Dissertation on

COMPARISON OF INTERNAL VEIN CANNULATION IN NEUTRAL HEAD POSITION VERSUS CLASSICAL CENTRAL APPROACH

Dissertation Submitted in partial fulfillment of

M.D. DEGREE EXAMINATION

BRANCH X – ANAESTHESIOLOGY

MADRAS MEDICAL COLLEGE, CHENNAI.

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI, TAMIL NADU

MARCH 2007

CERTIFICATE

This is to certify that the Dissertation " **COMPARISON OF INTERNAL JUGULAR VEIN CANNULATION IN NEUTRAL HEAD POSITION VERSUS CLASSICAL CENTRAL APPROACH**" is the original work done by **Dr.S.Vinodh kumar** in the Department of Anaesthesiology, Madras Medical College and Government General Hospital, Chennai for the award of Degree of M.D. (Branch X) Anaesthesiology, during the academic period of 2004-2007.

Place:
Date:

Prof.Dr.Kalavathy Ponniraivan, B.Sc**,** MD.,
DEAN,
Madras Medical College & Hospital,
Chennai.

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Place:
Date:

Prof.Dr.G.Sivarajan, MD., DA.,
Professor & HOD,
Department of Anesthesiology,
Madras Medical College & Hospital,
Chennai.

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I wish to express my sincere thanks to **Prof. Dr. Kalavathy Ponniraivan,** *MD*., Dean, Madras Medical College, Chennai for having kindly permitted me to utilize the hospital facilities to conduct this study.

I express my deep sense of gratitude to **Prof. Dr. G. Sivarajan,** *M.D., D.A*., Professor & Head of the Department of Anaesthesiology, Madras Medical College, Chennai for his constant encouragement and invaluable guidance.

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I express my heart-felt gratitude to my guide **Dr.R.Shanthimalar** M.D., D.A., Assistant

professor, for her constant guidance and invaluable help in every step of this study.

I thank all the Assistant Professors and Tutors for their able help, support and supervision during the course of the study.

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I thank all the patients included in the study and their relatives, for their wholehearted co-operation in spite of their illness.

Last but not the least, I would like to express my sincere gratitude to **Lord Almighty**.

DECLARATION

I hereby declare that dissertation entitled **"COMPARISON OF INTERNAL JUGULAR VEIN CANNULATION IN NEUTRAL HEAD POSITION VERSUS CLASSICAL CENTRAL APPROACH",** has been the original work done by me, under the guidance of **PROF.DR.G.SIVARAJAN, M.D., D.A** Professor and Head of Department of Anaesthesiology, Madras Medical College, Chennai in partial fulfillment of the regulations for the award of the degree of M.D. (Anaesthesiology), examination to be held in March 2007.

This study was conducted at Madras Medical College and Government General Hospital, Chennai.

I have not submitted this dissertation previously to any university for the award of any degree or diploma.

Place : Chennai. **DR.S. VINODHKUMAR**
Date :

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CONTENTS:

S.NO:		PAGE NO:
1.	INTRODUCTION	1
2.	AIM OF THE STUDY	3
3.	HISTORICAL PERSPECTIVES	4
4.	ANATOMY OF THE INTERNAL JUGULAR VEIN	6
5.	TECHNIQUES OF IJV CANNULATION	8
6.	IJV CANNULATION IN NEUTRAL HEAD POSITION	15
7.	REVIEW OF LITERATURE	17
8.	MATERIALS AND METHODS	23
9.	OBSERVATION AND RESULTS	34
10.	STATISTICAL METHODS	44
11.	DISCUSSION	45
12.	SUMMARY	51
13.	CONCLUSION	53

BIBLIOGRAPHY:

PROFORMA

MASTER CHART

1. INTRODUCTION

Central venous access is an integral part of patient management in many clinical settings. Percutaneous central venous cannulation is now common during perioperative care of major surgical patients, in intensive care monitoring, for long term hyperalimentation, for infusion of vasoactive drugs and also for rapid restoration of blood volume in case of unexpected acute blood loss.

Central venous access can be achieved through the internal jugular vein (IJV), subclavian vein, femoral vein or using peripherally inserted central catheters. The actual site chosen in a particular patient depends on the indication, individual institutional and operator experiences. Advantages of IJV cannulation relate to its consistent, predictable anatomic location and low rate of major complications. The right internal jugular vein (IJV) has a direct path to Right atrium (RA), most reliably reflects the CVP and is associated with fewest catheter tip malposition.

The standard conventional technique for placing central venous catheters in the IJV is by using anatomical landmarks. Rates of major and minor complications can be as high as 10%[1]. The rates, risks and the consequences of complications vary according to patient groups, neck abnormalities, and history of previous cannulation at the same site, experience of the operator, the presence of atypical vascular anatomy, the blood coagulability of the patient, the hydration status of the patient, awake or ventilated patients, elective or emergency

cannulation.

Standard approaches to internal jugular vein catheterization include the anterior, central and posterior routes [2]. All of these techniques are described with the head either turned or significantly extended in order to improve anatomical positioning and access. In trauma patients with unstable neck injuries following traditional approaches for the placement of ijv catheter poses additional neurological injuries during the procedure. Furthermore placing the patient in Trendelenberg position (15^0 head tilt downwards) increases the intracranial pressure (ICP) which is detrimental to neurosurgical patients and patients with head injury. To circumvent these problems IJV can be cannulated with the head held in neutral position, using simple bony and cartilagenous landmarks[3]. This method will be useful particularly in those with suspected cervical spine injuries and where central venous cannulation is most easily obtained via the internal jugular vein.

2. AIM OF THE STUDY

The aim of this study is to assess the ease of placement of internal jugular venous catheter in neutral head position, and to compare the success rate, failure rate and the complication rate of this technique with that of classical central approach.

3. HISTORICAL PERSPECTIVES

Aubanic is credited with the first description of infraclavicular subclavian venipuncture in humans in 1952. A major advance came in the following year when seldinger[4] described the replacement of catheter needle using a guide wire, a technique that now bears his name. During the mid 1950s percutaneous catheterization of the IVC via a femoral vein approach became popular until reports of [5] high incidence of complications were published.

An important development occurred in 1959, when Hughes and Magovern[6] described the clinical use of central venous pressure (CVP) measurements in humans undergoing thoracotomy. In 1962, Wilson and associates extended the practicality of CVP monitoring by using percutaneous infraclavicular subclavian vein (SV) catheterization. This technique achieved wide clinical acceptance, but enthusiasm was tempered when various, sometimes fatal complications were reported. Yoffa[7] reported his experience with supraclavicular subclavian venipuncture, claiming a lower incidence of complications, but his results were not uniformly reproduced.

Norduland and Thoren and then Rams and associates[8] performed external jugular vein (EJV) catheterization and advocated a more extensive use of this approach. Although EJV catheterization met the goal of causing fewer complications during venipuncture, positioning the catheter tip in a central venous

location was sometimes impossible.

The first large series on internal jugular vein (IJV) catheterization appeared in 1969, when English et al[9, 10] reported on 500 percutaneous IJV catheterizations. Reports confirming this route's efficiency and low complication rate followed, and it has remained a popular site for central venous access.

4. ANATOMY OF THE IJV

The internal jugular vein (IJV) emerges from the jugular bulb at the posterior compartment of the jugular foramen. It collects blood from the skull, brain, superficial parts of face and much of the neck. All its origin is its superior bulb, which is below the posterior part of the tympanic floor. The vein descends in the carotid sheath, uniting with the subclavian, posterior to the sternal end of clavicle to form the brachiocephalic vein. It is also dilated near its end as its inferior bulb, above which it contains a pair of valves. Posterior to the vein from above are; the rectus capitis lateralis, transverse process of atlas, levator scapulare, scalenus medius and the cervical plexus, scalenus anterior, phrenic nerve, thyrocervical trunk, vertebral vein and first part of subclavian artery, on the left it also crosses anterior to the thoracic duct. Medial to the vein are internal and common carotid arteries and the vagus nerve between vein and arteries but posterior to them. Superficially the vein is overlapped above, then covered below by sternocleidomastoid and crossed by the posterior belly of the digastric and the superior belly of omohyoid. Superior to the digastric, the parotid gland and the styloid process are superficial, the accessory nerve, and posterior auricular and occipital arteries crossing the vein. Between the digastric and the omohyoid, sternocleidomastoid arteries and the inferior root of the ansa cervicalis cross it, but

the nerve often passes between the vein and the common carotid. Below the omohyoid it is covered by the infrahyoid muscles and the sternocleidomastoid and it is crossed by the anterior jugular vein. Deep cervical lymph nodes lie among the vein, mainly on its superficial aspect. At the root of the neck, the right IJV is separated from the common carotid but the left IJV usually overlaps its artery. At the base of the skull the internal carotid artery is anterior, separated from the vein by the ninth to twelfth cranial nerves. The junction of the right IJV with the right subclavian and then the innominate vein forms a straight path to the SVC. As a result malposition and looping as a catheter inserted through the right IJV are unusual.

The internal carotid artery runs medial to the IJV, but, rarely may lie directly posteriorly the dome of the pleura which is higher on the left, lies caudal to the junction of IJV and SV. The thoracic duct lies behind the left IJV and enters the superior margin of the SV near jugulo subclavian junction. The right lymphatic duct has the same anatomical relationship but is much smaller and chylous effusion occurs only with left-sided IJV annulations[11, 12].

Tributaries

The tributaries of the internal jugular vein below the inferior petrosal sinus are in, order from above downwards, the pharyngeal plexus, facial, lingual, superior and middle thyroid veins.

Surface anatomy

The surface marking of the IJV is along a line from the lobule of the ear to the sternal end of the clavicle.

5. TECHNIQUES OF IJV CANNULATION

Many different methods are described for IJV cannulation. All these methods use the same landmarks but differ in the site of venipuncture and orientation of the needle. Defalque[13] grouped the methods into three general approaches.

1. Central approach
2. Anterior approach
3. Posterior approach

Central approach.

This is the most popular and frequently followed approach described by Daily[14]. The patient is placed in supine position with the head turned slightly to the left to expose the right side of the neck and keep the chin from interfering with the procedure. Anatomic landmarks including the sternal notch, clavicle and sternocleidomastoid muscle should be assessed before preparation and draping. The internal jugular vein lies in the groove between the sternal and clavicular heads of the sternocleidomastoid muscle, lateral and slightly anterior to the carotid

artery. The patient should be calm, sedated and receiving supplemental oxygen if necessary and monitored with an ECG, blood pressure monitor and pulse oximeter. Owing to the frequency and potential morbidity of infectious complications, strict aseptic technique is required.

Under sterile conditions, the relevant anatomy is again identified. The patient is placed in slight head down (Trendelenberg) position to increase the central venous pressure and jugular vein diameter. The intended venipuncture site is anaesthetized by subcutaneous infiltration with a local anesthetic solution (1% xylocaine) using a 25 gauge needle.

With the fingers of the left hand gently resting on the carotid artery pulse a valuable anatomic landmark, venipuncture then proceeds using a 22 gauge, $1^1/_2$ inch finder needle mounted on a 5. ml syringe. The needle is inserted at the apex of the triangle formed by the two heads of the sternocleidomastoid muscle, at an angle of approximately 30 degrees from the plane of the skin and directed at the ipsilateral nipple. Gentle aspiration will identify the jugular vein when dark venous blood enters the syringe. Although use of the small finder needle is an extra step in this procedure, it presumably increases the safety margin[15] because unintentional puncture of the carotid artery with this small needle is less likely to result in significant bleeding and hematoma formation. If the blood is not aspirated, the finder needle is advanced and then withdrawn, additional needle passes may locate the vein by fanning laterally in a small arc from the point where

the needle enters the skin. As long as the carotid artery remains palpable medially, exploring in an orderly fashion with the finder needle directed slightly more laterally will often identify the vein, with little risk of carotid artery puncture. If the vein is not located after several needle passes, the finder needle is withdrawn completely and checked for patency, the anatomy is reassessed and the puncture may then proceed with the needle entering the skin several millimeters closer to the palpated carotid pulse but still directed in a sagittal or slightly lateral direction. Because of the normal anatomic relation between the carotid artery and the internal jugular vein, one should resist the temptation to explore with a medial or leftward direction of the finder needle when this technique for venipuncture is used.

When the IJV is located with the finder needle, the needle is gently withdrawn, while the skin and surface anatomy remains fixed by the left hand. The vein is then repunctured with an 18-gauge 2 $^{1}/_{2}$ inch thin walled needle attached to a 5 ml syringe, following the same track used with the finder needle keeping in mind the location and depth of the IJV. It is common that the lumen of the jugular vein is compressed as this larger thin-wall needle is advanced, which causes the needle to pierce both front and back walls almost simultaneously[16, 17]. Consequently the thin - wall needle should be inserted only slightly beyond the expected depth, then slowly with drawn maintaining gentle aspiration on the syringe. Frequently, a sudden gush of free-flowing venous blood is identified

during needle withdrawal.

Successful puncture of the IJV is confirmed by the easy aspiration of dark venous blood. The syringe is removed during expiration and the hub occluded with a finger after ensuring that the back flow of blood is not pulsatile. A 0.035 inch guide wire is inserted through the needle, using either the J-shaped tip or the sort, flexible straight end. The wire should advance easily into the vein with little resistance. The ECG is monitored continuously to observe arrhythmias, which are common, if the wire tip contacts the walls of the right atrium or ventricle[18]. From this point in the procedure, it is critical that the clinician maintains control over the guide wire and pay attention to its depth of insertion and continued sterility.

In preparation for placing the central venous catheter over the guide wire, the puncture site is enlarged, using a # 11 scalpel blade to the size required for the intended catheter. A firm, tapered tip, vessel - dilator inserted to dilate the subcutaneous tissues around the guide wire and allow a larger catheter to pass more smoothly. The vessel dilator is removed and the central venous catheter is inserted over the guide wire while traction on the skin is maintained. The catheter is inserted to an appropriate depth that will place the tip in the superior venacava, above its junction with the right atrium. This depth is typically 15 to 18 cm if the catheter is placed is using the technique described. The position of the catheter tip always must be confirmed radiographically, because catheter tips located within the heart increase the risk of cardiac perforation and tamponade[19, 20, 21, 22]. Ideally

the catheter tip should lie within the superior venacava, parallel to the vessel walls and be positioned below the inferior border of the clavicles and above the level of the third rib, the T_{4-5} interspace, the azygos vein, or the tracheal carina. Finally the guide wire is withdrawn, attached by a Luer - Lock connector to the monitoring or the infusion tubing and sutured in place, and a sterile gauze or transparent dressing is applied. The venous pressure should be measured before infusion to document that the catheter is located in the jugular vein and not the carotid artery.

Alternative approaches

The anterior and posterior approaches are identical in technique, differing only in venipuncture - site and plane of insertion. For the **Anterior** approach[23, 24,25] the important landmark is the midpoint of the sternal head of the sternocleidomastoid muscle, approximately 5cm from both the angle of the mandible and the sternum. At this point, the carotid artery can be palpated 1 cm inside the lateral border of the sternal head. The index and middle fingers of the left hand gently palpate the artery, and the needle is introduced 0.5 to 1 cm lateral to the pulsation. The needle should form a 30 to 45 degree angle with the frontal plane and be directed caudally parallel to the carotid artery toward the ipsilateral nipple. Venipuncture occurs within 2 to 4 cm, sometimes only while the needle is slowly withdrawn. If the initial thrust is unsuccessful, the next attempt should be at a 5-degree lateral angle, followed by a cautious attempt more medially, never crossing the plane of the carotid artery.

The **posterior** approach uses the EJV as a surface landmark. The needle is inserted 1 cm dorsally to the point where the EJV crosses the posterior border of the sternocleidomastoid or 5 cm cephalad from the clavicle along the clavicular head of the SCM. The needle is directed caudally and ventrally toward the suprasternal notch at an angle 45 – degrees to the sagittal plane, with a 15 – degree upward angulation. Venipuncture occurs within 5 to 7 cm. If the attempt is unsuccessful, the needle should be aimed slightly more cephalad on the next attempt.

SUCCESS RATES

Internal jugular vein catheterization is associated with a high rate of successful catheter placement regardless of the approach used. Elective procedures are successful more than 90% of the time, generally within first three attempts, and the catheter malposition is rare[26, 27,28,29,30]. Operator experience does not appear to be as important a factor in altering the success rate of venipuncture as it is in increasing the number of complications[31,32]. Emergency IJV cannulation is less successful than that of the elective procedure.

COMPLICATIONS:

The incidence and types of complications are similar regardless of the approach. Operator's inexperience appears to increase the number of complications, but to an undefined extent, and probably does not have as great an

impact as it does on the incidence of pneumothorax in subclavian venipuncture. The overall incidence of complications in IJV catheterization is 0.1% to 4.2%[33, 34]. Important complications include carotid artery puncture, which constitutes 80 – 90% of all complications. In the absence of bleeding diathesis, arterial punctures are benign and are managed conservatively, without sequelae by applying local pressure for 10 minutes. Even in the absence of clotting abnormalities, a sizable hematoma may form, frequently preventing further catheterization attempts or rarely exerting pressure on vital structures [35,36] .Unrecognized arterial puncture can lead to catheterization of the carotid artery with a large bore catheter or introducer and can have disastrous consequences, especially when heparin is administered. Chronic complications which results from artery puncture include hematomas requiring surgical excision, arterio-venous fistula and pseudoaneurysm. 0% to 2% [37]. It usually results from a skin puncture too close to the clavicle. Pneumothorax can be complicated by heme, infusion of intravenous fluid, or tension.

An extraordinary number of case reports indicate that any complication from IJV catheterization is possible, even the intrathecal insertion of a Swan-Ganz catheter[38].In reality this route is reliable, with a low incidence of major complications.

6. IJV CANNULATION IN NEUTRAL HEAD POSITION

All the standard anatomical landmark techniques described requires either the head to be turned or extended in order to improve the IJV access. In patients with unstable neck injuries, following there standard techniques will place the patient at risk for additional neurological injuries. Placing the patient in Trendelenberg position (15° head tilt downwards) increases intracranial pressures which is detrimental in most neurosurgical patients. Cannulating the internal jugular vein with the head held in neutral position offers significant advantages in these patients.

Technique of cannulation:

The patient is placed in supine position (table flat, head in midline, sand bags on either side of the head to ensure immobilization of neck). The point of needle entry is directly superior to the lateral border of the bony depression caused by the insertion of the clavicular head of the sternocleidomastoid muscle on the superior surface of the clavicle. The insertion point is easily identified by running the finger firmly along the superior-posterior edge of the clavicle to find the indentation. The point of needle insertion is in a cephalad direction in the sagittal plane at the level of cricoid cartilage. The clavicular insertion of the sternocleidomastoid muscle and the cricoid cartilage are easily identified in almost all patients. The carotid artery is palpated prior to the placement of the finder needle to ensure that it is not directly under the insertion point, the carotid artery is not palpated during the procedure itself since pressure over the carotid decreases

the IJV diameter[39]. The finder needle is inserted at an angle of 60 – 90 degree to the frontal plane unlike the classical central approach. Once the vein is located catheterization proceeded in the same track as the finder needle using the seldinger technique.

Head rotation to more than 40 degrees increases the risk of carotid artery because of increased overlapping of the two vessels [40, 41]. IJV frequently collapses with the needle insertion which results in the puncture of its posterior wall and thus of the carotid artery when the two vessels overlap. Neutral head position decreases this risk.

Alternative approaches to IJV cannulation in neutral head position are also described. According to Kaushik et al., [42] with the head and neck held in neutral position the junction of the medial two thirds and lateral one third between the angle of mandible and symphysis menti is identified. A vertical line is drawn from this point to join another line drawn between the mastoid process and the medial end of the clavicle. The junction is the puncture point which reliably identifies the IJV. Lew Ys et al[43] described a method in which the venipuncture is made immediately lateral to carotid artery at the level of cricoid cartilage and directed caudad.

Ultrasound guided cannulation obviously would be a better technique but it is not always available and lack of training is also a limiting factor.

7. REVIEW OF LITERATURE

Cannulation of IJV in neutral head position has been previously reported in literature. The relationship between carotid artery and internal jugular vein at varying degrees of head rotation has been studied extensively

Willeford KL, Reitan JA, 1994

They conducted a study in 55 patients, where venous puncture is made along an axial line drawn superiorly from the lateral edge of the bony depression caused by the insertion of the sternocleidomastoid muscle on the superior edge of the clavicle. This line at the level of the cricoid cartilage, lies directly over the internal jugular vein the mean number of puncture attempts to locate the vein was 1.4. (0.2) per patient with an overall success rate of 98%. In 84% the internal jugular vein was located exactly where predicted, the others were just lateral to the point the complication rate (all short -term) was 3.6%. They proposed this technique as a safe and reliable method of gaining central venous access in patients with possible cervical spine injury following trauma.

Lew, YS, Lim SK 1998.

They conducted a study in which 40 patients had their IJV cannulation in neutral head position. Venous puncture was made immediately lateral to the carotid artery at the level of cricoid cartilage and directed caudad. The light IJV was

successfully located with the finder needle in 97.5% of the patients. The mean number of puncture attempts to locate the vein was 1.3 (0.1) per patient. In 72.5% (29 patients) the vein was located exactly at the predicted point after the first attempt. However the overall success rate was 87.5% and short term complication rate was 5.0%. They concluded this technique as a reliable, safe alternative for central venous access, especially in patients where cervical spine movement is contraindicated or restricted.

Kaushik S, Dubey PK, 1999

They described a newer approach to internal jugular vein cannulation with the head and neck placed in the neutral position the Junction of the medial two thirds and lateral one third between the angle of the mandible and symphysis menti is identified. A vertical line is drawn from this point to join another line drawn between the mastoid process and the medical end of the clavicle. The junction is the puncture point. In 120 patients studied the failure rate was 1.66% and there were no complications. They proposed this technique as a safe and reliable alternative in neurosurgical patients.

Sulek CA, Gravenstein N[44] 1996.

They undertook a prospective laboratory study to examine the effect of head position on the relative positions of the carotid artery and internal jugular vein. Subjects 18-60 yr of age who had never undergone IJV cannulation underwent

imaging of their IJV and carotid artery. Two dimensional ultrasound images of IJV and the carotid artery were obtained on the left and right sides of the neck at 2 and 4 cm from the clavicle along the lateral border of sternocleidomastoid at 0^0, 40^0 and 80^0 of head rotation from midline. The percent overlap of the carotid artery and the IJV increased significantly at 40°and 80° of head rotation from midline. The percent overlap of the carotid artery and the IJV increased significantly at 40° and 80° head rotation to both the right and left. The increased overlap of carotid artery and the IJV with head rotation more than 40° increased the risk of inadvertent puncture of the carotid artery associated with the common occurrence a transfixation of the IJV before it is identified during needle withdrawal. The IJV frequently collapses with needle insertion. This may result in puncture of the posterior wall of vessel and thus of the carotid artery when the two vessels overlap. To decrease this risk, the head should be kept in as neutral a position as possible during IJV cannulation.

Liberman A, Kayode A[45] 2001

They conducted ultrasound guided study in about 49 volunteers and commented about optimal head rotation for IJV Cannulation. They simulated catheter insertion via both anterior and central approach to the IJV using an ultrasound probe held in the manner of Syringe and needle.

Increased head rotation from 0°, 15°, 30°, 45° and 60° to the left of midline was associated with high probability of a simulated needle contacting the IJV and the

carotid artery. For both approaches the risk of carotid artery contact was <10% for head rotations<45°. Increased body surface area and body mass Index at head rotations of 45°or 60°. To optimize IJV contact while reducing the likelihood of inadvertent contact with the carotid artery, the head should be rotated no more than 30° in patients with high body mass index (MBI) or body surface area (BSA) but it may be turned to 60° if BMI or BSA is low.

Clenaghan S et al 2005[46]

They evaluated relationship between Trendelenberg tilt and internal jugular vein. (IJV) diameter and to examine any cumulative effects of tilt on the IJV diameter. With the help of a tilt table, healthy volunteers were randomized to Trendelenberg tilts of 10°, 15°, 20°, 25° and 30°. Ultrasound was used to measure and record the lateral diameter of the right IJV at the level of the cricoid cartilage. Mean supine IJV diameter was 13.5 mm and was significantly greater at 10° (15.m). There was no significant difference between 10° and greater angles of tilt. The effect of the previous angle of tilt did no prove to be statistically significant.

They concluded that increasing the degree of Trendelenberg tilt increases the lateral diameter of the IJV. Even a 10^0 tilt was effective the cumulative effect of the tilt was not significant ultrasound guided cannulation should be ideal, but in its absence Trendelenberg tilt will increase IJV diameter and improve the chance of successful cannulation. While 25^0 achieved optimum distension, this may not be

practical and may be detrimental C for example, risk of raised intracranial pressure)

Chandrakant Pandey MD, 2001[47]

- During IJV cannulation there are chances of complications like arterial puncture, hematoma formation, pneumothorax, thoracic duct injury, arteriovenous fistula and brachial plexus injury due to the inability to Judge the appropriate length that the large bore needle traverses in order to do the venipuncture complications can be avoided if the depth from skin to vein is measurable. They devised a 24-guage finder needle with centimeter markings. The guide puncture determines the direction of IJV and centimeter markings gave the exact distance at which IJV is hit. As the distance from the skin entry to the IJV is measured on the guide puncture needle, the 18-guage needle introduced to the prefixed distance to hit the IJV.

Gareth parry et al 2004

They conducted a study with the help of ultrasound in 21 patients. The purpose of the study was to establish the patient position resulting in the largest Right internal jugular vein (Rij) diameter was (mean ± standard deviation) 9.2 ± 2.18. Trendelenberg tilt of 15 degrees increased Rij diameter (12.1 ± 234mm). Palpating for the carotid artery decreased Rij diameter (8.2 ± 1.98) and rotation of

head 45^0 to the left did not reduce Rij diameter significantly.

Wang R, Snoey F[48] 2004

They prospectively studied vascular anatomy of the neck in 150 patients, with the help of ultrasound. The primary intervention was head rotation to the left as if the patient was positioned for right IJV catheterization. The patient' head was positioned at 0.45 and 90 degree of rotation ultrasound images were obtained in a transverse orientation. The percentage overlap of the carotid artery by the IJV was measured. In neutral position there was a mean overlap of 29% at the apex of the sternocleidomastoid. As the head was turned, the percent overlap increased. At 90 degrees there was a mean overlap of 72%. They concluded that IJV overlaps the carotid artery in the neutral position to a significant degree. This overlap increases until as the head is fully turned. They proposed two modifications to standard IJV line technique; minimize the patient's head rotation and use ultrasound guidance for IJV catheterization.

8. MATERIALS AND METHODS

This study was conducted in the cardiothoracic operation theatre of Government General Hospital, between May to August 2006. All the sixty six patients participated in the study were posted for elective major cardiac surgery. The study was done after getting the institutional approval and written informed consent obtained from all the patients included in the study.

The study was done in a prospective randomized manner. Sixty six patients of either sex posted for major elective cardiac surgeries satisfying the selection criteria was randomly allocated into two groups.

Group C: Patients in this group underwent IJV cannulation by classical central approach.

Group N: Patients in this group underwent IJV cannulation with their head held in neutral position.

Materials used

Standard triple lumen catheter kit (Biosensors international) include a 7-Frech (Fr) triple lumen catheter with 20 cm of usable length, a 0.032 inch diameter guide wire with straight and J tip, 18 gauge thin wall needle, a 7 Fr. Vessel dilator, a 22 gauge finger needle, appropriate syringes and suture material.

Selection of cases:

Inclusion criteria

Age 12 to70 years.

Elective IJV cannulation.

Exclusion criteria

Coagulopathy

Neck deformities

Local sepsis

Recent IJV cannulation

Emergency cannulation

SVC syndrome

Presence of carotid disease

Pre anaesthetic evaluation

Patients in the study group underwent a thorough preoperative evaluation which included the following:

History

History of underlying medical illness, previous surgery, anaesthesia and hospitalization.

Physical examination

General condition of the patient:

Vital signs.

Examination of respiratory system, cardiovascular system, abdomen, central nervous system and vertebral column.

Two persons were required during the study. One was the operator (Myself) who did the cannulation. Second was the observer who was recording the parameters. All the parameters and events were observed and recorded in the proforma by the observer throughout the procedure.

Pilot Study

Before going to the original study itself, there was a pilot study done on ten patients. The patients who satisfied the inclusion criteria had IJV cannulation in neutral head position under the supervision of senior anaesthesiologists. The observation and results were analyzed in detail. Based on the safety profile and success rate of the technique, institutional approval was obtained for the original study.

Patient Preparation

Standard monitoring devices (ECG, NIBP, and Pulse-oximeter) were applied. Intravenous access with two 16 gauge venflons was achieved. Patients were premedicated with inj. Morphine 0.1 mg/kg iv and inj midazolam 0.05 mg/kg iv Right IJV region was exposed, cleaned and draped. Infiltration with 3ml of 1% xylocaine at the site of skin puncture was given.

Group C

The patients under this group had their IJV cannulation by classical central approach. Patient was positioned in 15^0 Trendelenberg position with a small bed roll between the shoulder blades head turned about 30^0 towards the left side, arms kept by the side of the body Right IJV region was exposed, cleaned and draped. Infiltration with 3 ml of 1% xylocaine at the appropriate site of skin puncture given.

The operator stood at the head end of the patient. The anatomical landmarks were determined by palpating the two heads of the sternocleidomastoid and locating the apex of the triangle formed by them. The carotid artery pulsation was felt 1 to 2 cm medial to this point, beneath or just medial to the sternocleidomastoid muscle.

A 22-guage $1^1/_2$ inch finder needle mounted on a 5 ml heparin saline loaded

syringe was first used to locate the IJV. The carotid artery was just palpated prior to insertion of finder needle to ensure that it was not directly under the insertion point; the carotid artery was not palpated during the procedure itself. The finder needle is inserted at the apex of the triangle with an angle of 30-45 degrees to the frontal plane, directed at the ipsilateral nipple. The needle was advanced steadily with constant back pressure and venipuncture occurred within 3 to 5 cm. The venipuncture is demonstrated by free aspiration of dark venous blood. The direction of the finder needle and the depth at which venipuncture had occurred were noted. Then 18-gauge thin walled needle mounted on a 5 ml heparin saline loaded syringe was introduced in the identical plane and venipuncture was attempted in the same direction and depth. Once the venipuncture occurred, free aspiration of dark venous blood was demonstrated. The syringe was removed during expiration or Valsalva maneuver and the hub occluded with a finger after ensuring that the backflow of blood is not pulsatile. The operator secured the needle in place one hand while removing the syringe with the other. The needle was stabilized carefully in order to prevent the migration out of the IJV prior to guide wire insertion. The J tip of the guide wire was then inserted freely up to 20cm at which point the 18-guage needle was withdrawn. With the guide wire in place, a scalpel was used to make a generous 90^0 stab incision at the skin entry site to facilitate passage of the vessel dilator. The dilator was inserted down the guide wire to the hub, ensuring that control and sterility of the guide wire was not compromised. The dilator was then withdrawn and wet gauze was used at the puncture site to control oozing and to prevent air embolism down the needle tract. The triple-lumen catheter was then inserted over the guide wire ensuring that the

guide wire protruded from the distal lumen hub before the catheter tip penetrated skin. The catheter was then advanced 15 to 17 cm into the vein, the guide wire was with drawn and the distal lumen capped. After cannulation central venous placement was verified by waveform analysis in all patients, supplemented by chest x-ray later (taken postoperatively) to detect complications and catheter tip position.

If venipuncture did not occur at the initial thrust, back pressure was maintained and needle slowly withdrawn. If the first attempt was unsuccessful then the position, landmarks were reassessed. A fresh attempt is made 2 mm lateral to the initial puncture site. A decision of failure to locate the vein was made if the vein was not punctured even after fourth attempt.

If the venipuncture did not occur with 18-gauge needle after insertion up to a depth of 0.5 cm more than that of successful finder needle insertion was considered as a missed attempt. If the guide wire did not pass easily beyond the tip of the 18-gauge needle, the guide wire was withdrawn, the syringe was reattached and free aspiration of blood was re-established. If this was not possible the 18-gauge needle was withdrawn and a fresh attempt was made.

If the venipuncture or cannulation was unsuccessful after three consecutive attempts with the 18-gauge needle or development of significant hematoma (>2cm in any dimension) due to artery puncture, it was considered as failure in cannulation. Failure was followed by an attempt to cannulate the left IJV.

Group N

The patients under this group had their IJV cannulation with the head held in neutral position. The patients were put in supine position (table flat, head in midline, sandbags on either side of head to ensure immobilization of neck). The point of needle entry is directly superior to the lateral border of the bony depression caused by insertion of the clavicular head of the sternocleidomastoid muscle on the superior surface of the clavicle. The insertion point is easily identified by running the finger firmly along the superior posterior edge of the clavicle to find the indentation. A perpendicular line was drawn in cephalad direction from this lateral edge. A parallel line was drawn at the level of cricoid cartilage. Approach to the IJV is made through the point of intersection of these two lines.

The procedure was performed with the operator standing at the head end of the patient. The carotid artery was palpated prior to placement of the finder needle to ensure that it was not directly under the insertion point. The carotid artery was not palpated during the procedure itself. The left hand located, usually with the thumb, the lateral border of the described clavicular bony depression while the right hand performed the needle puncture. A 22 gauge finder needle was inserted at an angle of $60\text{-}90^0$ to the frontal plane with constant negative pressure. Once the vein was located, catheterization proceeded in the same track as the finder needle using the seldinger technique with on 18-gauge thin walled needle. If the

first attempt was unsuccessful, a second attempt was performed 2 mm lateral to the initial puncture site. After cannulation, central venous placement was verified by waveform analysis and a chest x-ray later (taken postoperatively) to detect catheter tip position.

Parameters observed:

1(a) Number of attempts with the finder needle (22-gauge) to locate the IJV

(b) Success at first attempt.

2. Depth of insertion

3. Number of attempts with the cannulating needle (18-gauge) to locate the IJV.

4. Guide wire insertion

5. Failure in locating the IJV.

6. Failure in cannulating the IJV.

7. Acute complications observed

    1. Carotid artery puncture

2. Hematoma

3. Others (if any)

Definition of parameters,

1 (a) Number of attempts with the finder needle (22-gauge) to locate the IJV. Defined as the total number of attempts required to locate the internal jugular vein.

Each attempt was defined as one, in which the finder - needle - syringe assembly was inserted and withdrawn in the same direction until free aspiration of dark venous blood occurs. Constant negative pressure was applied both during insertion and withdrawal of the needle. If the venipuncture had not occurred with the above mentioned one then it was considered as a missed attempt. The total number of attempts required to locate the vein including the missed attempts were taken into account.

b. Success at first attempt

Whether the IJV could be located with the finder needle during the initial attempt itself or not was noted.

2. Depth of insertion

The depth at which IJV was located with the finder needle from the skin margin was measured and recorded.

3. Number of attempts to locate the IJV using cannulating (18-gauge) needle.

The total number of attempts required for successful venipuncture including the missed attempts was recorded. Missed attempt was defined as one in which the venipuncture did not occur with the cannulating (18-gauge) needle after inserting it to a depth of 0.5 cm more than that of a successful finder needle insertion in the same direction.

4. Guide wire insertion

The guide wire insertion through the 18-gauge needle into the IJV, when it was passed freely with single attempt then it was recorded as easy guide wire insertion. Guide wire insertions requiring more than one attempt or repositioning of needle (18G) after successful venipuncture was recorded as difficult guide wire insertion.

5. Failure to locate the IJV.

Failure to locate the vein was defined as one in which the venipuncture had not occurred even after four attempts with the finder needle.

6. Failure to cannulate the IJV

Failure to cannulate the vein was defined as one in which cannulation was unsuccessful after three consecutive attempts with the 18-gauge needle or there was development of significant hematoma. (>2cm in any dimension). Failure is followed by cannulation of left IJV under standard techniques.

7. Acute complications observed.

A. Arterial puncture:

Carotid artery puncture during the procedure was documented. The artery puncture was followed by compression for five minutes to avoid hematoma formation.

B. Hematoma:

The development of significant hematoma (>2 cm in any dimension) if any was documented.

C. Other complications:

Other acute complications looked for were hemothorax, pneumothrax, subcutaneous emphysema.

9. OBSERVATION AND RESULTS

Sixty six patients of either sex posted for major elective cardiac surgeries satisfying the selection criteria were randomly divided into two groups.

Group N: Patients under this group had their internal jugular vein cannulated in neutral head position.

Group C: Patients under this group had their internal jugular vein cannulated through classical central approach.

Table 1: Distribution of age of cases by groups[$]

Age	Gr. N	Gr. C	p-value
No. of	33	33	
cases	39.15	36.27	
Mean	14.70	13.84	0.42
S.D.	42	35	
Median	45	28	
Mode	15-62	15-62	
Range			

Table 2: Distribution of cases by groups and sex[$]

Sex	Gr. N		Gr. C		p-value
	No.	%	No.	%	
Male	23	69.7	20	60.6	0.48
Female	10	30.3	13	39.4	

Table 3: Distribution of height of cases by groups[$]

Height (in cms)	Gr. N	Gr. C	p-value
No. of cases	33	33	
Mean	158.46	161.09	
S.D.	6.14	8.70	0.15
Median	158	163	
Mode	163	165	
Range	143-171	138-176	

able 4: Distribution of weight of cases by groups[$]

Weight	Gr. N	Gr. C	p-value
No. of cases	33	33	
Mean	59.67	60.79	
S.D.	11.25	13.83	0.72
Median	58	58	
Mode	72	58	
Range	41-78	32-82	

Table 5: Distribution of BMI of cases by groups[$]

Weight	Gr. N	Gr. C	p-value
No. of cases	33	33	
Mean	23.68	23.17	
S.D.	3.78	3.86	0.59
Median	22.8	21.9	

Mode	27	21.9	
Range	16.5-30.9	16.8-30.9	

The two groups were similar with respect to age, sex, height, weight and BMI.

Table 6: Distribution of cases* by number of attempts to locate with finder needle by groups[$]

No. of attempts	Gr. N		Gr. C		p-value
	No.	%	No.	%	
1	25	78.1	28	84.8	
2	2	6.3	2	6.1	0.72
3	5	15.6	3	9.1	

In group N 25 patients had their IJV located with first attempt, 2 patients required two attempts while 5 patients required a third attempt.

In Group C 28 patients had their IJV located with first attempt, 2 patients required two attempts while 3 patients required a third attempt.

The difference of results between the groups did not show any statistical significance. ($p = 0.72$).

Table 7: Distribution of cases* for the success at first attempt of cases by groups[$]

Success at first attempt	Gr. N		Gr. C		p-value
	No.	%	No.	%	
Yes	25	78.1	28	84.8	0.48
No	7	21.9	5	15.2	

IJV was located exactly where it was predicted i.e. with the first attempt in 78.1% patients of group N and 84.8% patients in group C.

The difference of results between the two groups did not show any statistical significance (p = 0.48).

Table 8: Distribution of mean depth of insertion of cases by groups[$]

Depth of insertion	Gr. N	Gr. C	p-value
No. of cases	33	33	
Mean	3.070	3.063	
S.D.	0.63	0.26	0.97
Median	3.1	3.1	
Mode	2.9	3.1	
Range	2.4-3.7	2.4-3.5	

The depth at which IJV is punctured from the skin margin ranges from 2.4 to 3.7 cm with a mean of 3.07 cm in Group N patients and 3.06 cm in group C patients.

The difference between the two groups did not show any statistical significance. ($p = 0.97$).

Table 9: Distribution of cases* by number of attempts with cannulating needle by groups[$]

Number of attempts	Gr. N		Gr. C		p-value
	No.	%	No.	%	
1	30	93.8	32	97.0	0.54
2	2	6.2	1	3.0	

Group N:

Mean = 1.034 (0.07)

Group C:

Mean = 1.030 (0.07)

The mean number of attempts with the cannulating needle (18 – gauge) for successful venipuncture was 1.03 (0.07) for both group of patients. The results did not show any statistical significance. (p=0.54).

Table 10: Distribution of cases* by nature of guide wire insertion and groups[$]

Nature of guide wire insertion	Gr. N		Gr. C		p-value
	No.	%	No.	%	
Easy	28	90.3	30	93.8	0.67
Difficult	3	9.7	1	3.1	

The guide wire insertion was found to be difficult in three patients (9.7%) of group N. Only one patient (3.1%) in group C had this difficulty.

The results did not show any statistical significance (p = 0.67).

Table 11: Distribution of cases by failure to locate by finder needle and groups[$]

Failure to locate	Gr. N		Gr. C		p-value
	No.	%	No.	%	
No	32	97.0	33	100.0	1.00
Yes	1	3.0	0	0.0	

In one patient (3%) of Group N the internal jugular vein could not be located with the finder needle even after 4 attempts. But there was no such failure in Group C patients.

The analysis of results did not show any statistical significance (p = 1).

Table 12: Distribution of cases by failure to cannulate and groups[$]

Failure in cannulation occurred in two patients (6.1%) of Group N while it occurred in one patient (3%) in Group C.

The difference of results between the two groups did not show any statistical significance.

Table 13: Distribution of cases by Carotid Artery (CA) puncture and groups[$]

CA puncture	Gr. N		Gr. C		p-value
	No.	%	No.	%	
No	31	93.9	30	90.9	1.00
Yes	2	6.1	3	9.1	

The incidence of carotid artery puncture in groupN was 6.1 %(2/33) while in groupC it was 9.1 %(33).

The difference of results between two groups did not show any statistical significance.

The incidence of hematoma in groupN was 6.1 %(2/33) while in groupC it was 3 %(1/33). The analysis of results between the two groups did not show any statistical significance.

10. STATISTICAL METHODS

Study material

A total of 33 cases each was randomly allocated to one of the following two groups of study viz. Group N – Neutral Head and Group C – Classical Head.

Statistical methods

The descriptive statistics of the variables studied are represented as two-way tables. The categorical factors are represented by the number and frequency (%) of cases. The continuous variables are represented by measures of central frequency (like mean, median & mode) and deviation (say, standard deviation and range). The differences in the proportions are tested for statistical significance using non-parametric Chi-square test for variables measured on nominal scale. Fisher's exact probability test is used to find out the statistical significance when the number of cases is nil or wherever indicated. For variables measured on a continuous scale, Student "t" test is employed to elicit the statistical significance of differences of the means of a single variable in two groups.

11. DISCUSSION

The observations and results show that cannulating internal jugular vein with the head held in neutral position doesn't differ significantly with that of classical central approach. The overall success rate, number of needle passes, failure rate, and complication rate were similar to that of classical central approach. However, in contrast to other methods, the neutral head position technique is advantageous in special populations such as patients with unstable neck injuries there being an obvious inherent advantage in not extending or rotating the neck.

Demographic Profile

The study was conducted in cardiothoracic operation theatre in patients posted for major elective cardiac surgeries. The patients were similar in both groups with respect to age, gender, weight, height and body mass index.

Number of attempts required to locate the IJV with finder needle (22-gauge): Minimizing the number of punctures with the cannulating needle (18-gauge) helps in decreasing the complication rate (_). So the institutional protocol insists on the use of a finder needle for locating the IJV.

Willeford KL et al conducted a study in 55 patients, where the average number of needle passes (finder needle) required to locate the vein was 1.4(0.2) per patient

where the faculty anesthetist was successful in their first attempt on 26 out of 29 patients whereas residents required more number of attempts.

Lew YS, et al conducted a study in 40 patients where the average number of needle passes required to locate the vein was 1.3(0.1) per patient.

In the present study the mean number of attempts required to locate the IJV with the finder needle, in Group N (Neutral head) was 1.33 (0.2) per patient. For patients in Group C, the mean number of attempts was 1.24(0.1) per patient. Of the 33 patients in Group N, 25 were located with the first attempt, 2 patients required two attempts and 5 patients required three attempts. IJV cannot be located even after four attempts in 1 patient (failure). Of the 33 patients in Group C IJV was located in first attempt in 28 patients, second attempt in 2 patients, while 3 patients needed a third attempt. Though the average number of attempts required to locate the ijv was slightly higher in group N analysis of results between the two groups failed to show any statistical significance Cp = 0.72).

Success at first attempt.

Willeford KL et al they showed that IJV was located with the first attempt in84% of patients with their head held in neutral position.

Lew YS et al, they showed that IJV was located with the first attempt in72.5% of patients with their head held in neutral position.

In the present study IJV was located exactly with the first attempt in 78.1% for the patients in Group N and 84.8% for the patients in Group C. The differences between the two groups did not show any statistical significance (p=0.48).

Depth of Insertion

Chandrakant Pandey et al (_) they showed that complications during IJV cannulation can be minimized if the depth from skin to vein was measurable after successful venipuncture with the finder needle. The 18-gauge needle was then inserted to the prefixed distance to hit the IJV.

Willeford KL et al showed the mean depth at which the IJV punctured was 2.9 cm in patients neutral head position.

In the present study the depth at which IJV punctured from skin margin ranges from 2.4 to 3.7 cm, with a mean depth of 3.07 in group N patients and 3.06cm in group C patients. There was no statistical difference between the two groups.

Number of attempts to locate the IJV with the cannulating needle (18-gauge)

It is the total number of attempts with the cannulating needle (18-gauge) for successful venipuncture.

Willeford KL, et al showed that the mean number of attempts with the cannulating needle was 1.06(0.05)

In the present study the mean number of attempts with the 18-gauge thin walled needle was 1.03 (0.07) for both group of patients. The results did not show any statistical significance. The use of the finder needle showed the direction and depth at which IJV is located. Thus the number of attempts with the larger needle was minimized.

Guide Wire Insertion

Willeford et al showed that the guide wire insertion was difficult in two cases (4.5%) in neutral head position. They said that, the relative collapse of the IJV in supine horizontal position may have contributed significantly to the inability to pass the guide wire, instead when the patient was placed in Trendelenberg position; the guide wire was easily passed.

In the present study the guide wire insertion was found to be difficult in three (9.7%) patients of Group N after successful venipuncture with the 18-gauge needle. The guide wire was removed and the needle repositioned and free aspiration of blood confirmed and the guide wire was inserted. Only one patient (3.1%) in Group C had difficulty in guide wire insertion. There is no statistical significance (p=0.67) between the two groups.

Failure to locate the vein

Failure to locate the vein was defined as one in which the venipuncture had not occurred with the finder needle even after four attempts.

Kaushik S, et al, in their study of 120 patients the failure rate was 1.66%

Willeford KL, in their study of 55 patients the IJV could not be located in one (2%) patient.

In the present study for one patient (3%) in Group N the vein could not be located even after 4 attempts. But there was no such failure in Group C patients. The difference in the results did not show any statistical significance.

Failure to cannulate the vein:

Failure to cannulate the vein is defined as one in which cannulation was unsuccessful even after 3 consecutive attempts with the cannulating needle or there is development of significant hematoma (72cm in any dimension)

In the present study failure in cannulation occurred in 2 patients (6.2%) of Group N while it occurred in one patient (3.0%) of Group C. The difference in the results did not show any statistical significance.

Acute complications observed:

a. Arterial puncture:

Willeford KL showed that the incidence of acute complications all related to arterial puncture occurred in 3.6% of patients in neutral head position.

Lew YS showed that the short term complication rate, all related to arterial puncture was 5.0% of patients in neutral head position.

Troianos et al (_) compared ultrasound guided IJV

cannulation with that of landmark technique. The incidence of arterial puncture was 1.4% in the ultrasound guided

cannulation when compared to landmark group which is 8.4%.

Arterial puncture was the most common acute complication observed. In the present study 2 patients (6.1%) of group N and 3 patients (9.1%) of group C suffered carotid artery puncture. The difference of results between the two groups did not show any statistical significance ($p = 1.00$).

The second major complication was hematoma which occurred in 2 patients (6.1%) of group N and 1 patients of group C (30%). The analysis of results did not show any statistical significance. Hematoma formation obscured the anatomy and led to failure of cannulation.

12. SUMMARY

In this study an alternative approach was used to cannulate internal jugular vein where the head and neck were kept in neutral position. Venous puncture is made along an axial line drawn superiorly from the lateral edge of the bony depression at the insertion of the sternocleidomastoid on the superior edge of the clavicle. This line at the level of cricoid cartilage directly overlies the internal jugular vein. In this study of sixty six patients, the neutral head position technique was compared with that of classical central approach in terms of following parameters;

- the mean number of attempts with the finder needle(22 gauge)to locate the IJV in groupN(neutral head) was 1.33(0.2) per patient while in groupC(central approach) it was 1.24(0.1) per patient.

- the percentage of success at first attempt in groupN was 78.1% while in groupC it was 84.8%.

- the mean depth at which IJV was punctured from the skin margin in groupN was3.07cm while in groupC it was 3.06cm.

- the mean number of attempts with the cannulating needle(18-gauge) to locate the IJV was 1.03(0.07) per patient in both the groups.

- guide wire insertion was found to be difficult in 9.7% of patients in groupN

and 3.1% of patients in groupC.

- failure in locating the IJV in groupN was 3%(1/33) while no such failure happened in groupC patients.

- failure in cannulating the IJV in groupN was 6.1% and in groupC it was 3%.

- the incidence of carotid artery puncture in groupN was 6.1% while in groupC it was 9.1%.

- the incidence of hematoma in groupN was 6.1% while in groupC it was 3.1%.

The difference of results between the two groups did not show any statistical significance.

13. CONCLUSION

From this study it is concluded that cannulating the internal jugular vein with the head in neutral position is a safe and reliable alternative technique that can be followed in situations where the head should not be extended or rotated as in trauma patients.

COMPARISON OF IJV CANNULATION IN NEUTRAL HEAD POSITION VS CLASSICAL CENTRAL APPROACH

DATE:

NAME OF THE PATIENT:

I.P. NUMBER:

DIAGNOSIS:

SURGERY PLANNED:

PREANESTHETIC CHECKUP:

H/O PREVIOUS IJV CANNULATION:

ANY OTHER RELEVANT HISTORY:

GENERAL EXAMINATION:

LOCAL EXAMINATION(NECK):

Height Weight BMI

Vital signs : BP PR RR SpO2

CVS:

RS:

ABDOMEN:

CNS:

ASA STATUS:

AIRWAY ASSESSMENT :

IJV CANNULATION

NEUTRAL HEAD / CLASSICAL CENTRAL APPROACH

Parameters observed:

1a. No. of attempts with the finder needle (22G) to locate the IJV:

1b.Success at first attempt:

2. Depth of Insertion:

3 .No. of Attempts with the Cannulating needle(18G):

4. Guide wire insertion:

5. Failure to locate:

6. Failure to cannulate:

7. Acute complication:

a.Artery puncture

b.Hematoma

c. Others (if any)