത്സയെ ഒരു തരത്തിലും ബാധിക്കുകയില്ലെന്നും ഞാൻ മനസ്സിലാക്കുന്നു ( )
- ഈ പഠനത്തിൽ നിന്ന് ഞാൻ പിൻമാറുകയാണെങ്കിൽ ഈ പഠനം ചെയ്യുന്ന ആളിനോ ആശുപത്രി മേധാവിക്കോ എന്റെ അനുവാദമില്ലാതെ തന്നെ എന്റെ ആരോഗ്യ വിവരങ്ങൾ പരിശോധിക്കാവുന്നതാണ്. ഇത് ഞാൻ സമ്മതിക്കുന്നു ( )
- എന്റെ വ്യക്തി വിവരങ്ങൾ മൂന്നാമതൊരാൾ വായിക്കുകയോ പ്രസിദ്ധീകരണങ്ങളിലോ മറ്റോ ഉണ്ടാകില്ലെന്നും ഞാൻ മനസ്സിലാക്കുന്നു ( )
- ഞാൻ സ്വന്തം ഇഷ്ടപ്രകാരം ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നു ( )
- ഒപ്പു വച്ച സമ്മതപത്രത്തിന്റെ ഒരു കോപ്പി ഇതോടൊപ്പം ഞാൻ സ്വീകരിക്കുന്നു( )

പേര് :

ഒപ്പ് :

തീയതി :

സാക്ഷിയുടെ പേര് :

പങ്കെടുക്കുന്ന ആളുമായുള്ള ബന്ധം :

തീയതി :

പങ്കെടുക്കുന്ന ആളിനെ ഉൾപ്പെടുത്തിക്കൊണ്ടുള്ള സമ്മതപത്രം

ഈ ഗവേഷണ പഠനത്തിന് ആവശ്യമായിട്ടുള്ള മുകളിൽ പറഞ്ഞ എല്ലാ കാര്യങ്ങളും ഒപ്പുവച്ച സമ്മതപത്രവും എനിക്കു ലഭിച്ചതായി ഞാൻ സമ്മതിക്കുന്നു. ഈ സമ്മതപത്രത്തിന്റെ ഒരു പകർപ്പ് പങ്കെടുക്കുന്ന ആൾക്ക് നൽകുകയും എല്ലാ കാര്യങ്ങളും പറഞ്ഞു മനസ്സിലാക്കുകയും ചെയ്തിട്ടുണ്ട്. കൂടാതെ പങ്കെടുക്കുമ്പോൾ ഉണ്ടായേക്കാവുന്ന പാർശ്വഫലങ്ങളും പറഞ്ഞു മനസിലാക്കിയിട്ടുണ്ട്. പങ്കെടുക്കുന്ന ആളിനെക്കൊണ്ട് സംശയങ്ങൾ ചോദിപ്പിക്കുവാനും ചോദിച്ച സംശയങ്ങൾക്ക് മറുപടി നൽകുവാനും എനിക്ക് സാധിച്ചതായി ഞാൻ സമ്മതിച്ചുകൊള്ളുന്നു.

ഡോക്ടറുടെ പേര് ഒപ്പ്

PROFORMA

Date:

Patient ID:

Identification data:

Name: Reg. no:

Age: Sex: Weight:

Height: Body Surface:

Diagnosis:

History:

Significant medical history:

Medical illness	Yes	No
Hypertension		
Diabetes mellitus		
COPD		
Smoking		
Dyslipidemia		
Arrhythmias		
Any other		

Significant Surgical history:

Drug history:

Physical examination:

General condition:

Pulse : BP:

CVS : RS:

CNS: :

Success of Block:

Temperature difference: >1.5 ☐ <1.5 ☐

Miosis Noted: Yes ☐ No ☐

Complications if any:

LIMA blood Flow: ml/minute

Hemodynamic changes:

Prebypass

	Heart rate	Radial		Femoral	
		Syst	Diast	Syst	Diast
Baseline					
5 minutes post block					
10 minutes post block					
15 minutes post block					
20 minutes post block					
Just Prior to LIMA flow measurement					

During Bypass:

	Radial (MAP)	Femoral (MAP)
10 mins post clamp		
Rewarming (34deg)		

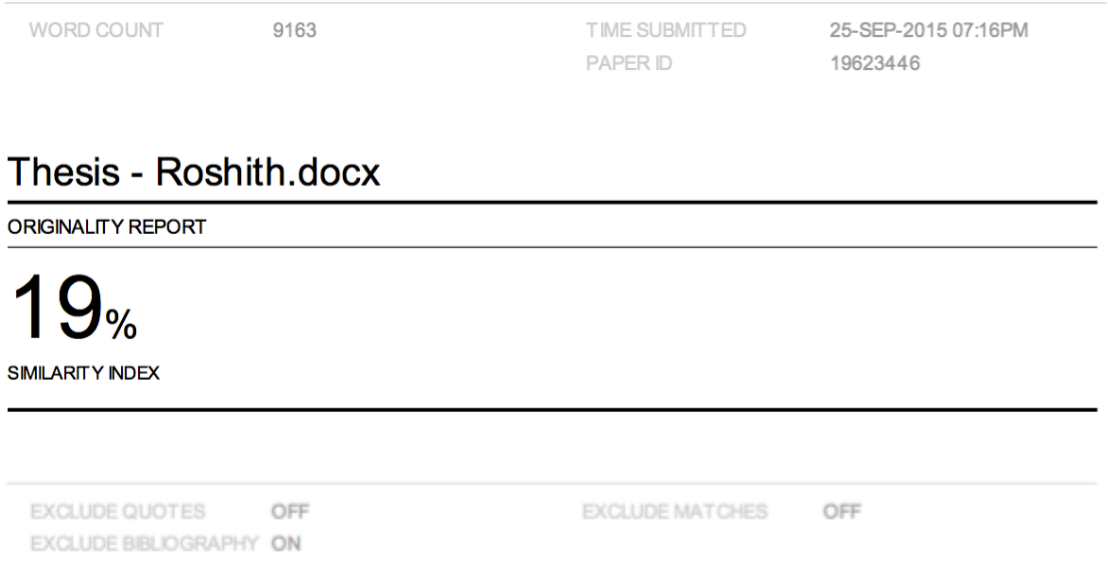
Post Bypass:

	Heart rate	Radial		Femoral	
		Syst	Diast	Syst	Diast
10 mins off bypass					
20 mins off bypass					
30 mins off bypass					
40 mins off bypass					
50 mins off bypass					
60 mins off bypass					
Shifting					

Incidence of arrhythmia:

PLAGIARISM CHECK REPORT

Performed with **iThenticate®,** iParadigms LLC, California



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		PAPER ID	19623446

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ORIGINALITY REPORT

19%

SIMILARITY INDEX

EXCLUDE QUOTES	OFF	EXCLUDE MATCHES	OFF
EXCLUDE BIBLIOGRAPHY	ON		

SGB DEMOGRAPHIC DATA

Identifiers		Demography							Comorbidities							Vitals			Systemic Examination			Block action		
No	Patient ID	Age	Sex	Height	Weight	BSA	LVEF	Grafts	ypertensio	DM	COPD	Smoking	yslipidemi	Arrhythmia	Others	Pulse	BP Systolic	BP Diastolic	CVS	RS	CNS	Temp Diff	Miosis	omplicatio
1	383048	61	M	164	65	1.72	50	4	1	0	0	1	1	0	0	60	150	90	0	0	0	1	0	0
4	376745	45	M	160	59.5	1.63	55	5	0	0	0	1	0	0	0	58	130	80	0	0	0	1	0	0
5	380946	71	M	156	58	1.59	54	4	1	1	0	0	1	0	0	58	140	70	0	0	0	1	0	0
8	379751	59	M	162	68	1.75	66	4	1	0	0	1	1	0	0	66	160	90	0	0	0	1	0	0
9	380552	60	F	150	62	1.61	52	4	1	1	0	0	1	0	Hypothyroi	58	150	70	0	0	0	1	0	0
11	373285	61	M	166	67	1.76	64	4	0	0	0	0	1	0	0	74	140	90	0	0	0	1	0	0
14	367131	74	M	161	61.5	1.66	52	5	1	0	0	1	1	0	H, Cholecys	80	130	80	0	0	0	1	0	0
15	374498	65	M	163	70	1.78	56	5	1	1	0	0	1	0		74	160	90	0	0	0	1	0	0
18	373841	62	M	165	68	1.77	54	5	0	0	0	1	1	0	rotid bulb d	50	140	90	0	0	0	1	0	0
20	378975	76	M	171	69	1.81	54	4	1	1	0	0	1	0	PCI to RCA	54	130	80	0	0	0	1	0	0
22	376150	52	M	170	68	1.79	45	5	1	1	0	1	1	0	0	60	140	80	0	0	0	1	0	0
23	366619	42	F	156	66	1.69	60	4	0	1	0	0	1	0	0	70	130	80	0	0	0	1	0	0
25	370767	58	M	150	51	1.46	60	5	0	0	0	1	1	0	0	70	140	70	0	0	0	1	0	0
27	370147	63	F	157	68	1.72	50	5	1	0	0	0	1	0	0	80	140	90	0	0	0	1	0	0
28	373675	50	M	168	69	1.79	58	5	1	1	0	1	1	0	0	80	150	90	0	0	0	1	0	0
31	372818	68	M	163	66.4	1.73	68	5	1	0	0	1	1	0	nic Alchoh	46	120	70	0	0	0	1	0	0
34	372550	50	M	172	65	1.76	64	5	1	1	0	0	1	0	ecent AWM	78	150	80	0	0	0	1	0	0
36	375148	62	M	168	74	1.86	55	5	1	1	0	1	1	0	Recent RTI	50	140	80	0	0	0	1	0	0
37	385464	51	M	162	61	1.66	66	3	0	1	1	1	1	0	0	62	140	80	0	0	0	1	0	0
39	279520	66	F	150	55.5	1.52	68	5	1	0	0	0	1	0	Hypothyroi	80	160	80	0	0	0	1	0	0
41	388946	56	M	168.3	80.5	1.94	63	4	1	1	0	0	1	0	0	84	154	88	0	0	0	1	0	0
42	378512	71	M	148.0	45	1.36	58	4	1	0	0	1	1	0	0	82	142	80	0	0	0	1	0	0
44	388427	58	M	154.3	59	1.59	52	5	1	1	0	1	1	0	0	60	160	90	0	0	0	1	0	0
47	376278	58	F	148.8	53	1.48	56	4	1	1	0	0	1	0	0	64	160	90	0	0	0	1	0	0
48	384712	58	F	166.2	79	1.91	60	5	1	0	0	0	1	0	0	72	150	86	0	0	0	1	0	0
51	385131	69	M	165.3	69	1.78	64	5	1	1	0	0	1	0	0	62	140	84	0	0	0	1	0	0
53	385225	69	M	170.3	64	1.74	68	3	0	0	0	1	1	0	0	52	130	80	0	0	0	1	0	0
56	390677	65	M	157.5	67.6	1.72	60	4	1	0	0	0	1	0	0	58	130	70	0	0	0	1	0	0
57	386496	50	M	176.0	77	1.94	54	5	1	0	0	1	1	0	0	70	150	90	0	0	0	1	0	0
59	391097	67	M	160.8	67	1.73	54	4	1	0	1	0	1	0	0	70	142	90	0	0	0	1	0	0
61	384897	68	M	162.6	57.4	1.61	60	5	1	0	0	1	1	0	0	70	120	84	0	0	0	1	0	0
64	379552	52	F	159.3	73.2	1.80	58	4	1	1	0	1	1	0	0	66	152	90	0	0	0	1	0	0
65	385275	58	M	157.7	57	1.58	52	5	1	1	0	1	0	0	0	62	138	80	0	0	0	1	0	0
68	385710	69	M	166.4	61.8	1.69	66	4	0	1	0	0	1	0	0	60	124	86	0	0	0	1	0	0
69	383856	53	M	167.2	69	1.79	58	4	1	0	0	0	1	0	nic Alchoh	70	140	78	0	0	0	1	0	0
71	385994	61	F	145.4	65.8	1.63	68	4	1	1	0	0	1	0	0	58	120	84	0	0	0	1	0	0
74	389014	67	M	162.9	58	1.62	62	5	1	1	0	0	1	0	0	62	126	80	0	0	0	1	0	0
75	391429	73	M	164.3	71.8	1.81	58	3	1	1	0	1	1	0	Hypothyroi	64	130	76	0	0	0	1	0	0
78	385062	69	M	165.0	71.5	1.81	62	4	1	1	0	1	1	0	0	70	140	84	0	0	0	1	0	0
80	386125	53	M	171.8	89.8	2.07	58	5	1	0	0	0	1	0	holelithias	56	134	88	0	0	0	1	0	0
82	386385	62	F	154.9	58	1.58	64	3	0	1	0	0	1	0	0	56	128	78	0	0	0	1	0	0
83	390868	59	M	171.4	63.8	1.74	70	3	1	1	0	0	1	0	0	68	140	82	0	0	0	1	0	0
85	386781	65	M	166.9	58.3	1.64	52	2	1	1	0	1	1	0	0	52	124	84	0	0	0	1	0	0
87	386940	60	M	162.2	47.3	1.46	50	4	1	0	0	1	1	0	0	60	120	84	0	0	0	1	0	0
88	382358	65	M	158.8	59.5	1.62	54	4	1	0	0	0	0	0	0	76	138	86	0	0	0	1	0	0
91	392823	42	M	159.1	56.5	1.58	50	5	1	0	0	0	1	0	0	70	136	90	0	0	0	1	0	0
94	391587	54	M	164.3	71	1.80	68	4	1	1	0	1	1	0	0	76	110	74	0	0	0	1	0	0
96	392085	51	M	165.4	74.5	1.85	64	4	1	1	0	0	1	0	0	64	146	82	0	0	0	1	0	0
97	391841	61	M	163.1	57.2	1.61	56	3	1	0	0	0	1	0	xiety disor	66	160	84	0	0	0	1	0	0
99	386757	62	M	167.1	63	1.71	60	4	1	0	0	1	0	0	0	78	130	88	0	0	0	1	0	0

SGB PRE BYPASS HEMODYNAMICS

Heart Rate						Radial Systolic						Radial Diastolic						Femoral Systolic						Femoral Diastolic					
Baseline	5 mins	10 mins	15 mins	20 mins	Measurem	Baseline	5 mins	10 mins	15 mins	20 mins	Measurem	Baseline	5 mins	10 mins	15 mins	20 mins	Measurem	Baseline	5 mins	10 mins	15 mins	20 mins	Measurem	Baseline	5 mins	10 mins	15 mins	20 mins	Measureme
65	55	70	72	70	72	150	120	124	114	108	116	90	82	84	80	74	76	148	116	128	110	108	110	90	80	80	76	76	74
54	56	58	54	54	68	150	130	110	114	106	110	92	84	76	70	68	70	142	128	108	112	106	110	90	82	74	70	68	70
58	52	50	48	52	50	180	120	110	105	108	107	100	70	74	82	80	80	176	120	110	104	108	104	96	72	70	80	80	80
68	60	56	50	62	64	180	130	114	132	124	114	96	86	76	82	80	74	176	130	114	130	124	116	92	84	76	80	80	72
70	80	78	90	66	70	140	116	110	102	92	106	84	70	70	64	60	64	132	114	110	100	90	100	84	70	70	64	60	62
88	80	76	74	80	82	134	110	104	107	102	110	72	70	68	74	70	74	136	114	112	108	111	116	74	70	74	72	80	82
64	70	79	65	58	57	160	140	106	114	104	94	90	70	56	56	52	53	164	144	96	97	98	90	90	70	60	53	50	52
68	70	64	66	70	58	140	132	130	124	110	124	90	88	80	84	80	74	138	130	128	120	110	124	86	88	82	84	80	72
54	45	48	56	52	58	160	148	146	152	130	120	98	88	84	88	84	80	162	144	144	150	126	120	98	88	82	84	80	80
54	48	60	52	50	54	130	110	112	120	110	108	80	74	70	76	70	70	134	108	114	120	116	104	82	70	70	78	70	70
66	62	70	70	58	56	130	126	124	114	110	110	84	84	88	80	82	84	134	124	124	116	110	112	82	84	88	80	82	84
80	72	70	66	78	84	130	110	108	110	114	106	80	72	70	66	68	70	130	108	110	114	110	110	82	70	70	66	70	70
74	72	68	65	65	68	140	134	120	110	105	105	70	72	68	62	64	68	144	132	128	114	107	108	76	76	72	70	66	70
82	80	82	78	88	80	140	156	124	118	116	112	90	90	76	74	74	70	144	154	120	110	114	110	86	92	76	76	74	70
92	84	86	82	80	84	146	134	130	134	116	112	80	76	72	72	70	70	144	138	136	134	118	114	82	74	76	76	70	70
50	51	54	60	50	50	120	124	122	124	136	97	67	57	68	70	72	50	124	120	124	126	132	100	67	64	66	74	77	50
70	70	71	72	72	78	130	128	110	110	108	110	80	68	68	66	56	70	130	130	115	114	110	110	80	65	68	68	54	70
48	52	51	51	52	58	143	138	130	122	111	104	83	74	70	70	62	66	138	136	130	120	106	108	78	78	72	72	63	64
56	52	60	72	56	60	152	110	102	112	110	120	92	82	74	84	72	84	150	110	100	112	110	118	90	80	70	80	70	82
74	70	84	66	60	62	170	132	122	120	116	118	102	80	78	70	74	78	160	130	114	116	116	118	98	78	76	70	72	74
80	68	72	64	66	62	128	128	106	110	106	112	84	84	70	70	68	68	128	128	104	104	104	108	80	84	70	70	66	66
74	70	56	52	64	60	140	132	130	124	118	110	90	88	84	84	80	80	136	130	136	120	118	110	94	88	82	82	80	80
56	50	46	50	52	50	170	132	132	130	124	120	94	88	82	80	76	76	166	128	130	130	122	120	90	88	80	80	74	76
56	50	48	44	46	50	158	110	104	108	120	124	82	70	62	66	74	78	152	110	102	108	118	120	80	70	60	64	70	74
70	74	70	58	60	62	164	102	100	96	132	128	96	82	80	74	86	84	160	100	108	90	130	126	92	80	80	74	86	82
80	70	74	78	74	62	170	140	132	130	114	116	100	82	80	80	74	70	164	136	130	130	110	114	96	80	80	80	74	70
70	62	60	54	56	58	142	126	120	118	106	108	80	80	74	70	68	66	140	124	118	118	108	108	80	80	74	72	70	68
50	44	42	60	62	58	132	114	116	120	112	116	80	70	72	72	78	74	130	112	112	120	110	112	78	70	70	70	74	74
76	72	70	56	64	60	114	100	104	116	112	110	72	60	64	70	62	64	110	94	104	110	112	110	70	60	64	70	60	64
56	60	64	58	60	64	132	104	124	114	110	118	76	78	86	80	82	88	130	100	122	114	110	118	74	72	88	80	80	86
82	70	68	72	68	66	116	92	90	96	100	106	80	66	60	64	70	72	116	92	90	90	100	104	80	66	62	60	68	70
70	72	68	66	70	62	130	106	124	138	140	120	80	60	74	82	84	74	132	106	122	140	140	120	80	60	72	80	84	74
74	72	68	66	54	60	150	108	102	96	104	110	92	64	60	58	62	70	146	108	102	98	100	110	90	60	60	58	60	70
64	66	60	58	56	56	110	102	96	90	104	110	74	60	54	60	68	76	110	100	96	90	104	110	72	60	54	60	66	74
78	70	74	66	64	66	170	106	102	100	118	122	90	66	62	60	82	80	164	106	104	100	112	120	88	66	62	60	80	80
60	52	50	56	54	52	110	102	90	98	104	110	70	60	56	52	64	74	110	102	88	94	104	110	70	58	54	50	62	70
56	50	48	52	50	54	118	112	118	106	112	118	78	80	72	70	74	76	120	112	116	102	112	118	74	80	70	70	72	74
60	74	70	68	66	76	148	108	120	134	136	128	80	70	74	82	86	82	142	104	120	130	132	128	80	72	72	80	82	80
66	64	68	70	84	80	134	110	132	130	128	126	82	66	74	78	70	74	130	108	130	130	130	128	78	66	72	76	70	72
82	58	62	64	70	66	160	126	142	150	124	128	90	80	86	88	76	84	158	118	142	148	122	128	88	76	82	86	78	84
70	62	64	70	64	58	136	124	104	100	120	120	90	82	74	60	68	64	134	122	100	100	120	120	88	80	72	60	68	62
74	72	60	64	62	66	152	114	116	118	124	120	96	78	80	80	82	80	150	114	116	114	122	120	94	74	80	80	82	80
48	54	58	52	60	64	130	110	130	130	120	122	88	70	82	84	74	80	132	110	126	130	120	120	82	70	80	80	72	80
58	52	56	70	76	68	110	94	96	100	104	114	76	62	60	64	68	70	114	90	94	100	100	116	76	60	60	62	64	70
70	66	62	70	58	56	132	118	100	106	128	122	78	74	62	68	76	80	132	114	100	100	130	120	78	74	60	66	76	80
74	52	50	60	62	54	150	114	126	144	128	126	90	84	88	90	84	82	146	114	126	140	128	122	88	82	86	84	84	82
70	88	86	90	86	88	110	102	118	120	140	120	72	72	84	80	86	80	110	100	120	120	140	120	70	72	84	80	86	80
70	54	50	62	66	64	154	118	110	108	112	122	96	76	72	70	70	74	152	118	104	108	110	120	94	74	70	70	70	72
74	70	68	70	62	66	180	124	120	126	122	120	90	84	80	82	80	80	174	120	120	124	120	120	88	82	80	80	80	80
62	60	68	70	82	56	136	120	148	132	122	118	90	80	90	84	80	80	136	114	144	128	120	120	88	80	90	82	80	80

SBG LIMA FLOWS and CPB HEMODYNAMICS												
		On Bypass				Post Bypass						
LIMA Flow		Radial		Femoral		Heart Rate						
Flow 1	Flow 2	10 mins	Rewarmin	10 mins	Rewarmin	10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting
15	13	52	55	56	50	76	84	90	92	78	108	92
15	16	48	60	50	60	86	90	88	84	86	82	88
14	16	56	70	58	72	78	84	90	92	88	80	94
12	12	70	54	74	60	96	94	90	88	86	90	92
9	10	64	60	66	62	80	92	90	94	90	88	82
12	13	48	57	50	56	90	90	90	90	90	90	90
13	14	58	70	60	73	84	86	91	101	100	94	90
12	14	60	48	60	50	86	88	94	100	112	110	94
8	12	56	66	58	68	90	96	98	114	110	112	100
12	13	50	64	52	64	82	86	74	88	80	74	78
12	13	60	58	62	60	90	90	102	88	86	78	82
8	10	70	72	70	74	74	70	76	80	80	80	80
14	13	50	52	54	52	80	94	96	90	90	88	96
9	10	52	60	54	56	80	86	82	90	78	88	90
9	12	49	51	53	56	90	82	86	88	90	86	92
13	9	45	43	50	48	50	58	54	53	54	56	56
13	12	46	47	48	47	82	84	81	83	82	80	86
13	10	54	64	56	66	86	74	78	90	84	76	72
14	12	70	70	74	72	104	102	110	100	98	88	90
15	15	66	56	66	54	56	70	72	88	84	82	80
10	14	48	60	48	66	88	90	94	100	104	112	110
16	10	64	70	64	70	92	90	84	88	82	90	96
10	9	62	66	60	66	64	66	70	72	78	88	80
12	12	82	58	80	60	80	80	80	80	80	80	80
14	13	62	50	60	54	98	90	84	88	86	90	94
16	15	50	62	50	66	96	90	84	100	102	114	100
12	14	64	62	64	62	118	100	120	108	92	90	98
9	13	48	60	50	60	74	80	82	88	84	88	94
15	17	42	60	44	66	96	102	104	110	126	114	104
12	14	50	48	50	48	96	94	92	88	84	90	96
8	10	64	74	64	74	96	90	92	88	84	86	98
10	9	52	58	50	60	82	90	94	92	88	98	104
13	13	64	60	64	60	102	118	124	126	108	102	110
10	13	56	64	54	74	84	82	90	94	98	102	100
14	13	62	50	62	52	92	98	104	84	88	92	96
13	15	48	58	50	60	72	84	90	80	100	112	92
11	10	62	54	64	56	84	80	86	92	84	82	90
13	14	58	66	60	66	84	86	102	100	94	92	84
14	15	86	74	88	72	98	90	82	86	90	94	80
14	15	58	66	60	62	82	90	96	88	84	90	82
9	12	60	64	60	66	74	90	84	88	78	92	90
10	11	58	62	60	62	62	78	96	90	102	110	86
9	13	66	74	68	74	80	80	80	80	80	80	80
11	14	74	72	74	72	84	86	100	94	96	92	88
10	11	42	80	42	80	94	90	82	80	74	90	90
16	15	78	70	78	70	90	88	70	78	88	76	80
16	16	64	82	64	84	92	84	78	82	96	86	80
10	10	42	68	46	66	94	90	86	82	78	80	84
9	11	50	62	50	64	56	60	64	58	70	72	76
11	13	72	70	76	74	98	90	76	80	100	94	90

SGB POST CPB HEMODYNAMICS																												
Radial Systolic							Radial Diastolic							Femoral Systolic							Femoral Diastolic							
10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting	10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting	10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting	10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting	rrhythmias
116	124	134	130	124	130	136	80	80	86	84	80	82	88	116	122	136	130	124	136	134	80	80	88	84	88	80	88	0
104	100	122	112	118	134	130	72	70	80	74	70	82	80	108	104	122	116	120	136	130	74	70	84	72	74	86	84	1
94	90	100	104	110	108	114	68	64	66	70	72	70	70	92	90	104	106	110	106	114	70	64	66	72	72	72	70	0
74	100	108	110	114	110	114	58	60	64	70	72	70	70	74	102	110	110	116	112	116	58	60	64	72	72	72	70	0
82	90	100	104	110	118	120	60	60	64	66	70	74	78	84	90	100	102	110	116	120	60	62	64	64	70	78	78	0
69	81	86	110	106	102	99	45	54	53	60	62	60	57	71	83	86	110	104	102	100	45	53	54	62	64	60	57	0
124	124	144	130	106	114	124	50	50	60	60	70	74	70	114	114	116	110	108	110	120	54	54	58	58	72	78	66	0
90	88	96	90	100	104	114	60	60	62	60	64	62	70	92	88	96	92	102	110	112	60	62	62	58	66	64	70	0
118	126	128	130	110	110	120	80	84	88	90	84	80	80	120	126	130	130	114	110	122	80	86	88	92	84	84	80	0
118	124	116	116	120	120	124	84	78	76	74	78	80	80	120	122	118	116	118	124	120	84	74	76	77	74	80	82	1
134	120	126	110	108	140	122	88	74	82	74	70	82	80	132	120	126	112	110	140	124	90	76	80	78	74	80	80	0
116	100	108	102	110	120	120	72	68	64	60	68	72	76	118	102	108	102	112	120	122	72	70	66	60	68	74	76	1
96	112	108	124	130	110	116	64	70	64	76	84	70	70	96	112	110	128	130	112	116	66	70	66	76	84	72	74	0
110	124	128	130	132	122	118	64	70	64	70	74	70	70	113	128	126	134	144	128	124	68	70	60	72	88	74	76	0
108	124	125	124	122	120	126	64	60	60	68	70	70	72	110	126	126	128	120	124	124	76	59	62	64	70	72	74	0
100	102	112	102	113	110	130	45	50	54	53	56	60	61	106	107	110	107	108	116	122	52	51	50	56	54	62	60	0
98	115	99	132	114	100	91	53	71	55	71	61	62	49	104	136	108	142	122	102	94	51	72	53	70	60	66	48	0
110	114	112	100	96	108	110	74	72	70	62	60	64	60	112	114	112	104	100	108	110	76	70	70	64	62	68	60	0
108	102	90	94	88	96	88	70	68	64	60	60	64	64	108	102	92	94	90	96	90	70	70	64	62	60	62	66	0
96	92	100	102	118	122	130	56	60	72	70	76	84	88	96	92	102	100	120	120	130	56	60	70	70	74	84	86	0
104	110	120	128	146	130	130	62	68	74	80	84	80	80	108	116	124	134	150	134	134	64	70	78	84	82	82	84	0
106	110	102	106	110	126	124	62	70	66	62	74	82	84	106	112	100	108	110	128	128	62	70	64	62	76	80	84	0
110	106	120	116	106	110	114	70	68	80	76	70	72	78	110	108	120	114	106	114	114	70	70	80	78	70	74	78	0
94	100	104	90	130	128	118	60	68	72	64	74	76	80	94	102	104	90	130	130	120	62	68	70	66	74	78	80	0
142	130	140	128	130	122	140	80	76	78	80	84	76	84	140	134	140	130	130	126	140	82	78	80	80	84	78	84	0
94	100	108	88	96	104	110	58	60	64	60	64	70	76	94	100	110	88	96	106	110	60	60	64	62	64	70	76	0
106	140	142	136	130	144	130	70	80	82	78	76	84	80	106	140	140	138	130	144	132	70	80	80	80	76	88	80	0
104	130	116	156	154	148	150	70	78	72	88	86	90	92	104	130	112	156	154	150	150	70	78	70	88	88	90	92	0
98	104	108	124	142	140	120	64	70	72	76	84	82	80	104	110	110	130	146	142	124	66	72	74	76	88	84	80	0
96	100	130	126	154	160	148	68	70	76	80	84	88	84	96	100	130	128	154	160	150	70	70	78	80	84	90	84	0
130	122	144	110	126	130	134	80	80	82	78	76	80	82	130	122	144	112	126	130	132	80	80	80	80	76	80	82	0
82	90	94	98	100	102	110	50	58	64	66	68	70	74	84	90	96	98	100	106	110	50	58	66	66	70	70	78	1
90	100	100	94	110	108	130	60	64	66	60	68	66	74	90	102	100	96	110	110	130	60	66	66	60	70	66	74	0
92	100	106	114	108	118	120	60	70	72	78	72	80	80	98	110	110	120	114	120	120	66	72	78	78	70	80	80	0
122	132	146	122	118	110	114	82	86	90	84	80	74	70	124	132	146	122	120	110	114	82	88	90	88	80	76	70	0
94	90	98	100	110	108	122	66	62	64	66	70	70	76	94	90	100	100	110	110	122	66	60	64	68	70	70	76	0
116	124	136	142	154	150	140	64	70	84	88	90	86	82	118	124	136	140	154	154	140	66	70	84	90	90	88	80	0
120	136	128	142	150	140	154	80	86	82	88	90	84	90	120	136	130	142	154	140	154	80	88	82	90	90	88	90	0
100	110	116	122	134	148	152	72	78	80	80	84	88	90	100	110	118	122	134	150	152	72	78	84	80	84	90	90	0
106	110	104	124	142	136	130	70	72	70	84	86	88	84	106	110	106	124	144	136	130	70	72	72	84	86	90	84	0
92	100	120	114	142	132	124	60	66	70	66	84	80	82	92	100	120	116	140	132	126	60	68	70	68	84	80	80	0
124	120	130	128	140	132	128	80	80	84	82	88	82	80	124	122	130	130	140	134	128	80	82	84	80	88	80	80	0
110	126	130	110	104	110	118	90	88	90	70	66	70	80	112	126	132	110	108	110	118	90	90	90	70	68	70	80	0
126	142	150	144	154	150	140	86	90	94	90	92	90	84	126	140	150	142	156	150	140	86	90	96	92	92	92	84	0
110	110	120	124	132	120	116	70	70	76	78	80	80	78	110	112	120	128	132	124	116	70	72	76	80	80	78	78	0
90	94	100	110	114	142	132	64	66	70	74	78	86	80	90	96	100	110	114	140	132	64	66	72	74	80	86	80	0
100	104	126	110	116	120	126	64	66	70	70	74	80	82	100	108	126	110	120	120	126	64	68	70	72	74	82	80	0
110	118	120	116	132	120	120	80	84	84	82	86	80	80	110	120	120	120	132	118	120	78	84	82	82	88	80	80	1
108	110	112	118	120	116	130	76	78	80	80	84	78	86	108	110	110	118	120	118	130	76	80	80	80	88	78	88	0
98	120	110	116	134	130	130	70	74	70	80	80	82	80	98	120	110	118	134	132	130	70	78	70	82	80	80	80	0

CONTROL GROUP DEMOGRAPHIC DATA

Identifiers		Demography					LVEF	Grafts	Comorbidities							Vitals			Systemic Examination			Block action		Complicatio
No	Patient ID	Age	Sex	Height	Weight	BSA			ypertensi	DM	COPD	Smoking	yslipidem	rrhythmia	Others	Pulse	BP Systoli	P Diastoli	CVS	RS	CNS	Temp Diff	Miosis	
2	374895	52	F	150	73	1.74	58	5	1	0	0	0	1	0	ypothyro	60	160	90	0	0	0	NA	NA	NA
3	373615	61	M	158	68	1.73	72	4	1	0	1	1	1	0	10 years	66	150	90	0	0	0	NA	NA	NA
6	382073	60	M	161	62	1.67	64	5	1	1	0	1	1	0	0	72	130	90	0	0	0	NA	NA	NA
7	382301	60	M	157	58	1.59	50	5	1	0	0	0	0	0	iety disor	70	130	80	0	0	0	NA	NA	NA
10	213448	56	M	157.5	66	1.70	50	5	1	1	1	1	1	0	0	74	130	80	0	0	0	NA	NA	NA
12	368676	54	M	152	63	1.63	56	5	1	1	0	0	1	0	0	60	170	92	0	0	0	NA	NA	NA
13	374971	54	M	161	75	1.83	60	5	1	1	0	1	1	0	0	70	150	90	0	0	0	NA	NA	NA
16	368344	57	M	158	56	1.57	64	4	0	1	0	1	1	0	0	80	154	84	0	0	0	NA	NA	NA
17	375580	61	M	164	71	1.80	48	5	0	1	0	1	1	0	0	82	150	86	0	0	0	NA	NA	NA
19	381120	72	M	160	63	1.67	62	5	1	0	0	1	1	0	0	50	180	100	0	0	0	NA	NA	NA
21	372477	55	M	181	70	1.88	48	5	1	1	0	0	1	0	0	80	140	90	0	0	0	NA	NA	NA
24	297334	58	M	168	67	1.77	46	5	0	0	0	1	1	0	0	58	140	90	0	0	0	NA	NA	NA
26	370509	54	F	152	58.5	1.57	68	4	1	1	0	0	1	0	0	80	140	88	0	0	0	NA	NA	NA
29	376990	69	M	168	68.5	1.79	62	5	1	1	0	0	1	0	0	88	150	80	0	0	0	NA	NA	NA
30	377485	58	M	158	53	1.53	58	4	1	0	0	1	0	0	BA	80	140	78	0	0	0	NA	NA	NA
32	279520	66	F	150	55.5	1.52	68	5	1	0	0	0	1	0	ypothyro	70	160	84	0	0	0	NA	NA	NA
33	393276	57	F	153	65.5	1.67	50	4	1	1	0	0	1	0	0	88	158	90	0	0	0	NA	NA	NA
35	339336	61	M	158	51.5	1.50	45	4	1	1	1	0	1	0	0	50	140	80	0	0	0	NA	NA	NA
38	399602	61	M	169.5	61.5	1.70	70	5	1	1	0	0	0	0	0	52	180	90	0	0	0	NA	NA	NA
40	376865	47	M	164	67	1.75	64	4	1	0	0	1	1	0	0	70	150	90	0	0	0	NA	NA	NA
43	389267	61	M	146.9	50.1	1.43	62	5	0	1	0	0	1	0	0	53	120	80	0	0	0	NA	NA	NA
45	386857	50	M	170.1	76.4	1.90	64	4	1	1	0	0	0	0	ic Alcoh	62	110	70	0	0	0	NA	NA	NA
46	304047	52	F	144.1	68	1.65	68	4	0	0	0	1	1	0	0	54	130	80	0	0	0	NA	NA	NA
49	391588	54	F	147.2	58	1.54	64	5	1	1	0	1	1	0	6 months	80	142	84	0	0	0	NA	NA	NA
50	388265	46	M	164.1	69.5	1.78	54	5	1	1	0	0	0	0	0	70	160	90	0	0	0	NA	NA	NA
52	390296	54	M	163.6	52.2	1.54	66	4	1	1	0	0	1	0	BA	54	160	92	0	0	0	NA	NA	NA
54	385285	59	M	159.4	74	1.81	52	5	1	1	0	0	1	0	BPH	56	170	92	0	0	0	NA	NA	NA
55	384954	65	M	165.9	68	1.77	56	4	1	0	0	1	1	0	0	60	148	88	0	0	0	NA	NA	NA
58	385091	49	M	153.5	71	1.74	66	4	0	1	0	0	1	0	iety disor	88	120	80	0	0	0	NA	NA	NA
60	385442	56	M	166.6	70	1.80	62	4	1	1	0	1	1	0	0	64	148	94	0	0	0	NA	NA	NA
62	391019	58	M	158.8	66.3	1.71	67	4	1	0	0	0	1	0	0	76	132	88	0	0	0	NA	NA	NA
63	392142	55	F	155.7	70	1.74	55	4	1	1	0	0	1	0	ypothyro	60	148	88	0	0	0	NA	NA	NA
66	382671	58	M	163.5	69	1.77	56	3	1	1	0	0	1	0	0	56	162	94	0	0	0	NA	NA	NA
67	330644	49	M	175.3	76.5	1.93	64	5	1	0	0	1	1	0	0	52	150	82	0	0	0	NA	NA	NA
70	391859	61	M	166.3	63.3	1.71	60	5	1	0	0	1	1	0	0	64	130	80	0	0	0	NA	NA	NA
72	372838	49	M	168.1	56.2	1.62	58	4	1	0	0	0	1	0	0	70	174	94	0	0	0	NA	NA	NA
73	384312	41	M	171.7	71	1.84	70	4	1	1	0	1	1	0	BA	72	130	80	0	0	0	NA	NA	NA
76	284885	44	M	183.4	83.3	2.06	64	5	0	0	0	0	0	0	0	56	110	74	0	0	0	NA	NA	NA
77	388223	40	M	161.3	64.5	1.70	54	4	1	0	0	0	1	0	0	60	120	70	0	0	0	NA	NA	NA
79	385748	45	M	162.0	60.5	1.65	68	4	1	1	0	1	1	0	0	76	130	80	0	0	0	NA	NA	NA
81	392179	78	M	171.2	61.5	1.71	64	4	1	0	0	0	1	0	0	88	140	90	0	0	0	NA	NA	NA
84	392096	74	M	163.9	62	1.68	60	4	1	1	0	0	1	0	BPH	70	138	88	0	0	0	NA	NA	NA
86	385042	49	M	164.4	63.3	1.70	64	3	1	1	0	0	1	0	0	64	130	90	0	0	0	NA	NA	NA
89	353315	52	F	144.2	52.5	1.45	66	5	0	1	0	1	1	0	ypothyro	82	142	82	0	0	0	NA	NA	NA
90	391173	47	M	169.2	61.5	1.70	56	4	1	0	0	1	1	0	0	66	126	84	0	0	0	NA	NA	NA
92	385122	48	M	168.6	61	1.69	60	5	1	1	0	0	1	0	0	76	130	88	0	0	0	NA	NA	NA
93	387177	72	M	158.4	72	1.78	62	5	1	0	0	0	1	0	olon canc	82	150	96	0	0	0	NA	NA	NA
95	387256	57	M	160.6	60.3	1.64	64	4	0	1	0	0	1	0	0	58	130	86	0	0	0	NA	NA	NA
98	393110	68	M	165.8	63.5	1.71	58	5	1	1	0	1	1	0	0	50	152	90	0	0	0	NA	NA	NA
100	388688	71	M	153.4	56.4	1.55	62	4	0	0	0	1	1	0	0	82	132	82	0	0	0	NA	NA	NA

CONTROL GROUP PRE CPB HEMODYNAMICS

Heart Rate						Radial Systolic						Radial Diastolic						Femoral Systolic						Femoral Diastolic					
Baseline	5 mins	10 mins	15 mins	20 mins	easureme	Baseline	5 mins	10 mins	15 mins	20 mins	easureme	Baseline	5 mins	10 mins	15 mins	20 mins	easureme	Baseline	5 mins	10 mins	15 mins	20 mins	easureme	Baseline	5 mins	10 mins	15 mins	20 mins	easurement
60	64	58	60	54	62	160	132	118	110	114	112	90	80	82	74	76	72	156	130	120	110	118	114	90	86	80	78	80	70
50	58	54	60	56	52	150	110	116	112	126	124	90	68	70	70	74	76	154	106	118	110	120	124	94	66	72	70	72	78
54	51	48	54	56	58	150	140	134	114	124	116	96	90	84	80	80	80	154	142	138	110	126	110	90	92	80	84	82	80
64	70	62	70	62	66	158	122	120	110	108	108	90	80	84	78	74	72	170	118	118	110	104	104	86	80	82	80	72	70
70	54	58	70	66	62	152	118	126	128	120	118	86	70	80	82	80	84	156	118	120	120	114	110	84	72	84	80	80	80
56	66	48	49	54	56	142	130	97	96	104	108	86	80	70	72	76	70	144	132	94	98	110	104	84	80	72	70	78	74
70	81	84	80	86	86	120	90	110	120	130	104	66	60	65	70	76	60	114	92	108	116	126	106	70	60	62	68	74	60
92	70	66	62	58	60	180	122	108	106	102	110	104	80	70	68	66	70	174	120	104	106	100	108	100	80	70	68	66	70
88	80	94	74	74	70	154	128	112	108	120	118	94	80	78	70	74	74	150	126	110	108	120	118	98	80	80	70	74	74
45	48	50	54	56	52	220	140	150	148	130	110	100	90	96	80	80	70	224	142	148	150	132	114	96	90	92	76	74	72
84	72	80	64	68	70	140	120	118	108	110	110	90	84	86	78	80	76	142	118	118	110	110	110	90	86	86	74	80	76
70	56	52	58	56	56	144	110	104	108	106	108	86	84	80	80	84	82	140	106	102	100	100	102	82	84	80	80	84	80
84	82	80	86	80	80	142	134	128	110	114	110	88	72	74	70	68	70	140	138	130	112	116	116	86	76	70	68	66	70
90	94	96	98	90	88	127	130	134	142	124	116	64	62	68	72	70	70	124	134	136	140	120	118	60	64	70	70	74	76
92	60	56	74	68	70	142	150	154	140	130	126	94	90	92	88	82	80	154	144	148	132	124	124	92	90	90	84	80	89
64	62	60	54	56	60	190	162	160	132	130	124	100	92	90	80	80	80	176	164	156	132	130	122	96	90	88	74	76	74
94	80	74	78	64	68	160	108	110	104	102	106	90	72	76	70	70	70	156	110	106	98	100	100	84	70	72	68	64	68
46	52	60	54	50	52	128	94	90	98	106	104	76	66	64	62	70	70	124	90	90	94	104	100	74	62	64	62	70	70
70	52	50	44	56	60	190	110	102	94	112	116	110	74	70	66	68	70	194	114	100	90	104	110	106	70	70	66	66	66
78	64	58	60	70	66	130	122	130	134	120	124	82	82	86	84	80	80	132	120	130	134	118	120	80	80	86	84	80	80
50	44	46	50	60	52	110	92	90	104	110	114	76	62	64	68	70	70	110	90	90	102	110	112	72	60	62	66	70	70
70	74	74	82	70	68	138	106	100	102	96	104	86	72	70	68	64	70	130	104	100	100	100	100	82	72	70	68	64	68
60	52	58	62	70	62	142	118	110	106	108	110	88	72	70	68	62	66	140	118	104	106	102	106	86	70	70	66	60	66
56	50	64	60	48	68	160	118	120	132	128	124	92	84	80	74	78	82	156	110	116	130	124	124	90	80	80	77	74	80
72	52	56	54	70	62	152	122	110	110	106	108	90	80	70	70	66	64	146	116	102	104	102	110	84	80	72	68	60	64
56	50	48	42	60	58	152	112	122	124	118	114	90	70	74	76	68	70	152	108	120	124	118	114	84	68	70	74	68	70
60	74	72	64	70	56	204	138	130	124	110	110	96	86	80	72	64	60	194	134	128	124	110	110	94	86	78	70	60	60
56	52	50	60	72	64	130	114	106	120	114	108	84	70	62	68	70	70	130	110	102	120	110	104	82	68	60	68	70	70
80	90	82	76	72	70	130	110	108	104	112	116	70	68	60	62	68	70	124	106	108	102	110	116	66	68	60	60	66	70
66	60	58	52	70	60	160	110	118	120	128	124	94	80	84	82	86	82	154	106	112	120	120	124	92	80	84	80	86	80
70	60	56	50	62	68	128	120	118	112	106	120	78	82	80	80	74	80	124	116	116	110	100	110	76	80	80	80	72	76
58	50	60	62	60	58	126	122	114	102	100	104	82	88	84	74	70	68	126	122	110	102	100	104	80	84	80	72	70	70
52	62	60	58	70	70	160	110	106	94	118	126	96	78	70	66	78	84	158	114	106	92	116	126	96	78	74	62	74	80
58	50	56	70	54	58	154	130	124	118	106	108	88	90	82	74	66	66	150	126	122	112	106	108	88	86	80	74	62	66
60	58	50	64	60	64	136	118	112	120	116	120	84	80	74	78	68	74	136	116	114	116	116	120	82	80	72	72	66	72
68	60	56	58	50	54	148	110	120	106	130	120	84	78	82	80	84	80	144	110	120	102	126	122	82	76	80	80	82	80
80	78	70	64	66	68	126	106	112	124	116	126	80	58	62	74	82	80	124	106	112	124	116	124	80	56	60	72	80	80
60	52	50	52	60	62	132	120	106	110	102	106	84	84	70	72	68	66	130	108	102	104	100	106	84	82	66	70	70	62
72	80	84	68	66	72	122	100	126	148	132	124	80	64	74	84	82	80	116	100	120	144	132	124	80	66	72	80	80	80
70	88	84	78	70	74	128	108	106	108	110	110	80	68	66	64	60	64	128	110	106	104	110	110	78	66	66	64	60	62
90	84	80	70	78	72	170	130	136	148	152	118	94	84	86	90	94	86	170	130	134	140	150	114	92	84	86	88	90	82
64	74	70	62	54	52	150	120	106	100	100	110	84	80	74	70	72	76	150	120	104	100	100	100	82	80	72	70	70	72
60	52	58	52	66	72	148	112	110	128	132	124	82	84	80	84	86	80	144	110	110	130	130	120	80	82	80	82	88	80
68	78	70	56	52	58	150	106	114	128	126	124	88	70	74	84	86	88	154	104	112	130	124	124	84	70	74	80	82	88
70	64	60	56	52	56	110	114	102	100	130	120	80	80	84	74	82	84	116	112	100	100	130	120	78	80	82	74	80	82
80	70	56	52	58	60	160	120	114	112	122	106	94	82	80	74	72	68	162	116	114	110	120	108	92	80	80	72	70	66
68	60	74	70	68	80	158	114	102	104	118	114	84	70	60	62	74	72	154	110	100	104	120	114	82	70	60	60	72	70
66	60	78	70	56	60	140	110	132	136	130	128	88	70	82	86	80	74	138	110	130	136	130	130	84	70	80	86	80	72
44	54	50	48	60	62	150	132	138	142	126	118	84	76	82	84	74	70	146	130	138	140	122	118	82	72	80	84	74	70
70	88	84	86	80	84	164	130	114	102	100	108	94	78	80	70	68	70	162	126	110	100	100	110	92	74	80	70	66	66

CONTROL GROUP LIMA FLOWS and CPB HEMODYNAMICS												
		On Bypass				Post Bypass						
LIMA Flow		Radial		Femoral		Heart Rate						
Flow 1	Flow 2	10 mins	Rewarmin	10 mins	Rewarmin	10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting
13	12	64	70	60	66	68	80	80	80	80	80	80
8	10	62	54	60	56	94	88	86	74	76	84	88
10	12	44	52	44	54	74	80	84	86	80	82	78
9	13	58	66	56	66	80	86	82	94	90	94	88
8	7	76	70	72	76	70	74	78	70	84	88	86
10	11	80	70	82	72	94	90	80	93	90	84	92
12	16	64	50	64	58	82	88	96	98	96	90	90
10	14	82	66	80	74	84	90	90	90	90	90	90
14	16	70	48	70	52	92	94	88	78	92	90	86
12	11	68	70	70	76	80	80	80	80	80	80	80
12	11	66	70	66	78	68	74	76	72	70	84	80
14	15	74	66	72	72	82	84	86	80	82	94	100
10	8	47	48	50	50	90	97	94	90	92	90	88
10	12	35	38	40	40	99	102	95	93	90	92	97
14	12	48	60	50	60	66	64	68	66	70	72	76
8	10	50	58	50	56	76	70	74	68	70	82	80
9	10	54	48	54	50	56	54	70	66	62	68	70
12	15	58	62	56	70	80	80	80	80	80	80	80
14	13	62	60	64	58	90	94	88	96	92	88	84
13	14	42	48	44	52	72	70	68	92	92	88	86
14	16	58	48	60	50	90	90	90	90	90	90	90
12	10	78	64	80	62	84	90	98	92	96	104	100
14	13	84	66	84	72	92	90	88	74	90	90	90
16	10	70	60	70	60	86	82	80	74	82	86	80
12	13	48	58	50	70	82	88	74	70	96	112	114
14	14	74	68	74	68	84	82	90	96	98	92	90
10	9	42	56	40	58	98	90	84	96	110	126	110
13	11	60	50	60	52	90	90	90	90	90	90	90
10	12	44	60	44	70	84	86	80	94	112	90	94
10	9	56	70	58	72	104	102	100	108	126	120	102
11	11	70	54	70	60	62	64	70	70	82	84	70
12	9	44	40	46	40	78	92	90	88	100	98	96
10	11	48	58	48	58	98	90	78	84	82	80	84
12	14	68	68	68	68	74	70	68	62	66	74	72
15	14	68	62	70	62	62	64	66	74	72	70	78
11	9	54	42	54	44	88	106	112	100	96	100	102
8	7	76	48	76	56	72	70	64	68	92	90	88
14	12	70	78	70	80	82	80	74	78	90	92	98
13	11	66	70	68	70	92	100	104	92	88	84	80
12	14	76	60	76	60	90	94	84	82	96	78	84
10	13	62	62	62	70	56	68	64	80	72	70	68
12	12	74	70	74	72	96	100	90	88	92	78	80
12	10	66	52	70	60	96	98	90	84	86	92	94
13	12	50	76	50	78	84	88	90	106	110	94	98
14	11	62	68	66	68	78	84	88	90	86	82	86
11	13	64	74	64	76	68	62	58	70	64	72	70
13	15	70	76	74	76	90	90	90	90	90	90	90
12	13	48	56	48	62	70	68	54	62	60	66	64
12	11	64	58	64	66	80	72	90	96	102	88	92
13	10	70	74	70	72	86	80	108	126	100	104	90

CONTROL GROUP POST CPB HEMODYNAMICS																												
Radial Systolic							Radial Diastolic							Femoral Systolic							Femoral Diastolic							
10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting	10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting	10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting	10 mins	20 mins	30 mins	40 mins	50 mins	60 mins	Shifting	rrhythmias
104	116	120	118	126	112	122	50	64	70	72	80	80	76	104	120	126	116	122	110	118	48	68	72	78	84	82	74	1
112	132	130	126	110	108	118	74	88	82	76	70	66	62	110	130	130	130	110	110	120	72	90	80	80	70	64	60	0
112	108	106	134	140	148	150	66	70	72	84	88	90	90	110	110	112	136	142	150	150	66	70	72	84	88	90	90	0
100	130	124	132	144	120	122	60	66	70	72	80	76	80	104	130	122	130	146	128	126	62	68	70	74	84	78	82	0
90	122	110	108	102	106	110	62	72	68	64	70	66	72	94	126	114	112	104	106	110	64	74	70	66	70	66	72	1
122	110	100	94	90	120	130	52	46	42	45	43	50	56	125	112	106	100	96	126	136	53	48	46	44	42	54	60	0
90	117	120	130	126	114	120	50	66	64	60	66	64	62	98	114	132	136	128	110	116	60	64	60	65	68	66	62	1
88	100	134	154	142	130	134	64	68	78	84	84	80	80	94	114	138	160	148	138	134	68	70	80	86	88	82	84	0
106	110	102	90	100	110	118	70	70	68	60	64	70	76	108	110	102	92	100	108	120	70	70	70	64	62	72	76	1
100	114	130	108	116	124	120	60	68	70	70	66	74	78	104	110	128	114	122	126	120	66	72	70	74	68	78	80	1
128	118	110	112	100	98	108	82	80	76	74	66	60	68	134	124	116	120	106	98	110	84	82	80	78	70	64	68	0
84	100	98	96	106	102	110	60	70	72	66	70	66	70	90	104	104	100	114	106	110	64	72	72	68	72	66	70	0
107	120	118	106	116	124	110	51	53	60	58	64	74	70	112	124	116	104	114	120	110	52	53	62	54	60	72	70	1
130	140	150	127	96	100	121	70	80	59	54	48	49	52	132	138	144	128	100	100	120	72	84	60	56	50	52	55	0
118	120	124	132	116	120	110	80	80	82	84	80	80	76	120	122	124	130	120	120	110	82	80	82	86	80	82	76	0
78	90	94	88	100	104	110	54	60	62	60	66	64	68	82	90	96	90	104	104	110	56	60	68	60	68	64	68	1
92	90	86	90	110	120	114	64	60	58	60	64	70	66	94	90	90	90	114	120	114	64	64	60	60	64	72	66	0
86	90	94	100	104	98	100	62	60	64	72	70	66	70	88	94	96	106	110	100	104	64	66	66	74	74	70	70	1
74	82	90	88	96	100	104	50	58	60	64	66	64	68	72	86	90	90	96	100	106	52	58	62	64	68	64	68	0
100	112	118	130	142	140	130	60	70	72	80	84	80	74	102	114	120	130	144	140	134	62	70	74	80	84	82	76	0
132	130	126	144	156	132	144	78	82	76	84	90	82	86	132	132	126	140	154	130	144	78	80	76	82	90	80	86	1
114	120	128	110	108	116	118	80	82	88	76	70	74	78	118	120	126	110	108	114	118	82	82	90	76	74	74	80	0
86	90	94	100	102	110	114	58	60	62	70	74	76	78	90	96	98	106	100	108	118	64	62	66	74	72	80	80	1
120	118	106	130	120	140	146	84	80	70	84	80	86	90	122	120	108	130	124	140	148	84	82	72	84	82	86	90	0
88	90	110	108	96	100	110	50	54	60	66	60	64	70	96	96	114	110	110	104	118	50	58	62	66	62	68	74	0
96	100	96	112	118	124	130	60	60	62	72	70	78	80	96	102	96	114	118	124	130	60	62	62	70	70	78	80	1
78	90	96	88	100	104	110	52	58	60	60	62	64	66	80	90	96	90	100	108	110	56	58	62	60	62	64	68	0
100	104	110	120	120	142	128	70	72	78	74	78	84	80	100	108	110	120	120	144	128	70	70	78	76	78	86	80	0
88	100	102	90	96	100	108	62	68	70	66	66	70	72	94	106	108	98	100	102	110	66	70	74	70	68	70	74	1
104	100	96	108	110	114	110	70	68	66	70	76	80	78	104	100	98	110	110	114	110	70	70	66	70	78	80	80	0
112	100	96	102	128	142	130	80	72	66	70	80	86	84	118	106	108	112	130	148	132	84	78	64	72	86	84	84	0
102	142	120	128	110	106	110	72	88	82	86	76	70	80	100	142	120	130	110	110	110	72	90	82	88	76	74	80	0
110	130	136	144	140	142	138	72	78	80	84	86	84	80	110	134	136	144	142	142	138	72	78	84	84	88	84	80	0
108	110	114	120	110	106	112	74	78	76	80	72	66	68	110	110	114	120	112	106	112	74	80	76	80	72	68	68	0
108	112	110	128	130	120	114	70	74	70	76	78	80	80	110	112	110	130	130	120	116	70	74	70	78	80	80	80	1
82	94	100	114	120	114	134	60	64	70	74	80	74	84	84	94	100	118	120	114	134	60	66	70	74	80	78	84	0
78	90	88	94	100	130	142	50	66	64	60	70	78	84	84	96	94	96	100	130	148	54	68	70	66	74	78	88	0
88	90	132	116	130	126	154	60	62	74	70	76	80	88	90	90	134	116	130	128	154	60	64	74	72	76	84	88	1
96	132	126	144	130	134	130	66	76	78	84	80	82	86	96	134	126	144	132	134	130	66	78	78	84	82	82	88	0
110	104	110	118	120	132	130	78	70	74	80	80	84	86	110	106	110	118	126	132	130	78	74	74	80	82	84	86	0
88	90	104	110	102	124	110	58	60	62	68	64	74	70	96	100	110	116	110	124	116	60	66	64	70	64	78	72	0
130	118	110	100	106	114	122	84	80	76	70	72	70	74	130	120	110	104	106	118	122	82	80	78	70	74	70	78	1
90	96	110	108	132	130	130	60	62	68	66	70	76	78	96	100	120	114	134	132	130	64	66	70	70	70	78	78	0
124	122	130	118	110	114	132	84	80	82	78	70	70	76	124	122	130	120	110	112	130	82	80	80	78	70	72	76	0
102	100	106	104	110	110	120	74	74	76	70	70	72	78	102	102	106	104	110	112	120	74	76	76	72	70	70	78	1
88	100	102	108	110	130	132	56	60	60	62	68	74	70	88	100	100	110	114	130	130	60	60	62	60	68	70	70	0
108	110	106	132	118	124	110	70	70	72	78	80	80	78	110	110	110	132	118	128	110	70	74	72	80	80	80	78	0
96	110	124	142	124	152	150	58	64	78	86	80	88	90	100	116	130	148	128	156	150	60	68	80	88	84	90	90	0
102	110	116	130	134	140	132	80	82	80	86	88	90	82	108	110	120	130	138	140	132	84	82	80	88	88	90	80	0
88	100	104	110	120	110	110	60	64	66	70	76	70	70	90	100	104	114	120	110	110	64	64	64	70	76	72	70	0