Evaluation Of The Effect Of A Loading Dose Of Dexmedetomidine On Blood Pressure By Factor Analysis

T Kunisawa, D Kawata, A Kurosawa, A Sugawara, H Iwasaki

Citation

T Kunisawa, D Kawata, A Kurosawa, A Sugawara, H Iwasaki. *Evaluation Of The Effect Of A Loading Dose Of Dexmedetomidine On Blood Pressure By Factor Analysis*. The Internet Journal of Anesthesiology. 2014 Volume 33 Number 1.

Abstract

Purpose: Dexmedetomidine (DEX) loading can cause blood pressure (BP) elevation, but decrease BP too. Anesthetic performance will improve if we better understand the effects beforehand. We performed factor analysis to determine BP changes in different patients affected by DEX loading.

Methods: DEX was administered to patients for sedation in the intensive care unit (ICU), emergency room (ER), operating room (OR), or as an adjunct to anesthesia in the OR. The DEX loading dosage was 1 μg/kg for 10 min. Factor analysis was performed to investigate what factors influence the effect of DEX on systolic BP (SBP).

Results: Forty-five patients received DEX for sedation (21 in OR, 10 in ER, and 14 in ICU) and 17 patients received DEX for adjuvant anesthetics. SBP in 25, 14, and 23 patients was elevated, unchanged, and decreased, respectively. Observed factors which had a correlation with SBP change were elective administration, general condition, stress/pain, pre-SBP, and combined anesthetic use.

Conclusion: BP change with DEX loading can be predicted to some extent. SBP in stressed patients tended to decrease and in anesthetized patients tended to increase.

INTRODUCTION

Because the distribution volume of dexmedetomidine (DEX) is large, a loading dose is needed to achieve rapid onset.[1] However, a loading dose of DEX can not only cause an elevation of blood pressure (BP), but also a decrease of BP, which may lead to a critical condition.[2-4] If we can predict the changes in BP, prophylaxis and/or treatment for hypertension and hypotension because of DEX loading becomes possible. Therefore, we evaluated observed factors that affect the change in BP due to DEX loading using factor analysis, which is a form of multivariate analysis.

MATERIALS AND METHODS

Patients

The subjects were 6-months-consecutive adult patients who received DEX administrated by only one anesthesiologist. The purpose of administration of DEX is not only on-label-use-sedation in the intensive care unit (ICU) and for procedural sedation, but also off-label use, including as an adjunct of anesthetics. Off-label use of DEX was approved and monitored by the Research Ethics Committee of Asahikawa Medical University (AMU), with written informed consent obtained from each patient.

DEX administration and acquisition of vital data

For the loading dose, 1 μg/kg of DEX was administered for 10 min, followed by continuous infusion at 0.4 μg/kg/h. Non-invasive BP was measured using a BP cuff before administration of DEX and every 2 min for 16 min after the start of DEX loading administration. Hypertension was defined as a maximum systolic blood pressure (SBP) >180 mmHg or a ≥30% increase from baseline. Hypotension was defined as a minimum SBP <80 mmHg or ≥30% decrease from baseline. The patients who had hypertension within 16 min were classified into the elevated group (E group). The patients who had hypotension within 16 min were classified into the decreased group (D group). The patients who had neither hypertension nor hypotension within 16 min were classified into the unchanged group (U group). Pharmacological treatment using ephedrine, phenylephrine, and nicardipine was performed when hypertension and

hypotension occurred.

Observed data used for factor analysis and statistical analysis

The following four characteristics of patients were used for analysis: age, gender (0 for male, 1 for female), height, and weight. The following five characteristics of patients' status at DEX administration were used for analysis: emergency (0 for elective, 1 for emergency), general condition (0 for good, 1 for poor), stress and/or pain (0 for absent, 1 for present), combined anesthetic use (0 for no anesthetics received, 1 for inadequate antecedent anesthetics received, and 2 for sufficient anesthetics). The effect of DEX on SBP was also used for analysis (-1 for hypotension, 0 for unchanged BP, and 1 for hypertension). Factor analysis, which is a form of multivariate analysis, was performed to determine the observed factor/s that affect BP change due to loading administration of DEX. Principal factor analysis and promax rotation were performed for factor analysis, and the factor number was determined using eigenvalues and a scree plot.

RESULTS

Indication for administration of DEX and patients' demographic characteristics

Indication for administration of DEX is shown in Table 1. DEX was administered for sedation in 45 patients (21 in the operating room, 10 in the emergency room, and 14 in ICU). Seventeen patients received DEX as an anesthetic adjuvant during surgery. The patients' demographic characteristics and condition before administration of DEX is shown in Table 2. Administration of DEX elevated, did not change, and decreased the SBP in 25, 14, and 23 patients, respectively.

Correlation matrix

A correlation matrix is shown in Table 3. DEX administration in an emergency situation tended to decrease SBP. SBP in patients in poor condition tended to be decreased. SBP in patients who were stressed and/or felt pain tended to be decreased. DEX administration tended to decrease high SBP present before the administration of DEX. SBP in patients who received sufficient anesthetics tended to be increased.

Factor pattern matrix after oblique rotation

Factor pattern matrix after oblique rotation is shown in Table 4. Observed data that affected Factor 1 were emergency, general condition, stress and/or pain, SBP, combined anesthetic use and effects of DEX on SB. Observed data that affected Factor 2 were gender, height, and weight. Observed data that affected Factor 3 were age and emergency.

DISCUSSION

Observed data effect on SBP

DEX has two sites of action: the central nervous system and peripheral blood vessels.[5-7] BP decreases when DEX acts on the central nervous system, and increases due to a direct vasoconstrictive effect on peripheral blood vessels. A patient's condition determines which site is more affected. For example, since peripheral blood vessels in patients with hypovolemia or pain are sufficiently constricted, SBP can decrease due to DEX sedation. In contrast, because the sedative effect is masked in patients who receive sufficient anesthetics, the vasoconstrictive effect will be pronounced. In this study, SBP in patients who received DEX in an emergency situation tended to decrease. Since these patients were releasing many internal catecholamines, DEX decreased SBP. Likewise, as patients in a poor general condition also had increased catecholamine levels, BP tended to decrease. A previous study also demonstrated that excessive tension due to arrival at OR increased BP, but this was decreased by DEX administration.[8] Because patients with subarachnoid hemorrhage or aortic dissection experienced pain, DEX decreased SBP in all cases. Although an increase in BP is taboo in these patients, DEX can be useful sedative in those patients.

Common factors created by factor analysis affecting SBP

Factor 1 seemed to represent a poor condition in patients. A poor condition and pain/stress had high factor loading. In contrast, combined anesthetic use had negative factor loading. Moreover, SBP before DEX loading had high factor loading because SBP was elevated by pain and stress.

Factor 2 seemed to represent physique. Male gender, height, and weight had high factor loading. However, Factor 2 had hardly any effect on DEX and SBP. Factor 3 seemed to represent the degree of emergency. Elective surgery was undertaken in patients of advanced age. However, these factors had little influence on the effect of DEX on SBP.

Limitation and future research

The chief limitation of this study is that the study population was limited to specific patients. Further studies may be required to examine which observed factors

influence the effect of DEX on SPB. For example, since SBP in patients with stress/pain tended to be high, loading of DEX tended to decrease SBP. However, SBP would have decreased further in more severe patients, such as those with severe heart failure or massive hemorrhage. Further studies are required to predict SBP change due to DEX loading.

CONCLUSION

SBP changes by DEX are predictable to some extent. SBP in patients in a poor condition or who were stressed or in pain was decreased by DEX loading. SBP elevated by tension was decreased by DEX loading. DEX loading decreases SBP because anesthetic agents mask the sedative effect of DEX.

Table 1

Indication for administration of DEX

Sedatives	45		
In OR		21	
tumor resection (with local anesthesia)			2
repair for inguinal hernia (with spinal anesthesia)			4
open reduction and internal fixation (with spinal anesthesia or brachial plexus block			15
In ER		10	
subarachnoid hemorrhage			4
trauma			4
aortic dissection			2
In ICU		14	
after surgery			13
sepsis			3
Adjuvant anesthetics	17		
cardiac surgery			5
neurosurgery			3
abdominal surgery			4
orthopedic surgery			5

OR: operation room, ER: emergency room, ICU: intensive care unit

Table 2

Patient demographics and condition before administration of dexmedetomidine

Group (effect of DEX on SBP)	Elevation group	Unchanged group	Decrease group
Number of patients	25	14	23
Gender (M/F)	16/9	9/5	13/10
Age ± SD (years)	56 ± 11	62 ± 17	65 ± 15
Height ± SD (cm)	164 ± 9	163 ± 10	160 ± 10
Weight ± SD (kg)	63 ± 10	61 ± 9	58 ± 10
Emergency (elective/emergency)	23/2	13/1	11/12
General condition (good/poor)	25/0	12/2	4/19
Stress and/or pain (absent/present)	25/0	9/5	8/15
SBP before administration of DEX ± SD (mmHg)	108 ± 12	126 ±22	151 ±27
Combined anesthetic use (none/inadequate/sufficient)	3/0/22	10/1/3	19/4/0

SBP: systolic blood pressure, DEX: dexmedetomidine, SD: standard deviation

Table 3

Correlation matrix

Data	1	2	3	4	5	6	7	8	9	10
1. Gender	-									
2. Age	-0.045	-								
3. Height	-0.820	-0.305	-							
4. Weight	-0.629	-0.244	0.835	-						
5. Emergency	0.092	-0.184	-0.039	-0.165	-					
6. General condition	0.061	0.190	-0.090	-0.238	0.630	-				
7. Stress and/or pain	0.089	0.239	-0.154	-0.172	0.416	0.673	-			
8. SBP	-0.051	0.097	0.044	0.070	0.399	0.523	0.558	-		
9. Combined anesthetic use	-0.002	-0.194	0.082	0.086	-0.268	-0.510	-0.664	-0.659	-	
10. Effect of DEX on SBP	-0.067	-0.266	0.156	0.211	-0.449	-0.763	-0.614	-0.677	0.771	-

SBP: systolic blood pressure, DEX: dexmedetomidine.
Bold: ≥0.4, underline: ≥0.7, red: ≥0.4 (effect of DEX on SBP)

Table 4

Factor pattern matrix after oblique rotation

Data	Factor 1	Factor 2	Factor 3
1. Gender	-0.147	-0.920	0.185
2. Age	0.228	-0.092	-0.853
3. Height	0.078	0.961	0.151
4. Weight	<0.001	0.900	0.056
5. Emergency	0.577	-0.119	0.631
6. General condition	0.836	-0.066	0.147
7. Stress and/or pain	0.815	-0.036	-0.066
8. SBP	0.836	0.216	0.022
9. Combined anesthetic use	-0.842	-0.103	0.182
10. Effect of DEX on SBP	-0.901	0.019	0.082

SBP: systolic blood pressure, DEX: dexmedetomidine.

Bold: ≥0.4, underline: ≥0.7

References

[1] Dyck JB, Maze M, Haack C et al. Computer-controlled infusion of intravenous dexmedetomidine hydrochloride in adult human volunteers. Anesthesiology 1993; 78:821-8.
[2] Hayashi D, Kunisawa T, Kurosawa A et al. [Effect of the initial loading dose of dexmedetomidine on hemodynamics in pediatric patients undergoing cardiac surgery]. Masui 2010; 59:362-5.
[3] Bloor BC, Frankland M, Alper G et al. Hemodynamic and sedative effects of dexmedetomidine in dog. J Pharmacol Exp Ther 1992; 263:690-7.
[4] Ebert TJ, Hall JE, Barney JA et al. The effects of increasing plasma concentrations of dexmedetomidine in humans. Anesthesiology 2000; 93:382-94.
[5] Kamibayashi T, Maze M. Clinical uses of alpha2 - adrenergic agonists. Anesthesiology 2000; 93:1345-9.
[6] Kunisawa T, Nagata O, Nagashima M et al. Dexmedetomidine suppresses the decrease in blood pressure during anesthetic induction and blunts the cardiovascular response to tracheal intubation. J Clin Anesth 2009; 21:194-9.
[7] Kunisawa T, Ueno M, Kurosawa A et al. Dexmedetomidine can stabilize hemodynamics and spare anesthetics before cardiopulmonary bypass. J Anesth 2011.
[8] Koroglu A, Teksan H, Sagir O et al. A comparison of the sedative, hemodynamic, and respiratory effects of dexmedetomidine and propofol in children undergoing magnetic resonance imaging. Anesth Analg 2006; 103:63-7, table of contents.

Author Information

Takayuki Kunisawa, MD, PhD
Associate Professor, Surgical Operation Department, Asahikawa Medical University Hospital
Asahikawa, Hokkaido, Japan
taka.kunisawa@nifty.ne.jp

Daisuke Kawata, MD
Staff Anesthesiologist, Department of Anesthesiology and Critical Care Medicine, Asahikawa Medical University
Asahikawa, Hokkaido, Japan

Atsushi Kurosawa, MD
Staff Anesthesiologist, Department of Anesthesiology and Critical Care Medicine, Asahikawa Medical University
Asahikawa, Hokkaido, Japan

Ami Sugawara, MD
Staff Anesthesiologist, Department of Anesthesiology and Critical Care Medicine, Asahikawa Medical University
Asahikawa, Hokkaido, Japan

Hiroshi Iwasaki, MD, PhD
Professor and Chair, Department of Anesthesiology and Critical Care Medicine, Asahikawa Medical University
Asahikawa, Hokkaido, Japan