145

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## CONTENTS



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# RECENT ADVANCES IN RESUSCITATION STRATEGIES FOR THE PATIENT WITH MULTIPLE INJURIES

*Lakesh Kumar Anand[1], Manpreet Singh[2], Dheeraj Kapoor[3]*


## ABSTRACT

Continous haemorrhage is the leading cause of potentially preventable deaths among injured patients. The last decade has seen a sea change in the management of major haemorrhage following traumatic injury. Damage control resuscitation (DCR), a strategy combining the techniques of permissive hypotension, haemostatic resuscitation and damage control surgery has been widely adopted as the preferred method of resuscitation in patients with haemorrhagic shock. The overriding goals of DCR are to, mitigate metabolic acidosis, hypothermia, coagulopathy and stabilise the patient as early as possible in a critical care setting. This review examines the background to these changes in resuscitation practice, discusses the central importance of acute traumatic coagulopathy (ATC) in driving these changes particularly in relation to the use of high FFP and /or platelet concentrate: RBC ratio and explores methods of predicting, diagnosing and treating the coagulopathy with recent transfusion protocols as well as newer coagulation factor concentrates and haemostatic adjuncts. Also, enlighten other areas of trauma haemorrhage management including the role of hypertonic saline and interventional radiology.


**Keywords:** Hemmorhage;Trauma;Injuries

## INTRODUCTION

Death due to traumatic injury is the leading cause of life years lost throughout the world and haemorrhage is responsible for 30 to 40% of total trauma fatalities, accounting for almost 50% of the deaths in the first 24 hours following trauma. Coagulopathy, together with hypothermia and acidosis, forms a “lethal triad” associated with a poor prognosis.[1] Recently, an early and previously unrecognized ATC was described in 25% of admitted patients and occurring before the above-mentioned traditional causes of traumatic coagulopathy.[2] This ATC has injury severity and shock and hypoperfusion as the key drivers, and is characterized by activation of the protein C system and hyperfibrinolysis.[2] In the last decade, the concepts of DCR, i.e., providing large amount of blood products to critically injured patients in an immediate and sustained manner as part of an early massive transfusion protocol, reducing the amount of crystalloid administered, has been introduced. Similarly, the concept of damage control surgery (DCS) have evolved, prioritizing early control of the cause of bleeding by temporary, non-definitive means.[3,4] The correction and prevention of traumatic coagulopathy has become a central goal of early resuscitation management of haemorrhagic shock following injury. This review will discuss the recent changes in our understanding of ATC; the importance of the interplay between coagulopathy


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and resuscitation techniques; and the background behind the recent shift in management of resuscitation towards the early use of red cells and blood products and damage control principles.

## PATHOPHYSIOLOGY OF TRAUMA IN THE EARLY PHASE

In the initial phase after trauma, pain and agitation trigger the release of endogenous catecholamines in the presence of normovolemia and may increase cardiac output and blood flow, thereby augmenting blood loss. Once hypovolemia develops, endogenous vasoconstrictive substances will induce redistribution of blood away from peripheral tissues and bleeding sites toward vital organs such as heart, lung and brain, thereby limiting further blood loss.[5] On the one hand, this mechanism may prevent early exsanguination at the scene of accident, but on the other hand, hypoperfusion of peripheral tissues may trigger the development of to organ failure in the later course of the disease.[6] Currently, no consensus on the definition of massive bleeding or massive transfusion exists. In general, a blood loss of 100 % or more of the blood volume within 24 h, 50 per cent or more within 3 h, or 150 ml/min or 1·5 ml per min per kg over 20 min is considered massive bleeding.[7] Trauma, bleeding and massive transfusion of allogeneic blood products result in dysfunction and severely compromised haemostatic performance. Considering the fatal outcome of uncontrolled bleeding, thorough understanding of the multifactorial aetiology of ATC as well as the early hemostasis represents a cornerstone of initial trauma management.

## UNDERSTANDING PATHOPHYSIOLOGY OF TRAUMATIC COAGULOPATHY

Trauma induced coagulopathy describes the hypocoagulable state that occurs after injury and exacerbates bleeding. It is an independent predictor of the need for massive transfusion [8,9] and death,[10] and patients who develop a coagulopathy have an increased likelihood of protracted intensive care stay, multi-organ failure (MOF), and specifically renal failure and acute lung injury.[11-13] Traumatic coagulopathy results from many independent but interacting mechanisms; and historically was thought to be the result of the combined effects of acidosis, hypothermia, haemodilution by resuscitation fluids and loss of coagulation proteins with continued bleeding and consumption. Recently an additional early cause of coagulopathy has been recognised, acute traumatic coagulopathy.[8, 13] Hess et al.[14] suggests six primary mechanisms involved in the induction of traumatic coagulopathy including tissue trauma, shock, hemodilution, hypothermia, acidemia, and inflammation.

Hypothermia is virtually unavoidable following traumatic injury caused both by heat loss at the scene of injury and treatments on arrival in hospital; it reduces haemostatic performance and is linked to an increased tendency to bleed.[15,16] In vitro studies have shown that coagulation protease activity is modestly reduced when temperatures decrease from 37.8°C to 33.8°C.[15] A similar temperature change appears to have a more significant effect on platelet function and can cause reduced platelet activation, aggregation and adhesion to von Willebrand factor on endothelial surfaces.[15,17] Below 33.8°C there is evidence of more protease dysfunction as well as significant platelet dysfunction. However, core body temperatures of less than 33.8°C are seen in less than one in every ten trauma patients.[18]

Acidosis is another common sequelae of severe trauma, caused by tissue injury, hypoxia, hypoperfusion and subsequent production of lactic acid. In a review of current literature, Lier et al.[19] suggest that there is notable impairment of hemostasis once a patients pH reaches 7.1 or below. This acidosis and coagulopathy in addition to hypothermia are the cornerstones of the infamous “triad of death” and /or “bloody vicious cycle”.[1,20] Studies have demonstrated that a pH of 7.2 leads to a 50% loss of activity of the prothrombinase (FXa/Va) complex.[21] Additionally, thrombin generation is affected; with values half normal at a pH of 7.1 and increased fibrinolysis has been reported.[16,22]

Haemodilution is an important iatrogenic (aggressive haemodynamic resuscitation with crystalloids and colloids) cause of traumatic coagulopathy. The volume of fluid administered both in vitro and in vivo is proportional to the coagulopathy,[23,24] and data show that more than 40% of trauma patients develop a coagulopathy after >2 L of crystalloid and colloid adminstration, rising to >70% after >4 L.[23] A recent study has suggested that haemodilution leads directly to prothrombin time (PT) prolongation by reduction of factor VII levels.[25] Starch based colloids further worsen dilutional coagulopathy by rendering fibrinogen dysfunctional, leading to abnormal fibrin polymerisation and poor clot stability.[26]

Till recently, ATC was thought to result from loss of coagulation factors during blood loss, active resuscitation with crystalloids. However, recent evidence suggests that ATC is a distinct early coagulopathy and occurs prior to significant dilution, within 30 min of injury and affects between 24% and 56% of patients.[8,9,27] Although the pathophysiology is not fully understood, it is thought to occur following injury and concomitant hypoperfusion.[13] It has been postulated that ATC is effected primarily through activated protein C, which causes both anti-coagulant effects (by inhibiting factors Va and VIIIa) and profibrinolytic effects by inhibiting plasminogen activator inhibitor-1 (PAI-1).[13] Another group has argued instead of the importance of tissue factor activated coagulation with resultant consumption of coagulation proteases and development of a disseminated intravascular coagulation syndrome with a significant fibrinolytic component.[28,29]

Whether caused by ATC or by other mechanisms, the extent of fibrinolysis is of clinical importance as it correlates with transfusion requirement[20] and mortality.[28, 30] High levels of tissue plasminogen activator (tPA) have been described in coagulopathic patients.[2, 31] tPA is a potent activator of plasminogen which is thought to be released from endothelial cells in response to injury. Brohi's group also reported a fall in PAI-1 levels in patients with increasing hypoperfusion.[2] PAI-1 inhibits the effects of tPA, and therefore with increasing shock, fibrinolysis becomes more marked[2] a hypothesis supported by other clinical studies.[20,29,30]

## DIAGNOSIS OF ACUTE TRAUMATIC COAGULOPATHY

Historically a diagnosis of ATC was made when the activated partial thromboplastin time (APTT) and/or PT were prolonged by more than 1.5 times the upper limit of normal.[32] Although there is some evidence to suggest that these values are too conservative[33] there is a lack of consensus on a definition of traumatic coagulopathy.[34] Plasma assays (APTT, PT) have the advantage that they are available in most hospitals, are standardised and studies have reported that both the PT and APTT are independent predictors of mortality.[9,35] The PT/INR may be more sensitive than the APTT to traumatic coagulopathy, and therefore a better marker.[36]

Newer viscoelastic tests, such as thromboelastography (TEG) and ROTEM, are being increasingly used in trauma.[30, 37-39] Mortality after trauma is independently associated with low clot strength values determined by ROTEM.[40] Recent data also show that ATC can be characterised by ROTEM testing; [41] a 5 min clot amplitude (a measure of clot strength) of <36 mm can be used to diagnose ATC and predict the need for blood transfusion. The use of TEG/ROTEM in massively bleeding trauma patients is now recommended by current guidelines[42] and teaching books [43] and it could be speculated that systematic use of TEG/ROTEM to identify coagulopathy and guide transfusion therapy might be superior to blind transfusion based on different ratios and this warrants further evaluation.

## DAMAGE CONTROL RESUSCITATION

There has been a marked shift in the practice of trauma resuscitation over the last decade, towards DCR, following data from the military and changes to our understanding of traumatic coagulopathy.[44] DCR centers on the application of several key concepts, namely, the permissive hypotension, the use of blood products over isotonic fluid for volume replacement, and the rapid and early correction of coagulopathy with component therapy.[4] This resuscitation strategy begins from ground zero in the emergency room and continues through the operation theatre and into the ICU. DCR employs multiple approaches to combat acidosis, hypothermia, coagulopathy and hypoperfusion. While DCR strategies aim to reduce haemorrhage and optimise coagulation, definitive haemorrhage control typically requires surgical or interventional radiological control.

## PERMISSIVE HYPOTENSION

The concept behind permissive hypotension involves keeping the blood pressure low enough to avoid exsanguination while maintaining perfusion of end organs. Permissive hypotension is one of the central components of DCR and is a strategy which limits fluid therapy, either by delaying the time of administration or minimising the volume given.[44] This practice has evolved in part to limit intravenous (IV) fluid administration (minimising acidosis, hypothermia, and dilutional coagulopathy effects) and also to reduce theoretical risks of clot displacement, so-called "popping the clot", by maintaining a lower systolic blood pressure (SBP). There has been limited, but evolving evidence for the role of permissive hypotension in trauma resuscitation.

One of the well-known randomised controlled trials (RCT) to examine this strategy reported an 8% reduction in absolute mortality in penetrating torso trauma for patients receiving delayed fluid resuscitation and experiencing a lower SBP preoperatively.[45] They demonstrated that, regardless of the victim's blood pressure, survival was better in their urban "scoop and run" rapid transport system when no attempt at prehospital resuscitation was made. Other RCTs, however, have not reported significant mortality benefits either from delaying fluid therapy or from targeting a lower SBP[46, 47] and a systematic review was unable to confirm benefit or harm from these techniques.[48] Whether these differences are due to permissive hypotension being more applicable to penetrating trauma rather than blunt, or whether other confounding factors play a role remains to be shown.

Some of the more recent evidence around permissive hypotension has come from experimental studies. Data from an animal model suggested that a target mean arterial pressure (MAP) of 50 to 60 mmHg conferred most survival benefit in the setting of uncontrolled haemorrhagic shock.[49] Ninety minutes of permissive hypotension was the tolerance limit. But other models provide conflicting results; a study in pigs with blast injuries reported a poorer outcome (survival time) with permissive hypotension compared to normo-tensive resuscitation.[50]

In man, preliminary data from an RCT have been recently published reporting results from 90 patients, in which target MAP of 50 mmHg (LMAP) and 65 mmHg (HMAP) throughout operative care were compared.[51] The LMAP cohort received significantly fewer blood products, smaller volumes of fluids intraoperatively, were less likely to develop postoperative coagulopathy and had a significantly lower all cause early mortality rate. The results of the trial was awaited with interest. The target SBP of 80 to 100 mmHg until major bleeding has been stopped in the initial phase following trauma without brain injury, in massively bleeding trauma patients is now recommended by current guidelines[42]

## HAEMOSTATIC RESUSCITATION AND TRANSFUSION STRATEGIES

The old adage on shock management is to replace what the patient has lost; if blood has been lost then blood should be replaced (hemorrhagic). The central tenets of haemostatic resuscitation is the early use of 'balanced transfusion'; aiming to deliver red blood cells (RBC) and fresh frozen plasma (FFP) in a ratio of 1:1 with the aim of attenuating coagulopathy.[44] This approach was pioneered by the military, following publication of a retrospective study that reported a 46% reduction in death rate for patients who received high ratios of FFP:RBC.[52] Many, but not all subsequent studies, have reported results that have broadly conferred[53-57], however, there is no absolute agreement as to which specific FFP:RBC ratio (i.e. 1:1, 2:3, etc.) improves mortality.[58] Instead, it seems that increased FFP administration per se may be beneficial in patients requiring massive transfusion (MT).[59] Although a major premise for administering higher FFP ratios is to target traumatic coagulopathy, few of the mentioned studies report clotting changes making it difficult to ascertain whether this effect is realised.

In contrast, FFP has been reported of little benefit in patients receiving fewer than 10 units of RBC, with higher incidence of acute respiratory distress syndrome (ARDS) and no improvement to survival.[60] Certainly transfusion of blood and blood products is not without risk; transfusion-related acute lung injury (TRALI),[61] MOF, infection and increased length of stay have been linked with massive transfusion of older aged blood and high FFP:RBC ratio in trauma patients receiving MT carry increased relative risks of sepsis, single organ failure and ARDS.[58] Blood products must be given judiciously with the balance of risk and benefit weighed up carefully.

The role of platelets (PLT) for intact haemostasis is well established, observational studies have supported the idea of higher than standard doses of platelets and fibrinogen in massively transfused trauma patients.[56, 62] The effect of high vs low PLT transfusion rates shows that there was a significantly lower mortality in patients receiving a high PLT: RBC ratio.[63] Further, effect of both FFP and PLT: RBC ratios was evaluated with high vs low, patients who received high ratios was associated with a significantly lower mortality compared with the low ratios group.[54] Recent meta-analysis of retrospective studies on survival (January 2005 to November 2010) concerning massively transfused trauma patients confirms a significantly lower mortality in patients treated with the highest FFP and/or PLT ratio when compared with the lowest FFP and/or PLT ratio.[64]

A change in the transfusion paradigm of how to treat patients with massive blood loss, with early and aggressive administration of fresh frozen plasma (FFP) and platelet concentrates together with red blood cells aiming for a 1: 1: 1 ratio, goal-directed by employing TEG/ ROTEM to guide coagulation management, were reported to reduce both MOF and mortality significantly[64] and this approach is now recommended by teaching books in transfusion medicine.[65]

## FRESH WHOLE BLOOD

The rationale behind fresh whole blood (FWB) resuscitation concept is to transfuse red blood cells, plasma, and PLT in the same proportion as found in circulating whole blood, thus leading toward a unit-for-unit ratio to prevent and treat coagulopathy due to massive hemorrhage. It should be emphasized, however, that such a practice at best will result in a hematocrit around 30%, coagulation factor concentration of about 65%, and a PLT count of approximately 90000/h.p.f., and thus being far from what normally circulated in the vascular system.[3]

FWB resuscitation is argued by many to be the optimum transfusion product for patients in need of MT, since all blood constituents are administered in physiological quantities.[66] Whole blood has been used in the military setting, where cohorts of previously grouped, virologically tested blood donors are in close proximity and can be called upon at short notice.[67] There are few robust data available to analyse the effects of FWB. A recent publication compared 100 combat casualties who received FWB with 254 patients given component therapy for major blood loss.[68] 24 h and 30-day mortality was improved in the FWB group. Virological safety is one of the main concerns with FWB, and prohibits its use outside the military setting.[69]

## DAMAGE CONTROL SURGERY

Severely injured trauma patients require effective haemorrhage control, but by the nature of their injuries will not tolerate prolonged operative procedures. The concept of DCS has evolved to allow temporising, yet life-saving surgical procedures immediately after injury, with delayed definitive corrective surgery at a later date after the patient has been stabilised in critical care. This has led to improved survival rates in the severely traumatised, exsanguinating patients due to the timely management by an abbreviated laparotomy, secondary correction of abnormal physiological parameters (hypothermia, coagulopathy and metabolic acidosis) and then planned definitive re-exploration; the damage control sequence. This is a central tenet of DCS and has been discussed elsewhere in detail[70] and will not be discussed further in this article.

## OTHER CONSIDERATIONS
## HYPERTONIC SALINE

The use of hypertonic saline (HS) is increasing in those with traumatic brain injury (TBI), and is said to have a particularly useful role for the treatment of raised intracranial pressure (ICP) whilst administering small volume fluid resuscitation.[71] HS solutions typically improve cardiovascular output as well as cerebral oxygenation whilst reducing cerebral oedema. In addition it has been reported that HS may have beneficial effects on modulation of the inflammatory response to trauma by attenuating neutrophil priming.[72]

Clinical studies however do not provide compelling evidence to support the use of HS either for TBI or for haemorrhagic shock. One recent study using 5% HS in trauma patients within 1 hour of admission to the hospital associated with a trend toward decreased mortality.[73] But many other RCTs have not demonstrated mortality benefit in this patient group[74-76] including the most recent and largest RCT comparing HS, HS/dextran and normal saline. This trial recruited two separate cohorts, one with TBI (n = 1087)[77] and one with haemorrhagic shock (n = 853)[78]; with primary endpoints of neurological outcome at 6 months after TBI and 28 day survival, respectively. The TBI study was terminated early due to futility, as interim analysis was unable to demonstrate an improvement in neurological status or indeed mortality at 6 months.[77] The second study demonstrated no significant difference in mortality at 28 days, and this study was terminated early for concerns of a potential (albeit statistically non-significant) increase in mortality observed with a subgroup of patients receiving HS but no blood transfusions within the first 24 h.[78] Despite, progress in the management of patients with severe TBI the use of HS in the management of ICP still controversial.[79]

## INTERVENTIONAL RADIOLOGY

Interventional radiology (IR) is increasingly used in the management of trauma haemorrhage, uses minimally invasive endovascular techniques to stem haemorrhage. In trauma, the main application is to control endovascular haemorrhage by blocking bleeding vessels (transcatheter arterial embolisation or relining them (stent grafting).[80,81] The objective is to stop the bleeding without the physiological stress of surgery. IR control of haemorrhage is best applied to solid organ viscus,[81] those patients with difficult surgical access, co-existing patient morbidity or distal vessel bleeds that will result in rapid focal treatment compared with traditional open surgical approaches. Given that IR therapy is designed to occlude distal flow from the vessel, the target arteries must be expendable or nonessential, or have a relatively resistant vascular bed, e.g. with sufficient collateral supply or with end organ parenchymal reserve. In particular, pelvic trauma may benefit from IR methods of haemorrhage control.[82] Pelvic trauma has a high mortality from persistent haemorrhage, with distal vessel bleeds often being difficult to control. IR has the benefit of providing diagnostic information and simultaneous embolisation and haemorrhage control. Quoted success rates for haemorrhage control range from 85 to 100%[83] but mortality remains as high as 50% from concomitant injuries. But it seems that for IR techniques to offer maximum benefit, the intervention must be undertaken quickly. In a recent analysis of hypotensive trauma patients using IR control of haemorrhage (n = 1748),[84] the time taken to perform IR was a crucial predictor of mortality. For every hour delay in the starting of IR the risk of mortality increased by 47%. These findings were independent of injury mechanism. Early implementation of IR input may have a significant effect upon patient mortality, with typically high success and low complication rates.

## HAEMOSTATIC ADJUNCTS
### *TRANEXAMIC ACID*

Tranexamic acid (TA) blocks the lysine binding site of the plasmin molecule irreversibly, thereby blocking the binding of plasminogen to tissue plasminogen activator and to fibrinogen, which is needed for activation. A reduction of approximately 30 per cent in transfusion requirements has been demonstrated with tranexamic acid; although this is a smaller effect than that observed with aprotinin, tranexamic acid has a preferable side-effect profile. The CRASH-2 study, a large multi-centred RCT, examined the effect of TA on mortality and transfusion requirement in 20 211 injured patients with traumatic injury and haemorrhagic shock. The authors came to the conclusion that the administration of tranexamic acid improved survival by approximately 10 per cent in this population.[85] Subsequent data analysis confirmed that the beneficial effects of TA were maximal if given in the first 3 h of injury.[86] The study was very large and was able to detect a small effect but as no adverse effects were found, TA should probably be given to all adults with probable haemorrhagic shock, unless a contraindication exists.

## HAEMOSTATIC WOUND DRESSINGS

Local haemostatic dressings, which are used particularly in crisis areas and war situations as a temporary measure until definitive wound care can be given, have been available for several years. All these products actively facilitate local haemostasis and are considered superior to commonly used standard gauze dressings. Unfortunately, only retrospective data analyses and experimental animal studies are available.[87,88]

QuickClot® is a 'molecular sponge'. It is biologically inert, not absorbed and binds water molecules. The removal of water gives rise to local coagulation, with the formation of a stable clot. This product is applied directly on to the wound and kept under manual compression for 5–6 min. A pressure dressing is then applied over the haemostatic product. The dressing should not be removed until definitive surgical care of the wound can be undertaken.[87]

Combat Gauze™) is gauze impregnated with kaolin and indicated for temporary external control of traumatic bleeding. In animal trials, this product was superior to other wound dressings. Nevertheless, so far no clinical trials have been performed to prove the efficacy of this bandage. At present, Combat Gauze is recommended by the US military to control life-threatening haemorrhage.

HemCon® consists of chitosan, a deacetylated form of chitin, and has a topical haemostatic effect. It was licensed by the US FDA in 2003 and forces have been trained to use. In a retrospective analysis, it was used successfully in 68 patients, the bleeding being halted or the haemorrhagic tendency being markedly improved in 97 per cent of patients. In 66 per cent of the patients, conventional pressure and gauze dressings initially failed to stop the bleeding.[88]

### *PROTHROMBIN COMPLEX CONCENTRATES AND FIBRINOGEN CONCENTRATE*

Prothrombin complex concentrate has been used for many years for the treatment of congenital coagulation disorders and is recommended for reversing oral anticoagulation. It contains coagulation factors II, VII, IX and X. There are differences

between products in the concentrations of these factors and other constituents including heparin, protein C and protein S. Recently there is increasing interest in prothrombin complex concentrates (PCC) and fibrinogen concentrates for massive blood loss. Advantages of these agents are standardisation of dose, lower viral transmission risk, low volume, and lack of transfusion associated adverse events.[30] So far the literature offers only case report and observational evidence in favour of their use.[30, 89] Not only will efficacy need to be demonstrated in controlled trials, but safety issues (i.e. effects on thrombosis and disseminated intravascular coagulation) will need to be fully assessed prior to formulation of recommendations for use.[90]

***Recombinant activated factor VIIa (rFVIIa)***

Recombinant activated factor exerts its effect through accelerating timely and sufficient development of thrombin at vessel lesion sites. The mechanism of action depends on the presence of tissue factor, activated platelet surface and factor X. Two RCTs have been published looking at the effectiveness of rFVIIa in trauma patients.[91,92] Both reported reduced RBC use following rFVIIa administration in blunt trauma but no associated improvement in mortality. Dirkmann et al. Recently tested the hypotheses that FXIII concentrate, PCC, rFVIIa, and TA inhibit fibrinolysis to different degrees, and that platelets contribute to antifibrinolysis in citrated whole blood from volunteers, they concluded that only TA, FXIII, and PCC significantly inhibited r-tPA– evoked hyperfibrinolysis whereas rFVIIa had no effect, they also found that the effects of exogenous FXIII were dependent on the presence of functional platelets.[93] Hypothermia and acidosis decrease the efficacy of rFVIIa and should likewise be optimized if possible; acidosis in particular should be avoided. If the pH is less than 7·2, therefore, buffer therapy should be administered. The consensus view remains that there is no strong evidence to support rFVIIa use in standard treatment for traumatic bleeding.[94]

## LIMITATIONS OF THIS REVIEW

This paper was not intended as a systematic review and is therefore open to author bias. The literature around traumatic coagulopathy and major blood loss is limited, and high quality evidence from randomised controlled trials and systematic reviews is lacking. The majority of the data reviewed in this article comes from observational studies, and conclusions from these results should be made cautiously. Higher quality evidence has been reviewed thoroughly in recently published systematic reviews.[34, 64, 95]

## CONCLUSION

Mortality in patients with trauma haemorrhage is high, and the last decade has seen a significant shift in resuscitation strategies used to manage severely injured trauma patients. However, the evidence to support such change is limited. In order to move forward large randomised controlled trials and well conducted observational studies with pragmatic endpoints are needed to improve our understanding of the complex interplay between bleeding and resuscitation, traumatic coagulopathy and mortality.

## CONFLICT OF INTEREST

All the authors have no conflict of interest to declare.

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# MINIDOSE SPINAL BUPIVACAINE HYDROCHLORIDE WITH OR WITHOUT INJECTION FENTANYL CITRATE IN DAY CARE SURGERY

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## ABSTRACT

**Aim:** This study was conducted to compare the efficacy of different intrathecal diluted dosage of 0.5% hyperbaric Bupivacaine with or without Fentanyl in day care surgery

**Methods:** 100 patients of ASA I & II and aged 30-50 years were divided in four groups.25 patients in each group.

Group 5:5mg 0.5% Bupivacaine plain (1ml) 3 cc made with saline

Group 5, 25: 5mg 0.5% Bupivacaine (1ml) +25mcg Fentanyl 3 cc made with saline

Group 10, 25: 10 mg 0.5% Bupivacaine (2ml) +25 mcg Fentanyl 3 cc made with saline. Onset and duration of spinal block, quality of block, side effects and intraoperative supplemental anesthetic requirement were noted.

Results: Hypotension was noted in 2 patients in Group $_{5,25}$, 4 patients in Group $_{10,25}$ and none patient in Group$_{s.}$ 2 patients in Group $_{10,25}$ need Inj. Mephentermine 6mg IV bolus twice. Both time to 2 segment regression and time to $s_2$ regression was faster in Group $_{5,0}$>Group $_{5,25}$> Group$_{10,25}$. These differences also affected for delaying the discharge criteria. 4 (16%) patients in Group $_{5,\ 25}$ and 4 (16%) patients in Group $_{10,25}$ had pruritus.

**Conclusion:** Mini dose of 5mg hyperbaric Bupivacaine diluted in 3 cc of 0.9% saline and addition of 25mcg Fentanyl gives satisfactory spinal anesthesia and early discharge which is recommended in day care surgery.

Keywords: - anesthetic technique, subarachnoid, Mini dose, Bupivacaine hydrochloride, Fentanyl citrate

## INTRODUCTION

In present era, wide spread use of small bore, pencil point needle, really cuts down the post-spinal headache incidence in day stay unit. Lignocaine hydrochloride was the drug of choice in spinal anesthesia for ambulatory anesthesia. Set up with 60mg Lignocaine 5% heavy Pollock et al reported 16% and Hampi K F reported 37% incidence of

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transient radicular symptoms.

It has been documented that total duration, hemodynamic response and motor recovery is proportionally dependent to total milligram dose of spinal anesthetic injected [3].

Addition of short acting, lipophilic upload like Fentanyl with low dose diluted (sub therapeutic) spinal anesthetic drug enhances sensory effect and early recovery from motor blockage[4,5]. Hemodynamic stability is additional advantage of low dose spinal anesthetic drug used.

To avoid controversy and uncertainty for use of Inj. Lignocaine, We conducted the study, comparison of the efficacy of different intrathecal diluted dosage of 0.5% hyperbaric Bupivacaine with or without Fentanyl in day care surgery like TURBT and Intra Cavitory radiation (ICR).we had kept the volume of spinal anesthetic drug constant. We would observe the onset of action, duration of analgesia, quality and recovery.

**METHOD**

After institutional ethical committee approval and informed consent from patient, the prospective randomized study was conducted in total 75 patients, divided in 3 groups, 25 in each group. All patients of ASA grade 1 and 2, aged 30-50 years posted for TURBT and Intra Cavitory Radiation (ICR) were included.
Exclusion criteria were Age>60 years, ASA grade 3 or more, coagulopathy, spinal deformity, Infection at injection site, Known hypersensitivity to amide local anesthetic or Fentanyl. All the patients were subjected through physical and systemic examination pre-operatively. Routine investigations like CBC, PT, APTT, X-ray chest, ECG and x-ray spine was done in each patient.

All patients were kept nil by mouth for 6 hours pre-operatively .Tab. Lorazepam 1 mg given at night on previous and Tab. Diazepam 5 mg 6:00 AM on day of surgery. In OT, for standard monitoring like 3 lead ECG, HR, NIBP, SPO2were applied. After 18G IV line insertion, all patients were pre-loaded with 10ml/kg Ringer lactate in 30 minutes. Baseline hemodynamic vital data were recorded.

Under all aseptic precautions with patient in lateral position, 24 gauge spinal needle introduced in midline $L_3$-$L_4$space. After free flow of CSF, spinal anesthetic drug was injected. All patients were randomly allocated to one of these groups

Group $_5$:5mg 0.5% Bupivacaine plain (1ml) 3 cc made with saline

Group $_{5,\ 25}$: 5mg 0.5% Bupivacaine (1ml) +25mcg Fentanyl 3 cc made with saline

Group $_{10,\ 25}$: 10 mg 0.5% Bupivacaine (2ml) +25 mcg Fentanyl 3 cc made with saline

Patients were immediately positioned supine after spinal drug given. Intra-operatively $O_2$ was given 4 l/min by nasal cannula. Inj .Ringer Lactate 6ml/kg was given to all patients intra operatively.

Time to peak level of block was calculated from the time to spinal drug given to the time at which sensory blockage reaches to peak dermatome level. Level of sensory block was assessed by pin-prick using sharp beveled 24 gauge hypodermic needle at 2 minutes interval on both sides until level was stabilized for 10 minutes and noted as highest peak level. Thereafter level was assessed till end of surgery every 10 minutes till 2 segments regression and then every twenty minutes till regression to $s_1$ dermatome. Bromage scale was used to assess motor blockage at the time of highest sensory block as below.

0-full flexion of knees and feet possible, able to lift extended legs

1. Unable to lift extended legs, able to flex knees full flexion of feet possible

2. Unable to flex knees, flexion of feet possible
3. Unable to move legs and feet



Heart rate and blood pressure (systolic and diastolic) were recorded at every 2 minutes interval for first 10 minutes, than every 5 minutes interval for next 20 minutes and thereafter every 10 minutes till time to $s_2$ segment regression. Hypotension was defined as a fall in systolic pressure by more than 30% of pre-operative value. Inj. Mephentermine male ate 6mg was given IV in bolus dose which were repeated after 5 minutes as when required.O2 4/l minute was given to all patients via mask.

Heart rate lower than 50 beats/minute was recorded as bradycardia, Inj. Atropine 0.6 mg IV bolus was administered. Respiratory depression defined as respiratory rate less than or equal to 10 breaths per minute or Spo2 less than or equal to 85%.Patient awakening or IPPV at 12-15 /minutes given with 100% o2 till SPO2 reach more than 95%.

Degree of analgesia during surgery was graded as

A: no pain
B: sensation of touch and strain
C: mild discomfort but surgery completed without additional analgesia
D: patient complained of pain and advised to have more analgesia or GA.

In these patients 30 mg pentazocine slowly IV given

E: failed spinal, no motor or sensory analgesia.GA was given

No intraoperative sedation given

Follow up for these cases for incidence of pruritus, nausea, vomiting or headache was done until discharge or shifted toward from recovery area. Criteria for discharge were granted as complete resolution of motor block, normal sensation on feet and buttocks, voiding of urine, stable vital parameters, no nausea and vomiting, VAS<3,no bleeding or surgical complication.

All data were analyzed statistically using Student's' test and ANOVA test online from www.graphpad.com. The p value <0.05 was considered as statistically significant.

**Results**

There were 25 patients in each group.

In our study age, sex, weight and duration of surgery in all groups were comparable as one way ANOVA analysis (Table 1).

There was no difference between all groups in the highest level of blockage as checked by needle prick [T7, T8] respectively or time taken to highest sensory level [$Group_s$-11 minutes, $Group_{5,25}$-11minutes, $Group_{10,25}$ -10 minutes]. Significantly intense motor blockage (Bromage scale 2 and 3) was achieved in all patients of $Group_{5,\ 25}$ and $Group_{\ 10,\ 25}$ and 22 patients in $Group_{\ s}$.

Hypotension was noted in 2 patients in $Group_{\ 5,25}$,4 patients in $Group_{\ 10,\ 25}$ and none patient in $Group_{s.}$ 2

**Table 1 Demographic Data**

| | $Group_5$ | $Group_{\ 5,25}$ | $Group_{10,25}$ |
|---|---|---|---|
| Age | 51.84±6.13 | 55.84±5.93 | 55.84±5.16 |
| Wt | 55.36±10.62 | 61.00±9.55 | 54.15±8.36 |
| Duration of Surgery | 99.03±18.22 | 99.30±16.31 | 108.70±19.64 |

All groups were comparable with each other (P>0.05)

**Table 2 Intraoperative Complications**

| Complications | Group$_5$ | Group $_{5,25}$ | Group$_{10,25}$ |
|---|---|---|---|
| Hypotension | 0 | 2 | 4 |
| Pruritus | 0 | 4 | 4 |
| Bradycardia | 0 | 1 | 4 |
| Nausea/Vomiting | 0 | 0 | 1 |
| Resp. distress | 0 | 0 | 0 |
| Sedation | 2 | 2 | 0 |
| Urinary retention | 0 | 0 | 0 |

Group $_{10,25}$ had more hypotension, bradycardia than other groups.

**Table 3 Results**

| | Group$_5$ | Group$_{5,25}$ | Group$_{10,25}$ |
|---|---|---|---|
| Time to highest sensory level | 9.96±0.82 | 10.03±0.59 | 10.03±0.44 |
| Height of block | $T_8$ | $T_8$ | $T_6$ |
| Time to 2 segment regression | 113.11±10.29 | 156.34±12.01 | 221.5±10.04 |
| P value | | 0.0016124 | 0.00612 |
| Time to $S_2$ segment regression | 120.46±10.37 | 144.576±10.37 | 212.26±13.3.6 |
| P value | | 0.0001 | 0.0001 |
| Time to urinate | 168.65±5.45 | 181.11±5.23 | 305.61±9.31 |
| P value | | 0.0001 | 0.0001 |
| Time to discharge | 186.98±12.99 | 210.80±11.86 | 320.03±11.10 |
| P value | | | |
| Motor block Bromage Scale 0-1-2-3 | 02-13-10-0 | 01-06-12-06 | 00-1-11-13 |
| Failed Block | 4/25 | 1/25 | 0/25 |
| Pain treatment required | 4/25 | 1/25 | 0/25 |



patients in Group $_{10, 25}$ need Inj. Mephentermine 6mg IV bolus twice.

2 patients in Group$_{5,25}$ , 4 patients in Group$_{10,25}$ experienced mild to moderate pruritus started in 7-10 minutes after spinal drug given and lasted for 2 hrs.($s_2$ segment regression) .It was not seen in Group$_{5,0}$. Inj. Promethazine Hydrochloride 25 mg bolus once was sufficient to make patient comfortable.

Time taken to 2 segment regression was significantly lowered in Groups in which Fentanyl added. Both time to 2 segment regression and time to $s_2$ regression was faster in Group$_{5, 0}$>Group$_{5, 25}$> Group $_{10, 25.}$ These differences also affected for delaying the discharge criteria.
Early discharge was possible with Group$_{5,0}$, while Group$_{5,25}$were discharged earlier than Group $_{10,25}$.Mean time to discharge from the time of spinal injection in Group$_{5,0}$,Group$_{5,25}$,Group $_{10,25}$ were 186.98 12,99, 210.80 11.86, 320.03 11.10 respectively.

## DISCUSSION

This study shows that use of low dose Inj. bupivacaine hydrochloride 5mg diluted to 3ml with 0.9%NaCl and addition of 25mcg fentanyl citrate intensifies sensory block and increase duration of analgesia and early discharge.

Addition of opioids to spinal local anesthetic is synergistic action as they act by different way of action [4, 5, 6]. Intrathecal opioids inhibits the afferent synaptic transmission via A delta and C fiber by opening presynaptic effect with hyper polarization[7, 8, 9,10] and reduced neuronal activity[5]. Local anesthetics work by blockage of voltage gated $Na^+$ channels in axonal membrane and pre synaptic inhibition of $ca^{++}$channels [11]

Studies of addition of intrathecal Fentanyl less than 20mcg were done; Ben David et al reported increase in duration and intensity of sensation blockage using 10mcg Fentanyl with Bupivacaine.

Kuusneimi et [12] al used 25mcg Fentanyl with different dose Bupivacaine (10, 7.5, 5mg) and other studies defines that 25mcg Fentanyl provides maximum intraoperative analgesia with sub anesthetic local anesthetic dose which provides early ambulation and could be considered as equipotent dose[13] . Ben David et al [14] reported increase in duration and intensity of sensory blockage using 10 mcq Fentanyl with Bupivacaine.

This study demonstrate that the case of a fixed volume diluted local anesthetic with addition of opioids provides early recovery to 2 segment regression and $s_2$ segment, hence early discharge.

Pruritus is a common complaint in patients receiving intrathecal Fentanyl. None patient in Group$_{5, 0}$, 4 (16%) patients in Group$_{5, 25}$ and 4 (16%) patients in Group $_{10, 25}$ had pruritus. If it is mild and relieved in 1 hr, then requires no treatment and only reassurance. We had lower incidence of pruritus compared to Pramod Patra[15] 56% in 7.5 mg Bupivacaine+ Fentanyl 25mcg and Bupivacaine 5mg with Fentanyl 25 mcg 36%.

In our study we had premeditated patients Tab.lorazepam 1mg at previous night and Tab. Diazepam 5mg 4hrs before surgery. But we had not encountered any respiratory depression case in any groups.

## BLOCK HEIGHT

There is no difference in the spread of 0.5% Bupivacaine in 5% or in 8% dextrose solution. Duration of blockade was unaffected by baricity.[16, 17]

In our study we had kept volume constant and dose varies, median peak sensory height level was $T_8$ in Group$_{5, 0}$, $T_8$ in Group$_{5, 25}$ $T_6$ in Group $_{10, 25}$.

Kararmaz at et[17] al reported peak sensory block level at $T_{10}$ in Bupivacaine 4mg and Fentanyl

25mcg; in our study it was lower $T_6$ or $T_8$ in all our groups. This might be due to that we had used a higher dose Bupivacaine 5mg.In other study done by Pramod Patra reported median sensory at $T_9$ in Bupivacaine 5mg with Fentanyl 25mcg.

**BLOCK INTENSITY**

Block intensity is reflected by degree of motor blockage and intra operative sensation. It was decreased by the simultaneously increase in dilution and decrease in dose.

In our study in Group $_5$ 4 out of 25 patients had intraoperative pain, 15 out of 25 patients had motor blockage of Bromage scale 0-1 in comparison to Group$_{5,\ 25}$ and Group$_{10,\ 25}$. Failed spinal anesthesia was noted in 4 patient of Group$_5$ and 1 in Group$_{5,25}$.

Bupivacaine 5mg in 3 cc (Group $_5$) did not provide reliable adequate anesthesia for TURBT and ICR procedures. In our study, simply addition of 25mcg Fentanyl added to this 5mg Bupivacaine in 3 ml solution is enhancing the motor blockade.

**BLOCK DURATION**

The duration of spinal blockage as measured by time of spinal drug given to complete central regression ($s_2$ segment regression) .Block duration is decreasing when dilution increasing and dose of Bupivacaine is decreasing.

In this study we had compared different dosages of Inj. Bupivacaine dilution in 3 ml of 0.9% saline. Sensory recovery of $s_2$ segment and complete sensory recovery was earlier in Group$_5$ than of Group$_{5,25}$ and it was significantly delayed(P<o.o5) in Group$_{10,25.}$This data demonstrate a drastic difference of earlier recovery using technique of minidose of spinal drug diluted with saline than routinely using undiluted dose.

**HEMODYNAMIC STABILITY**

Hypotension was present in 4 patients of Group$_{10,\ 25}$ .Vasopressor supports for hypotension was given in form of Inj. Mephentermine in 2 out of 25 patients in Group$_{10,\ 25}$ .While Vasopressor agent was not needed in any patient of minidose diluted dose of Group$_5$and Group $_{5,25}$which was significant.

Use of minidose of spinal anesthesia drug reduced severity and incidence of hypotension. However low dose of spinal anesthetic drug can give rise to failure or inadequate anesthesia for surgery. But addition of small dose of opioids such as Fentanyl can produce functional blockage.

**CONCLUSION**

In conclusion, this study demonstrated early ambulation and adequate intraoperative analgesia by using minidose of 5mg hyperbaric Bupivacaine diluted in 3 cc of 0.9% Saline and addition of 25mcg Fentanyl gives satisfactory spinal anesthesia for TURBT and ICR.

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# INTRATHECAL PLAIN ROPIVACAINE 0.5% VERSUS PLAIN ROPIVACAINE 0.5% WITH CLONIDINE IN LOWER LIMB AND LOWER ABDOMINAL SURGERY-A PROSPECTIVE, RANDOMIZED, DOUBLE BLIND STUDY

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**ABSTRACT**

The purpose of this study was to compare the safety and efficacy of intrathecal plain ropivacaine 0.5% (20 mg) and intrathecal plain ropivacaine 0.5%(17.5 mg)with clonidine(30µg) in lower limb and lower abdominal surgery. 60 patients, in age group of 18-60 years scheduled for lower abdominal and lower limb surgery were studied. Patients were randomly allocated to receive 20 mg of ropivacaine or 17.5 mg ropivacaine with 30µg clonidine in a double blind fashion. Spinal block was performed in siting position using 26 G Quincke-point needles using standard midline approach at L2-3 or L3-4 interspace. The characteristics of patients in two groups were comparable in terms of age, gender, height, weight and ASA classification. Time of onset of sensory and motor block, time of maximal spread of block and height of block were comparable in both groups. 30 patients in ropivaciane –clonidine group were able to attain complete block as compared to 27 patients in Ropivacaine group, which is statistically significant. Duration of block at T10 and total duration of block was significantly longer in ropivacaine-clonidine group. In conclusion, the results of our study showed that clonidine 30 µg when added to plain ropivacaine 0.5% resulted in more intense and predictable block which lasted for longer duration as compared to ropivacaine 0.5% alone.

**INTRODUCTION**

Ropivacaine (S-(-) enatiomer of 1-propyl 2, 6-pipecolo-xylide) is structurally related to bupivacaine but has less motor blockade and is associated with less C.N.S. and cadiac toxicity. It has been reported that ropivacaine is less potent than bupivacaine [1,2,3,4]. Sufetanil and fentanyl has been used by investigators to improve the efficacy of ropivacaine. Opioids are associated with several side effects when combined with local anaesthetics. Intrathecal clonidine when combined with local anaesthetics has lesser side effects. Clonidine was combined with ropivacaine in women undergoing caesarean section by Atus Duman [5]. This study was designed to compare the safety and efficacy of intrathecal plain ropivacaine 0.5% (20 mg) and intrathecal plain ropivacaine 0.5% (17.5 mg) with clonidine (30µg) in lower limb and lower abdominal surgery.

**METHOD**

With institutional review board approval and written informed consent, 60 normotensive patients (ASA grade I and II), in age group of 18-60 years, body weight of 50-90 Kg scheduled for lower limb and lower abdominal surgery were included in the study. Patients who had contraindications to spinal anaesthesia, allergy to local anaesthetic agents, H/o backache, substance abuse, who had participated in any clinical trial in preceding 3 months, had been enrolled previously in this study or had significant derangement of lab values were excluded from the study.

Patients were randomly assigned to one of the two groups using computer generated randomisation table. Patients of group R received 20 mg of isobaric ropivacaine (4 ml) and of group RC received 17.5 mg of isobaric ropivacaine, clonidine30 µg and normal saline to make it 4ml. The study solution was prepared by a person at the time of procedure and was not involved in data collection. Patient and person involved in data collection were blinded to the contents of study solution.

All patients had standard monitoring of heart rate, mean arterial pressure, peripheral oxygen saturation and respiration rate throughout surgery. After securing a good intravenous access by 18 G intravenous cannula, patients were preloaded with 10ml/Kg of lacated Ringer's solution over a period of 15 minutes. Spinal block was performed in siting position using 26 G Quincke-point needles using standard midline approach at L2-3 or L3-4 interspace. Bevel of needle during injection of drug was cephaleded and drug was injected over a period of 30seconds. Position of needle was confirmed by aspiration and reinjection of CSF before and after injection of study solution. Patients were immediately turned to supine horizontal position.

Sensory blockade was assessed in both sides of trunk in anterior axillary line using a short bevel 25G needle every 15 minutes till end of surgery and thereafter every 30 minutes till recovery from block. Motor blockade in lower limbs was assessed by using a modified Bromage scales [0 - no paralysis, 1 - inability to raise extended leg against gravity but able to flex knee, 2 - unable to flex knee but able to flex feet, 3 - unable to flex ankle]. Variables recorded and compared were initial onset of sensory block (assessed at T10 level), level of highest block, time to reach highest level block (time between injection and maximal blockade), median duration of analgesia at T10 level and time to regression of block to S2 dermatome.

Mean arterial blood pressure was recorded every 5 min throughout the study. Patients were considered hypotensive when either systolic or mean arterial pressure decreased below 20% of baseline value. Patients were treated with IV mephenteramine 6mg till recovery of blood pressure. A decrease in heart rate of less than 50 bpm was treated with 0.6 mg of IV atropine.

**RESULTS**

The characteristics of patients in two groups were comparable in terms of age, gender, height, weight and ASA classification (Table1). Duration of surgery in both groups was statistically comparable. All patients were able to complete their surgical procedures in spinal anaesthesia.

Table-1. Patient characterstics

| | Ropivacaine Group (n=30) | Ropivacaine+Clonidine Group (n=30) |
|---|---|---|
| Age (yr) | 40±17 | 41±18 |
| Gender(F/M) | 13/17 | 12/18 |
| ASA physical status(I/II) | 23/7 | 28/2 |
| Weight (Kg) | 78±15 | 76±13 |
| Height (cm) | 177±12 | 175±11 |

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There was no significant difference in the median time of initial onset of sensory block which was 2 minutes in ropivacaine group and 1.5 minutes in RC group. 26 patients in R group and 29 patients in RC group were able to get anaesthesia at T6 level. The median time to reach the highest level of analgesia was 17.5 minutes in R group and 15 minutes in RC group. This difference is statistically not significant. No difference of analgesia was found in cauded spread of analgesia between two groups. The median duration of analgesia at T10 dermatome is significantly longer in RC group (130 min) than R group (110 min). Total duration of analgesia i.e. complete recovery of block is also significant longer in RC group (320 min) as compared to R group (270 min).

The time to initial onset of motor block and time to reach the maximum degree of motor block was similar in both groups. Complete motor block occurred in 27 patients in R group and 30 patients in RC group. The total duration of motor block was significantly longer in RC group which was 254 minutes, while it was 200 minutes in R group (Table 2).

10 patients in group R and 13 patients in RC had epidodes of hypotension which was easily managed with bolus dose of mephenteramine. On comparison between groups, episodes of hypotension were statistically not significant. There were no significant changes in ECG in intraoperative and postoperative period.

Table-2. Characterstics of neural block

| | Ropivacaine Group | Ropivacaine-Clonidine Group | P value |
|---|---|---|---|
| **Sensory block** | | | |
| Time of initial onset(min) | 2 | 1.5 | NS |
| Time of maximal cephalded spread(min) | 17.5 | 15 | NS |
| Highest block(segment) | T7 | T6 | NS |
| Patients with block at T6 level | 26 | 29 | S |
| Duration at T12(min) | 110 | 130 | HS |
| Total duration(min) | 270 | 320 | HS |
| **Sensory block** | | | |
| Time of initial onset(min) | 8 | 6.5 | NS |
| Time to maximal block(min) | 19 | 17 | NS |
| Patients with complete block | 27 | 30 | S |
| Total duration(min) | 200 | 254 | HS |

## DISCUSSION

In this study, we compared plain ropivacaine with mixture of ropivacaine and clonidine when given intrathecally. Mixture of ropivacaine and clonidine was physically compatible when freshly prepared and no precipitation was seen in syringe upon aspiration of C.S.F. during administration of drug intrathecally. Addition of clonidine in ropivacaine resulted in intense and longer duration of motor block and analgesia as compared to ropivacaine alone.



Ropivcaine was found to be less potent and produces shorter duration of motor block than bupivacaine in animal models [6, 7]. No evidence of neurotoxicity was found when ropivacaine was administered intrathecally in rats [8,9].

Ropivacaine has lower cardiotoxic potential and less CNS toxicity than racemic bupivacaine [10, 11]. Ropivacaine was used intrathecally by Ven Kleef et al in 1994[12]. They found that the analgesic spread was extremely variable with both 0.5% and 0.75%ropivacaine, sometimes being restricted to the lumbosacral segments, sometimes extending to the upper thoracic segments. Authors concluded that less intense and less duration of motor block occurs with 0.5% ropivacaine as compared with 0.75% ropivacaine. Intrathecal ropivacaine was compared with intrathecal bupivacaine for transurethral resection of bladder and authors concluded that 15 mg of intrathecal ropivacaine provided similar motor haemodynamic effects but less potent anaesthesia than 10 mg bupivacaine [4]. In an another study done in patients undergoing major orthopaedic surgery, ropivacaine 17.5 mg was found to have similar quality of anaesthesia but duration was shorter as compared to 17.5 mg bupivacaine[13]. Gautier and colleagues compared 12 mg of hyperbaric ropivacaine intrathecally to 8 mg hyperbaric bupivacaine in patients undergoing knee arthroscopy and estimated that 12 mg of ropivaciane was approximately equivalent to bupivacaine[14]. Ropivacaine with clonidine has been used in caudal block for inguinal surgery in children[15], for epidural analgesia for labour [16], in spinal anaesthesia for patients undergoing caesarean deliveries and for intrathecal anaesthesia for knee arthroscopy[17].

In this study we compared intrathecal ropivacaine 0.5% (20 mg) with intrathecal ropivacaine 0.5%(17.5 mg) and clonidine 30 µg. Addition of clonidine resulted in more predictable and intense blockade as compared to ropivacaine alone. Clonidine in ropivacaine resulted in longer duration of anaesthesia, making it less useful for ambulatory anaesthesia. But sometimes inadequate duration of anaesthesia might increase the risk of incomplete surgery in spinal anaesthesia and increasing the risk of conversion to general anaesthesia.

Changes in blood pressure and heart rate in both groups were modest, which may be due to adequate preloading before the commencement of spinal block.

## CONCLUSION

Intrathecal administration of plain ropivacaine 20 mg or plain ropivacaine17.5 mg with clonidine was well tolerated and provided effective anaesthesia for lower abdominal and lower limb surgery. Addition of clonidine resulted in more intense and predictable block which lasted for longer duration as compared to ropivacaine alone.

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# ATROPINE INDUCED MALIGNANT HYPERTENSION DURING EPIDURAL ANAESTHESIA WITH BUPIVACAINE AND CLONIDINE

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## ABSTRACT

Hypotension following regional anaesthesia is a well documented problem. However, sudden malignant hypertension after successful sympathetic blockade by epidural anaesthesia using clonidine along with bupivacaine was reported following atropine medication for severe bradycardia in a young patient for orthopaedic surgery. Preoperatively, the diastolic hypertension was the only problem with the patient. Severe hypertension was managed properly and timely by nitroglycerine infusion with successful outcome.

**KEY WORDS:** diastolic hypertension, sympathetic blockade, atropine, malignant hypertension.

## INTRODUCTION

Severe hypertension during general anaesthesia leading to congestive heart failure or even cardiac arrest is not a new entity in the literature and is described at several instances. However, severe hypertension following successful sympathetic block is not mentioned in the Anglo-Saxon literature. Herein, we discuss a unique case report of hypertensive crisis following atropine medication for severe bradycardia during successful epidural anaesthesia with bupivacaine and clonidine (alpha agonist used as adjuvant with local anaesthetic). This drug induced severe hypertension was managed properly by nitroglycerine infusion.

## CASE REPORT

A 35yr old, ASA Grade II, male patient was admitted with diagnosis of 3 months old non-united fracture talus. He was scheduled for ankle arthrodesis with external fixator application. On preoperative evaluation patient of 65 Kg (approximately) weight and 170 cm height with vitals as follows: P/R-90/min, BP-138/104mm of Hg, R/R-14/min. He was premedicated with Inj Midazolam 2mg i.v and coloaded with 750 ml of lactated ringer's solution. Epidural block was performed at L3-L4 inter space by an experienced anaesthesiologist using 18G Touhy needle, an epidural catheter of 20G was inserted cephalad and kept 4 cm into the epidural space for post operative pain relief.

A test dose of 3 ml of 2% lidocaine with 1:200,000 epinephrine solution was injected into the epidural

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space for confirmation of placement of epidural catheter. After excluding intrathecal or intravascular placement of catheter, epidural anaesthesia was established by injecting 15 ml of 0.5% bupivacaine and 5 ml of normal saline with 50 µg of clonidine as adjuvant. Sensory block was achieved at T12 dermatome within 10 minutes which was ascertained by loss of sensation to pin prick and motor blockade was also corresponds to Bromage scale 3, the maximum sensory level attained was T4, after 20 minutes of epidural injection.

Noninvasive digital monitoring of P/R, BP and $SpO_2$ along with height of block and pain scoring by visual analogue scale (VAS) were recorded continuously. Surgery was started smoothly. Patient's P/R decreased from 90/min to 68/min with BP of 120/84mmHg at 20 minutes after start of surgery. Approximately 30 min after the start of procedure, P/R declined to 45/min and at that time BP was 110/80 mm of Hg. Inj Atropine 0.4 mg i.v. was given for bradycardia. Adequate response was not found and same dose was repeated. After 2 minutes of repeated dose, pulse rate of the patient increased to 98/min but at the same time BP was recorded as 210/120 mm of Hg. A search for all possible causes of hypertension was made. Injection atropine ampoule was also rechecked, patient was asked for any pain sensation but he denied. Level of sensory block was found to be T4. However, a top-up dose consisting of 10ml of 0.125% Inj bupivacaine was also given to exclude inadequate analgesia, which further increased the height of block. The sensory block ascended upto T2 level, however ventilation appeared adequate and saturation was well maintained above 98%. BP was still 204/110 mm of Hg and P/R around 90/min. Inj nitroglycerine solution was started in infusion @ 4 µg/kg/min. BP came down within 10 min to 140/90 mm of Hg and was titrated to maintain a BP of 130/80 mm of Hg. Nitroglycerine infusion was continued for around 30 min at the same rate after which it was tapered off slowly. Patient's BP was monitored closely after stopping the infusion and it was maintained within normal limits. Surgery continued for 2.5 hrs but patient did not complain any discomfort, and P/R, BP and ventilation was well maintained throughout procedure.

The patient was shifted to post anaesthesia care unit (PACU) where he was monitored for 2 hrs. In PACU his vital signs remained stable and he did not experience any kind of discomfort. At the time of discharged from PACU to his hospital room his motor block had reversed to Bromage scale 0, his sensory block had receded to L1 and his vitals were as follows: P/R-80/min, BP- 130/80 mm of Hg, R/R- 12/min and $SPO_2$-98%.

## DISCUSSION

Hyperdynamic adrenergic circulatory state is the term given to borderline or labile hypertension[1].Various factors have been implicated by which the heart rate and blood pressure are elevated during hypertension. The increased venous tone[2], emotional hyper-reactivity[3] and adrenomedullary hypersecretion[4] were postulated as possible mechanism and accounted for sympathetic over activity or a hyperkinetic circulatory state.

However, decreased parasympathetic inhibition with increased beta-adrenergic stimulation along with increased sympathetic cardiac activity is also present in high output borderline hypertensive patients. Concurrent condition was simulated[5] in hyperkinetic borderline hypertensives by beta blockade with propanolol in literature, where cardiac output remained elevated and did not return to baseline [5]. Similar situation happened in our patient with successful autonomic blockade by bupivacaine and clonidine, an $\alpha_2$ agonist which is not previously reported.

Robinson et al.[6] experimented the effect of autonomic blockade and baroreflex differences found hyperbolic relation when plotted the pulse interval against arterial pressure. The peripheral parasympathetic-sympathetic nerve interactions are important factors which affect the slope. The other way of modulation of baroreflex regulation of pulse interval by the balance of sympathetic and parasympathetic influences, acting on sinoatrial node, thus changing the central reflex sensitivity[7]. Subsequently, patients with borderline hypertension and hyperkinetic circulation simultaneously exhibit an increase of sympathetic and a decrease of parasympathetic tone. Similar observation were found in our case, the sympathetic blockade by epidural anaesthesia in high output borderline diastolic hypertension leads to extreme bradycardia due to intact beta-adrenergic system, treatment with atropine leads to severe hypertension due to inherent increased alpha sympathetic tone and decrease of parasympathetic tone[8] in these patient. Therefore, significant increase in blood pressure with therapeutic dose of injection atropine was noticed. These findings indicate that a reduced parasympathetic activity is one of the components involved in the altered baroreflex sensitivity in borderline hypertensives.

In our case report, the primary effect of epinephrine test dose and use of clonidine as adjuvant with local anaesthetic leads to alpha receptor activation. As patient has sympathetic block with bupivacaine and clonidine with epidural anaesthesia, it resulted in profound hypertension and bradycardia due to activation of carotid baroreceptor and secondary increase in parasympathetic tone. As peripheral vasodilatation results in unopposed alpha constrictor response hence tachycardia induced by epinephrine is not seen.

## CONCLUSION

the syngergistic activity of cloinidine and epinephrine on the alpha receptor activation coupled with the sympathetic blockade induced peripheral vasodilataion, probably lead to this uncommon observational finding of maliganat hypertension and bradycardia , after a therapeutic dose of i.v atropine.

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# PROSPECTIVE RANDOMIZED TRIAL OF RIGHT AND LEFT PERIPHERALLY INSERTED CENTRAL VENOUS CATHETERS IN ADULTS

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## ABSTRACT

**Background** : Peripherally inserted central venous catheters are often used in clinical practice to monitor central venous pressure and administer drugs and fluids to patients undergoing major surgical procedures.

**Methods:** In a prospective randomized controlled trial 150 ASA gradeI-II patients undergoing major elective surgery were studied Central venous cannulation through either right (group 1, n=75) or left (group 2, n=75) antecubital veins was performed .Chest radiographs were taken in the post operative period and studied for the final location of the tip of the catheter .The final location of the catheter tip in relation to carina on chest x-ray, (catheter tips were considered 'CENTRAL' if they resided within the superior vena cava or at the superior vena cava- right atrial junction), and the angle of the catheter tip with the vertical axis on chest x-ray (an angle of <40 degrees with the vertical axis was considered to be optimal).

**Results:** The catheter tips were placed at desirable central location and angle in 61/73 (83.5%) subjects in group1 and 64/73 (87.67%) subjects in group 2 (statistically not significant). Catheters placed via right side were misplaced more often (8/73; 10.9%) than those inserted via left side (0/73; 0%), $p<0.05$.

**Conclusions:** Right sided catheters were prone for misplacement than left sided. However, the tip can be placed at desirable central location and angle comparably via either side.


**Keywords:** Peripherally inserted central venous catheters, right sided catheters, left sided catheters, Superior vena cava, Right atrium, Carina, catheter misplacement

## INTRODUCTION

Central venous catheter placement is often utilized in clinical practice perioperatively to monitor central venous pressure (CVP), administer vasoactive drugs and intravenous fluid rapidly. Peripherally inserted central venous catheters (PICCs) are popular for central venous access due to the ease of insertion and low risk of technical complications.[1]

Correct placement of the tip of the PICC is important for reliable CVP measurement. Further, incorrect placement of the tip may cause arrythmias, thrombosis and, rarely, cardiac perforation.[2] After initial controversy, it is now generally agreed that a catheter used for routine vascular access indications works well when positioned within the superior vena cava (SVC) or at SVC-right atrium (RA) junction.[3] Standard AP chest X-ray reliably assesses the location of the catheter tip using carina as anatomical landmark.[4] A distance within 3 cm above and 5 cm below the carina is considered appropriate for the position of the catheter tip.[5]

The present study was planned to compare tip placement of the PICC and the angle with the vertical axis, when the catheter is inserted from right antecubital veins as compared to those inserted from the left side.

## METHODS

This prospective randomized study was conducted after approval from Institutional Ethics Committee and informed consent of the patients.

Since we could not find any other prospective study of this type for the background calculation of the sample size, we initially conducted a pilot study. Our pilot study of 20 cases revealed that the percentage of catheters reaching the desired location was 50% for right sided catheters and 30% for the left sided ones. Considering a 20% difference as clinically significant a sample size of 75 in each group was arrived at, corresponding to $\alpha=0.05$ and power=0.80.

One hundred and fifty patients of both genders, belonging to ASA grade I and II, in the age group 18-70 years, scheduled for major elective surgical procedures were included in the study. Patients with bleeding diathesis, obesity, sclerosis of the antecubital veins and those requiring long term (>72 hours) cannulation of the central veins were excluded from the study. Routine preoperative evaluation was done in all the patients. In OR an appropriate vein was selected in the following order of preference.

(1) Basilic or median cubital vein,
(2) Tributary of basilic vein on the postero-medial aspect of the forearm.

Patients were randomized, using computer generated random table, to group 1 (PICC insertion through right arm) or group 2 (PICC insertion through left arm). Trained anaesthesiologist with three years experience inserted the PICC lines following induction of GA in all patients, using aseptic technique. The patient's arm was abducted at 90° for cannulation. A long line (70 cm) needle-over-catheter type CVP cannula (Cavafix, 16 G cannula with an 18 G catheter, B Braun) was used. Distance from the insertion site to right 4$^{th}$ inter-costal space served as guide for length of catheter inserted on either side..

A chest x-ray of the patient was obtained in the immediate postoperative period with the patient in supine position and arm in 90° abducted position. All the radiographs were analyzed with the help of radiologist . The distance of the tip of PICC from the carina and the angle the tip made with the vertical axis was recorded. PICC tips were considered 'CENTRAL' if they resided anywhere within the SVC or at the low SVC-RA junction. Given that the SVC is 6 cm long and the carina is roughly 3.5 cm higher than the SVC-RA junction; a distance within 30 mm (3cm) above and 50 mm (5cm) below the carina was considered an acceptable central location (Figure 1). Various 'non-central' tip locations in major veins were also identified as the ipsilateral brachiocephalic (between medial end of clavicle to 3cm above carina) of and the subclavian vein (from the medial end of clavicle to outer border of 1$^{st}$ rib). An angle of <40° with the vertical axis was considered to be optimal. The cases with poor quality X-ray film were excluded

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during radiological evaluation.

The data was analyzed using Chi-square and Fisher exact tests and a value of <0.05 was considered to be statistically significant However for pair wise comparison and type I error Bonferrione adjustment was done and then a p value of <0.02 was considered as significant

## RESULTS

Table 1 shows the demographic profile of the patients in two groups. Two cases were excluded from each group due to poor quality of the X-ray films. Overall, 85.03% subjects had central location of the PICC tips. The two groups were statistically similar in terms of location of the tips, 61/73 (83.56%) subjects in group 1 and 64/73 (87.67%) subjects in group 2 had an optimal / central location of the PICC tips (Table 2). 97.5% of the centrally located PICC tips had an angle <40° with the vertical axis. Various 'NON CENTRAL' tip locations in major veins were also identified. These include the ipsilateral brachiocephalic, ipsilateral internal jugular vein and the subclavian vein (Table 3). Misplacement of right sided PICC into the internal jugular vein was significantly more (8/73; 10.96%) as compared to 0/73 (0%) in the left sided PICC.**Discussion**

Peripherally inserted central venous catheters (PICC) are relatively easier to insert and require less skill as compared to subclavian and internal jugular catheters.[6] PICC are often used during major surgeries and perioperative period to monitor CVP and administer intravenous drugs and fluids. The rate and nature of the complications with PICC is also relatively less as

**Table 1: Demographics of the patients in the two groups**

| | Group I<br>Right sided PICC | Group II<br>Left sided PICC |
|---|---|---|
| **Age** | **34.2(13.4)** | **33.1(13.6)** |
| **Male :Female ratio*** | **48:27** | **51:24** |
| **Body weight** | **62.1(12.2)** | **60.1(12.2)** |
| **Height** | **162.8(8.7)** | **162.4(7.)** |

**Table 2 : Radiological location of the PICC tips**

| | Group I (n=73)<br>Right sided PICC | | Group II (n=73)<br>Left sided PICC | | P value |
|---|---|---|---|---|---|
| | **n (%)** | **95% CI** | **n (%)** | **95% CI** | |
| Centrally located | 61 (83.56%) | (75.17%-91.95%) | 64 (87.67%) | (80.23%-95.11%) | 0.479* |
| At <40° angle with vertical axis | 61 (83.56%) | (75.17%-91.95%) | 64 (87.67%) | (80.23%-95.11%) | |

*not significant

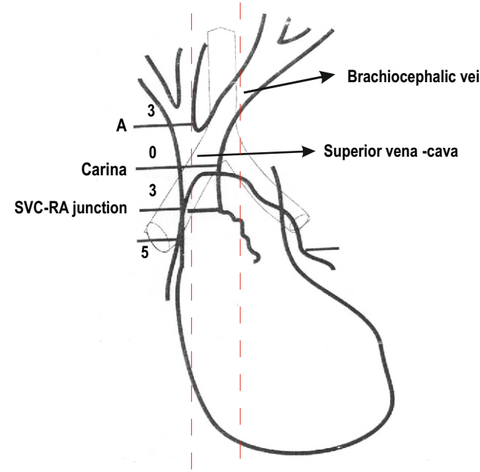


**Table 3 : Various non central locations of the PICC tips**

| | Group I (n=73)<br>Right sided PICC | | Group II (n=73)<br>Left sided PICC | | |
|---|---|---|---|---|---|
| **Location of the tip** | **n (%)** | **95% CI** | **n (%)** | **95% CI** | **P value** |
| Ipsilateral internal jugular vein | 8 (10.96% | (3.89%-18.03%) | 0 (0%) | (0%-4%) | 0.006* |
| Ipsilateral brachiocephalic vein | 2 (2.74%) | (-0.95%-6.43%) | 4 (5.48%) | (0.33%-10.6%) | 0.681 |
| Ipsilateral subclavian vein | 2 (2.74%) | (-0.96%-6.43%) | 5 (6.85%) | (1.13%-12.57%) | 0.442 |

*p<0.02 (significant)

Fig. **1 Central or optimal location of PICC tip**




compared to subclavian or internal jugular catheters.

In a study Tocino et al, suggested that left sided central venous catheters are difficult to insert through neck veins due to left brachiocephalic vein joining SVC at right angle. As a result, the catheter often abuts against the wall of the SVC making the insertion relatively difficult.[7] This explanation holds true for the present study too, although antecubital veins were used for insertion of PICC, as both (neck and antecubital veins) have the common terminal course .

The correct placement of the tip of the catheter is important for reliable CVP measurement and safety. It is well known that a catheter positioned in SVC and SVC –RA junction is appropriate location for the tip of

the catheter. The confirmation of catheter tip is often done using standard A-P chest radiograph. For radiological evaluation, PICC tips within a distance of 30 mm above and 50 mm below the carina are considered to be in an acceptable central location. The rate of successful initial PICC tip placement varies from 44% to 99%.[8-13] Wide variation in initial success rate is due to inconsistency in defining 'central' location. Recently, in an interesting study, Venkatesan et al found that though 'central' location was the most common tip position for right sided PICCs, the brachiocephalic vein (ipsilateral) was the commonest location for left sided ones.[5] The left sided PICC were less likely to reach the central position due to the longer distance traversed by the left sided catheters to reach the SVC. In contrast, our study showed that the two groups were statistically similar in terms of location of the tips ( 61/73; 83.56% subjects in group 1 and 64/73; 87.67% subjects in group 2 had an optimal / central location of the PICC tips). This could be because ours was a prospective study in which we measured the approximate length of the catheter to be inserted by laying open the sheath from antecubital fossa to right 4$^{th}$ intercostal space for both approaches . Since the left brachiocephalic vein is 3.5 cm longer than the right (6 cm vs 2.5 cm ), the left sided catheter needs to be pushed further in order to aim for a central location.

A misplacement rate of 14.38% was observed in the present study when the central venous catheters were inserted from antecubital veins. Another study has reported a misplacement rate of 7.9% in ICU patients.[14] Misplacement has been reported more commonly in patients who have had multiple previous central venous catheters and have central vein thrombosis or stenosis and distortion of the venous anatomy.[15]

Six of our PICCs in group 1 (right sided group) were located in the ipsilateral internal jugular vein (IJV). No such case was observed in the left sided PICC group. Similarly, in a study conducted by Boon et al two out of twenty-three catheter tips were located in the IJV.[16] Venkatesan et al reported an 11% incidence of PICC entering the IJV.[5] An 18% incidence has been reported in two different studies by Ragasa and coworkers and Burgess and collegues.[13,17] Lumley and Russel have recommended a neck compression test to detect IJV placement.[18] A recent study has recommended a saline flush test to successfully detect misplaced subclavian vein catheters into ipsilateral internal jugular veins. [19] The incidence found in our study (7.14%) is lower than the incidence quoted in other studies probably because of the different maneuvers which were used to increase the success rate of cannulation like further abduction of the arm (>90degrees)and turning the patient's head to the opposite side. Once the PICC tips were detected to be in the IJV, the catheters were removed. No significant complication resulted from this misplacement. In case of misplacement some of the options suggested are to remove, reposition with screening under aseptic conditions, or use them for short term duration.

The angle the catheter tip makes with the wall of the vein or the heart is crucial. Clinical evidence indicates that the more perpendicular the catheter is to the wall, the greater is the risk of perforation. Tocino et al, emphasized that left-sided catheters tend to impinge on the lateral wall of the SVC during insertion, thereby increasing the risk of perforation which has been well documented.[7] In a study, Stonelake et al, reported that right sided central venous catheters rarely form a significant angle between the tip and the SVC whereas a high proportion of the left sided central venous catheters had an angle to the vertical above 40°.[20] This was because the majority of these left sided central venous catheters were high up in the brachiocephalic vein. However, in our study; statistical analysis did not reveal any significant difference among the two groups in terms of the angle the tips made with the vertical axis.

Various maneuvers have been suggested to improve the success rate of PICC insertion in the absence of image guidance (fluoroscopic) and ECG. Application of digital pressure on same sided supraclavicular fossa and turning the patient's head to the same side of cannulation increases the success rate by 78%.[13]

Thiagarajan et al also suggested that PICC placed in non central veins provide reliable and safe intravenous access for administration of many medications and isotonic solutions for longer duration.[21] However, these locations may not be acceptable for long–term use in ICU particularly for the infusion of vasopressors, total parenteral nutrition, chemotherapy drugs etc.

To conclude, this study shows that the right sided peripheral long lines are more prone to misplacement than left sided. However, the placement of the tip of the catheter is comparable via either side, both in terms of desirable central location as well as the angle with the vertical axis. However, a larger trial is needed to validate the results of this study. Further, it is possible that involving more than one radiologist may affect the radiological interpretations.

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# EVALUATION OF THE DUOSCOPE™: A NEW DISPOSABLE DUAL BLADE LARYNGOSCOPE.

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**ABSTRACT**

**Background:** Duoscope is a novel, single use, disposable, dual blade laryngoscope specifically made for intubations in pre-hospital and emergency situations.

**Materials and methods:** 50 ASA grade I and II patients were included in this observational study. All patients were intubated using adult and large adult combination of Duoscope. We assessed overall intubation success rate, intubation attempts, intubation time, POGO (Percentage of Glottic Opening) score, modified Cormack-Lehane grading. Complications such as hypoxia or airway injury were also assessed.

**Result:** All patients were intubated with Duoscope without any failure. 90% patients were intubated on 1st attempt. Mean intubation time was 17.2 (5.12) s. Median Cormack-Lehane grade was 1. Average POGO score was 86.79 (21.39)%. There was no incidence of oesophageal intubation and no episode of hypoxia. Three patients had airway trauma.

**Conclusion:** Duoscope is equally effective and safe in easy laryngoscopic scenarios. Its use should be encouraged in the operating room as well as pre-hospital settings where intubation is needed.

**Key words:** Duoscope, laryngoscope, intubation

## INTRODUCTION

Securing an airway in emergency situations often becomes challenging to the anaesthesiologists due to multiple reasons. Lack of prompt availability of appropriate sized blades, improper illumination, heaviness of the conventional Macintosh or Miller laryngoscopes are the few important factors [1, 2]. The Duoscope™ [Figure1] (Parker Healthcare Pvt. Ltd., Redland Drive, Mitcham VIC, Australia) is a novel

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dual blade disposable emergency laryngoscope [3]. Designed as a premium disposable intubation device predominantly for the accident and emergency, the Duoscope can be an important aide to any medical professional's emergency airway cart. Light-weight, compact and immediately accessible for operation, it utilises one blade for intubation while the other blade is perfectly suited as the handle. Produced with high quality plastic, it is manufactured in 3 designs with a variation of sizes for different age and weight groups. It is available in child-adult (Miller 1+Macintosh 3), child-large adult (Miller 1+Macintosh 4) and adult-large adult (Macintosh 3+Macintosh 4) combinations. Duoscope is targeted towards ambulance, flying doctors and accident emergency/rescue operations. There are no studies on Duoscope at present.

The objective of this observational study was to assess the performance of this new disposable laryngoscope on routine basis.

## PATIENTS AND METHOD

Following approval and written informed patient consent to participate in the study, we studied 50 ASA physical status I–II patients, aged 18 years of age or older, scheduled for surgical procedures requiring tracheal intubation, in an observational clinical trial. Patients were not included if risk factors for gastric aspiration and/or risk factors for difficult intubation (Mallampatti class III or IV; thyromental distance less than 6 cm; interincisor distance less than 4.0 cm) were present or where there was a history of relevant drug allergy. Data were collected by an independent, unblinded observer.

Standard monitoring including pulse oximeter, Electrocardiograph, Non invasive blood pressure, and end tidal carbon dioxide were applied. Prior to induction of anaesthesia, all patients were given fentanyl (2 $\mu g.kg^{-1}$) intravenously. A sleep dose of propofol (2–3 $mg.kg^{-1}$) was titrated to induce anaesthesia. Following induction of anaesthesia, all patients' were ventilated with sevoflurane (2.0–2.5%) in oxygen, atracurium 0.50 $mg.kg^{-1}$ was administered, and the trachea was intubated 3 min later. Intubation was done using adult-large adult combination (Macintosh3 + Macintosh4) of the Duoscope. Thereafter, the lungs were mechanically ventilated for the duration of the procedure and anaesthesia was maintained using sevoflurane (1–2 %) in a mixture of nitrous oxide and oxygen in a 2:1 ratio.

No other medications were administered, or procedures performed, during the 5-min data collection period following tracheal intubation. The following outcomes were recorded by an unblinded observer: overall intubation success rate; the number of intubation attempts; intubation time (defined as the time from picking up the Duoscope until appearance of the capnograph waveform through the tracheal tube); frequency of oesophageal intubation; mucosal trauma (blood detected on the devices); lip or dental injury; and hypoxia (SpO2 < 95%). The intubating investigator also reported the modified Cormack and Lehane laryngoscopy grade [4] and the Percentage of Glottic Opening (POGO) score [5].

Based on previous studies,[6] we determined that the mean intubation time for the Macintosh3 + Macintosh4 combination of Duoscope was 12.7 s with a standard deviation of 5.9 s. Power analysis showed that in order to show 50% effect size, with 80% power at the 0.05 level of significance, 47 patients were required for each group. Therefore, we recruited 50 patients in total to account for possible drop-outs.

## RESULT

During the study period, 50 patients were intubated using the Duoscope. Patient and laryngoscopy characteristics are given in Table 1. Overall intubation success using the Duoscope was 100% (50/50). First, second, and third intubation attempt success rates using the Duoscope for direct laryngoscopy were 90% (45/50), 8% (4/50), and 2% (1/50), respectively [Table 2]. Mean intubation time was 17.2 (5.12) s. Median Cormack-Lehane grade was 1. Average POGO score was 86.67 (21.39) %. There was no incidence of oesophageal intubation and no episode of hypoxia. Three patients had airway trauma. A summary of all 50 intubations is provided in the flowchart.

## DISCUSSION

Duoscope is a new dual blade plastic made, disposable laryngoscope, specifically made for emergency situation in both pre-hospital and hospital

**Table 1:** Demographic parameters. Data are as *n* (%) or mean (SD).

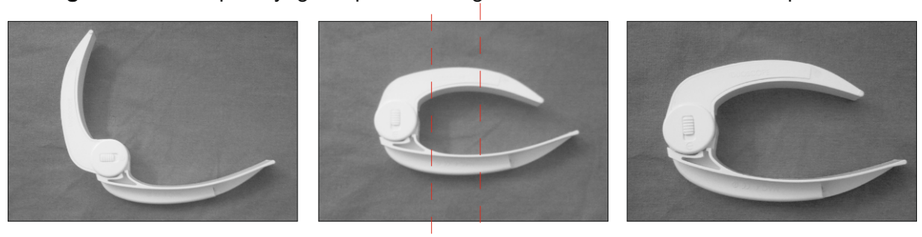
| | Patients ($n$ = 50) |
|---|---|
| Age (yrs) | 43.67 |
| Sex (male:female) | (13.46)31:19 |
| BMI* ($kg/m^2$) | 28 (8) |
| Mallampati score | 1 |

**Table 2:** Intubation characteristics of Duoscope. Data are as *n* (%) or mean (SD).

| | Patients ($n$ = 50) |
|---|---|
| Success rateIntubation attempts | 30/ 30 (100%) |
| 1 | 45 (90%) |
| 2 | 4 (8%) |
| 3 | 1 (2%) |
| Intubation time (seconds) | 17.2 (5.12) |
| Median CL grade* | 1 |
| POGO score | 86.79 (21.39)% |
| Complications | |
| Hypoxia | 0 (0%) |
| Airway trauma | 3 (6%) |

*CL= Cormack-Lehane

**Figure 1:** Duoscope laryngoscope. Adult-large adult combination in different positions.



settings. Incorporating bright white Light Emitting Diode's for illumination and light-weight lithium batteries for power sources, the Duoscope remains illuminated for up to 240 hours and is a fraction of the weight of conventional blades.

To our knowledge, this is the first observational clinical study evaluating Duoscope. As we assigned patients age starting from 18 years and above, we selected adult-large adult combination of Duoscope (Macintosh3 + Macintosh4). The main finding of our study is that the Duoscope can be used for direct laryngoscopy and tracheal intubation with a high success rate in patients without predictors of difficult intubation. All 50 patients were successfully intubated with Duoscope. Similar success rate was described by Asai *et al.*[7], Cheung *et al.*[8] and Ray *et al.*[9] with Macintosh blade. Subjectively, we considered the Duoscope to have a lighter feel to our standard direct laryngoscope handle and blade. It's light source allowed adequate visualization of airway structures without undue glare or reflection and attending anaesthesiologists commented that they felt "comforted" by having the lighter weight of the instrument. The 90% success rate on first attempt with Duoscope also corroborated with these studies. The average duration of intubation was 17.2 (5.12) seconds. Maharaj *et al.*[10] reported 14.2 (7.4) seconds and Twigg *et al.*[11] reported 13 seconds of intubation time with Macintosh laryngoscope in easy laryngoscopy scenario. This relatively increased intubation time with Duoscope can be explained by the absence of handle like conventional Macintosh laryngoscope. Absence of proper grip due to absence of serrated handle might have resulted in this increased intubation time[12]. Nevertheless, this increased intubation time is not clinically significant.

The median Cormack-Lehane grading was 1 in our study. Similar result with Macintosh blade was shown by Tutuncu *et al.*[13] . Ferrando *et al.*[14] also reported similar result in their study. Average POGO score was 86.79 (21.39) % with Duoscope. Twigg *et al.*[11] and Kim *et al.*[15] also reported similar results with Macintosh blades in easy laryngoscopic scenario. Three patients (6%) received airway trauma during laryngoscopy with Duoscope. McElwain *et al.*[16] also reported 6.6% of airway trauma with Macintosh blade. Though Duoscope is lighter than Macintosh blade, the same incidence of airway morbidity is possibly due to same amount of lifting force is required in both these laryngoscopes. An advantage of Duoscope is that the construction being similar to that of a Macintosh blade, there are no limitations to the type of tube used (endotracheal tube, nasotracheal tube, double lumen tube, etc.) or intubation adjuncts (Magill forceps, bougie, airway exchange catheters, etc.) and also the blades can be adjusted at different positions to use according to the position of larynx.

## CONCLUSION

Duoscope is a light weight, compact, portable, dual blade disposable laryngoscope. It is effective and safe in easy laryngoscopic scenarios. Therefore, it's use should be encouraged in the operating room as well as pre-hospital areas where intubation is necessary. More over it has a scope of managing even the airway which fails with conventional laryngoscope due to its unique property of different opening positions.

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**Acknowledgements**

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2. Organisation as author : The Royal Marsden Hospital Bonemarrow Transplantation Team. Failure of syngeneic bonemarrow graft without preconditioning in post- hepatitis marrow aplasia. Lancet 1977; 2: 742 4.

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