Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(5), 887-891 | ISSN:2251-6727

Assessing Dexmedetomidine's Effectiveness and Hemodynamic Impact as a Hypotensive Agent in Posterior Fixation Surgery for Traumatic Spine Injuries

Aishwarya Srinivasan (Junior resident) [1], **Shraddha Naik (**Professor) [1] **and Rojin Sebastian (**Junior resident) [1]
[1]Department of Anaesthesiology, Krishna Institute of Medical Sciences, Karad. Krishna Vishwa Vidyapeeth (Deemed to be University) Karad, Maharashtra, India.
Corresponding author: **Aishwarya Srinivasan(**Junior resident)
Department of Anaesthesiology, Krishna Institute of Medical Sciences, Karad. Krishna Vishwa Vidyapeeth (Deemed to be University) Karad, Maharashtra, India

(Received: 28 October 2023 Revised: 08 November Accepted: 02 December)

KEYWORDS
alpha 2-agonist, controlled hypotension, dexmedetomidine, spine surgery

ABSTRACT:
Background: The aim of this study was to assess the effectiveness of dexmedetomidine (DEX) as a medication forinducing controlled hypotension during posterior fixation surgery for traumatic spine injuries, and to compare its performance with that of nitroglycerin (NTG).Methods: Fifty patients classified as ASA I or II and aged between 20-60 years, scheduled forposterior fixation surgery, were randomly divided into two groups. One group received a dexmedetomidine (DEX) dose of 1 μg/kg over 10 minutes before anesthesia induction, followed by a maintenance infusion of 0.2-0.7 g/kg/h during the procedure. The other group received a nitroglycerin (NTG) infusion of 3-5 μg/kg/min after anesthesia induction to maintain the mean arterial blood pressure (MAP) between 65 and 70 mmHg. The study compared the two groups concerning the achievement of the target MAP, intraoperative blood loss, and the ability to reverse the hypotensive state. Continuous variables were assessedusing a Student's t-test, while categorical variables were analyzed with a chi-square test. A P-value less than 0.05 was considered statistically significant. Results: In the DEX group, patients achieved the target mean arterial blood pressure (MAP) with superior control over heart rate (HR) compared to the NTG group during the observation period. Notably, the DEX group alsoexhibited significantly less intraoperative blood loss (420.11 149.34 ml) in contrast to the NTG group (560.51 160.88 ml),with a P-value of 0.01. However, the time required for hypotension reversal in the NTG group (5.60 1.93 min) was shorter than that in the DEX group (9.10 2.16 min), albeit without statistical significance (P = 0.65). Conclusion: Dexmedetomidine (DEX) has proven to be a both effective and safe agent for inducing controlled hypotension in adults undergoing posterior fixation spine surgery.

I. INTRODUCTION

In the early days of spinal surgeries for traumatic spine fractures, these procedures gained notoriety due to their as- sociation with substantial blood loss, posing significant risks to patients both during and after surgery. Additionally, the excessive bleeding often made it challenging for surgeons to maintain clear visibility in the surgical field. Fortunately, advancements in anesthetic agents, pharmaceuticals, and monitoring technologies have successfully tackled this issue. One widely adopted approach to mitigate blood loss and enhance the surgeon's view during spinal fusion surgery is the practice of controlled hypotension. Many anesthetics and vasoactive drugs have been successfully employed to induce deliberate hypotension in medical procedures. These options include volatile anesthetics, direct-acting vasodilators, auto- nomic ganglion-blockers, β-adrenergic receptor blockers, β- adrenergicssss blocking agents, prostaglandin E1, and cal cium channel blockers. When selecting drugs for the purpose of achieving controlled hypotension, several critical factors must be considered. These factors include the ease of drug administration, ensuring they are quick to take effect and rapidly cease

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(5), 887-891 | ISSN:2251-6727

their influence when discontinued. Addition- ally, drugs chosen for this purpose should metabolize without producing toxic byproducts, have minimal adverse effects on vital organs, and exhibit predictable and dose-dependent responses. These criteria are essential to ensure the safety and effectiveness of controlled hypotension during medical procedures. Nitroglycerin (NTG), a directly acting vasodila- tor, has found application in inducing hypotension due to its desirable characteristics, including rapid onset, quick offset, and the ability to be carefully titrated. Nevertheless, it's worth noting that NTG can bring about certain challenges. It has the tendency to trigger reflex tachycardia, which can result in an elevated heart rate, and it can also lead to venous
congestion in the vicinity of the surgical site. These effects can ultimately contribute to increased blood loss during the surgical procedure. Despite numerous clinical trials exam- ining the effectiveness of dexmedetomidine (DEX) in miti- gating intraoperative bleeding among adults, there remains a limited understanding of its role as the primary hypotensive agent in posterior fixation surgery for spine injuries. This prospective, randomized study was conducted to address this knowledge gap by directly comparing the efficacy and safety of DEX with that of nitroglycerin (NTG) as hypotensive agents in adult patients undergoing posterior fixation surgeryfor traumatic spine fractures.

II. MATERIALS AND METHODS

Following the receipt of ethical committee approval from ourinstitutional ethics committee, our study enrolled 50 eligible patients aged between 20 and 60 years, all of whom were scheduled to undergo posterior fixation surgery as a result oftraumatic spine fractures. Prior to participation, each patient provided written informed consent. To ensure randomization, we employed the equal group random allocation method, assigning patients into two distinct groups: the DEX group and the NTG group. Patients with pre-existing respiratory or cardiac dysfunction, renal insufficiency, liver impairment, or bleeding disorders were excluded from the study to maintain the integrity of our sample and results. In both the DEX and NTG groups, patients received premedication consisting of intravenous injection of ondansetron at 4 mg, intravenous injection of glycopyrrolate at 0.2 mg, intravenous injection of midazolam at a dosage of 0.05 mg per kilogram of body weight, and intravenous injection of fentanyl at a rate of 2 micrograms per kilogram. Following premedication, anes- thesia induction was achieved through the administration of intravenous thiopentone sodium at 5 mg per kilogram. Tracheal intubation was facilitated using intravenous vecuro- nium bromide at a dosage of 0.1 mg per kilogram. Monitor- ing included continuous assessment of temperature and end-tidal carbon dioxide (ETCO2) levels. Subsequently, patients were carefully positioned in a prone position on a Relton's frame for the surgical procedure. During the course of the procedure, anesthesia was maintained using isoflurane with a Tec 7 vaporizer, combined with a gas mixture of oxygen and nitrous oxide in a 50:50 ratio (O2:N2O). The concen- tration of isoflurane remained constant at 1% throughout the entire observation period, which extended for 60 minutes post-induction. Adequate muscle relaxation was attained by administering incremental doses of intravenous vecuronium bromide. Throughout the surgery, a state of normocapnia (normal carbon dioxide levels), normothermia (normal body temperature), and normovolemia (normal blood volume) was carefully maintained. Additionally, the anesthesiologist had the option to adjust the concentration of isoflurane as needed based on hemodynamic variables after the initial 60 minutes of observation had passed, ensuring optimal patient manage- ment during the procedure. Following the successful place- ment of the implants, the hypotensive infusions, whether with DEX or NTG, were promptly discontinued. The time it took for the hypotensive state to reverse was meticulously recorded. This reversal of the hypotensive state was definedas the duration it took for the mean arterial blood pressure (MAP) to return to baseline levels after discontinuing the hypotensive agent. To achieve a statistical power of 0.80 anda significance level (α) of 0.05 for detecting a minimum intergroup difference of 10% in blood pressure and heart rate(HR), a sample size of 25 patients per group was deemed nec- essary. This sample size calculation ensures that the study has sufficient statistical strength to identify clinically meaningful differences in blood pressure and heart rate between the DEXand NTG groups.

III. RESULTS

In total, 50 patients were included in the statistical analysis, and upon examination, it was found that the two groups exhibited similarities in terms of age, sex,

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(5), 887-891 | ISSN:2251-6727

weight, and ASA physical status. The duration of surgery was also comparable between the two groups, with no significant difference ob- served. Baseline hemodynamic parameters, including heart rate (HR), mean arterial pressure (MAP), and preoperative hematocrit levels, were alike in both groups. In the results, which indicated a significant reduction in blood loss in the dexmedetomidine (DEX) group compared to the nitro- glycerin (NTG) group, with a p-value of 0.01. However, it's worth noting that the time required for the hypotensive state to reverse was shorter in the NTG group, although this difference was not statistically significant. In the DEX group, all patients successfully achieved and maintained the desired target mean arterial pressure (MAP) throughout the observation period. However, in the NTG group, nearly all patients met the target MAP, with only two exceptions that necessitated additional therapy to sustain the desired MAP level. It was also observed that the average heart rate (HR) in the NTG group was notably higher when compared to the DEX group at all the time points throughout the observation period. Over the course of the observation, the NTG group displayed a mean increase in HR by 28.46% from their baseline values, whereas the DEX group exhibited a mean decrease in HR by 21.7%. These differences in HR between the two groups highlight the distinct cardiovascular effects of these agents during the study period. During the surgical procedure, three patients in the DEX group encountered episodes of bradycardia between the 80th and 100th minute of surgery. Fortunately, these instances were effectively man- aged with the administration of atropine. Conversely, none of the patients in the NTG group experienced bradycardia. Importantly, neither the NTG nor the DEX group had any cases of uncontrolled hypotension, underscoring the effective control and management of blood pressure throughout the surgical procedures.

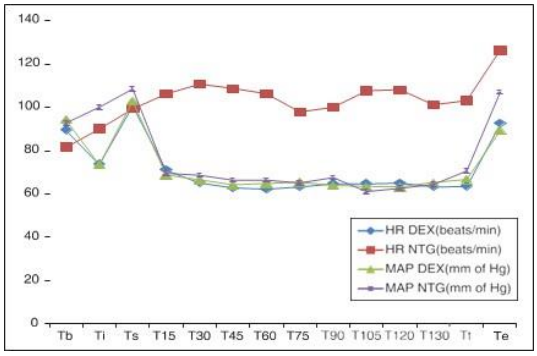

FIGURE 1: Mean arterial blood pressure (MAP) and heart rate (HR). Patients in dexmedetomidine (DEX) and nitro- glycerin (NTG) groups achieved the target MAP. NTG groupdemonstrates a significantly higher HR during steady state hypotension. All the values depicted are means at the corre- sponding time points

IV. DISCUSSION

One of the key findings of our study was the successful use of dexmedetomidine (DEX) to induce controlled hypotension while maintaining the desired hemodynamic profile. The re-duced blood loss observed in the DEX group further supports the effectiveness of achieving the desired level of hypoten- sion with this agent. Hypotensive anesthesia has previously been employed successfully in posttraumatic spinal surgeries for traumatic spine fractures, as demonstrated by Ullrich et al. This approach has proven to be both safe and effective in reducing blood loss during these procedures. In our own study, the patients included had spine fractures spanning from T10 to L5 and underwent surgery within a timeframe of 48 to 72 hours following the traumatic event. While dexmedetomi-dine (DEX) is officially approved by the United States Food and Drug Administration (FDA) for specific uses, such as sedation in intubated patients in the intensive care unit and procedural sedation in non intubated patients, its effective- ness in achieving controlled hypotension has been previously documented in adult patients undergoing maxillofacial and ear surgeries by Durmus et al. and Richa et al., respectively. Building on their findings, our study also confirms that DEX can be a valuable tool for inducing controlled hypotension in posterior fixation spine surgeries. We observed a substantial 19.78% reduction in mean arterial pressure (MAP) in the DEX group, aligning closely with the results achieved by Richa et al. The favorable

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(5), 887-891 | ISSN:2251-6727

hemodynamic profile achieved with dexmedetomidine (DEX) can be attributed to the well- established sympatholytic effects of agonists. These receptors play a critical role in regulating the autonomic and cardiovascular systems. They are located on blood vessels, where they mediate vasoconstriction, as well as on sym- pathetic nerve terminals, where they inhibit the release of norepinephrine. At lower doses, DEX primarily exerts its sympatholytic effects. When DEX binds to receptors, it ef- fectively reduces sympathetic nervous system activity, lead- ing to increased cardiac vagal activity. This dual mechanism results in a decrease in heart rate (HR) and cardiac output, contributing to the controlled hypotensive state. Indeed, the incorporation of cardiac output monitoring alongside intra- arterial mean arterial pressure (MAP) recordings would have provided a more comprehensive understanding of the factors influencing blood loss and controlled hypotension in your study. Transesophageal echocardiography is a valuable tool in this context, offering precise and real-time measurements of left ventricular end-diastolic volume and cardiac output. However, it's worth noting that the availability of these resources can be limited in certain healthcare facilities, as was the case in your institute. Despite these limitations, yourstudy still yielded valuable insights into the efficacy of DEXin achieving controlled hypotension during posterior fixationspine surgeries.

FUNDING
This research did not receive any specific grant from fundingagencies in the public, commercial, or nonprofit sectors.

CONFLICTS OF INTEREST
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTIONS
All authors equally contributed to preparing this article.

REFERENCES

[1] Malcom-Smith NA, Mcmaster MJ. The use of induced hypotension to control bleeding during posterior fusion for scoliosis. J Bone Joint Surg Br 1983;65:255-8.
[2] Tobias JD. Fenoldopam for controlled hypotension during spinal fusion surgery in children and adolescents. Paediatr Anaesth 2000;10:261-6.
[3] Degoute CS. Controlled hypotension: A guide to drug choice. Drugs 2007;67:1053-76.
[4] Rodrigo C. Induced hypotension during anesthesia with special reference to orthognathic surgery. Anesth Prog 1995;42:41-58.
[5] Yazbek-Karam VG, Aouad MM. Perioperative uses of dexmedetomidine. Middle East J Anesthesiol 2006;18:1043-58.
[6] Gertler R, Brown HC, Mitchell DH, Silvius EN. Dexmedetomidine: A novel sedative-analgesic agent. Proc (Bayl Univ Med Cent) 2001;14:13- 21.
[7] Ullrich PF Jr, Keene JS, Hogan KJ, Roecker EB. Results of hypotensive anesthesia in operative treatment of thoracolumbar fractures. J Spinal Disord 1990;3:329-33.
[8] Durmus M, But AK, Dogan Z, Yucel A, Miman MC, Ersoy MO. Effect of dexmedetomidine on bleeding during tympanoplasty or septorhinoplasty. Eur J Anaesthesiol 2007;24:447-53.
[9] Richa F, Yazigi A, El Hage C, Jebara S, Hokayem N, Antakly MC. Dexmedetomidine: An agent for controlled hypotension in maxillo- facial surgery. Eur J Anaesthesiol 2004;21:60.
[10] Naveen Eipe Manickam Ponniah. Perioperative Blood Loss Assessment- How Accurate. IJA 2006;50:35-8.
[11] Shapiro DS, Loiacono LA. Mean arterial pressure: Therapeutic goals and pharmacologic support. Crit Care Clin 2010;26:285-293.
[12] Bhana N, Goa KL, McClellan KJ. Dexmedetomidine. Drugs 2000;59:263-8.
[13] Kelm M, Schrader J. Control of coronary vascular tone by nitric oxide. Circ Res 1990;66:1561-75.
[14] Bloor BC, Ward DS, Belleville JP, Maze M. Effects of intravenous dexmedetomidine in Humans. II. Hemodynamic changes. Anesthesiology 1992;77:1134-42.
[15] Aboushanab OH, El-Shaarawy AM. A comparative study between mag- nesium sulphate and dexmedetomidine for deliberate hypotension during middle ear surgery. Egypt J Anaesth 2011;27:227-32.
[16] Ignarro LJ. After 130 years, the molecular mechanism of action of nitro- glycerin is revealed. Proc Natl Acad Sci U S A 2002;99:7816-17.
[17] Guggiari M, Dagreou F, Lienhart A, Gallais S, Mottet P, Philippon J, et al. Use of nitroglycerin to produce controlled decreases in mean arterial pressure to less than 50 mm Hg. Br J Anaesth

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(5), 887-891 | ISSN:2251-6727

1985;57:142-7.

[18] Cincikas K, Ivaskevicius J. Application of controlled arterial hypotension in endoscopic rhinosurgery. Medicina (Kaunas) 2003;39:852-9.

[19] Relton J, Hall J. Reduction of haemorrhage during spinal fusion combined with internal metallic fixation using a new scoliosis operating frame. J Bone Joint Surg Br 1967;49B:327-8.

[20] Aoki H, Inoue M, Mizobe T, Harada M, Imai H, Kobayashi A. Platelet function is inhibited by nitric oxide liberation during nitroglycerin-induced hypotension anaesthesia. Br J Anaesth 1997;97:476-81.

[21] Soliman DE, Maslow AD, Bokesch PM, Strafford M, Karlin L, Rhodes J, et al. Transoesophageal echocardiography during scoliosis repair: Com- parison with CVP monitoring. Can J Anaesth 1998;10:925-32.