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Dexmedetomidine Versus Magnesium for Facilitating I-gel® Insertion

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Research Article

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Abstract

Proper airway management with minimal complications is the main task of the anesthesiologist. Attempts to prevent complications of endotracheal intubation led to the introduction of supraglottic devices; one of them is the i-gel®. Dexmedetomidine is an alpha-$_2$ agonist having unique properties as analgesia, hemodynamic stability, sedation and diminishing airway reflexes as well as the stress response of intubation and extubation. Magnesium has muscle relaxant properties. It also inhibits cholinergic neuromuscular transmission, stabilizes mast cells, and enhances the production of nitric oxide and prostacyclin. This study was designed to compare the effects of adding either Dexmedetomidine or magnesium before propofol anesthetic induction on the ease of i-gel® insertion.

Materials & Methods: 60 adult patients of either sex, ASA I–II, 20–50 years old received general anesthesia for elective procedures. Patients were randomly allocated into either: Dexmedetomidine (Group D) (n=30) received IV Dexmedetomidine 1 μg.kg^{-1} or Magnesium (Group M) (n=30) received IV Magnesium sulphate 50 mg.kg^{-1} before induction of anesthesia. Systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR) and Bispectral index (BIS), Ramsey Sedation Score (RSS) & Electric Cardiometry (ICON®) data were measured.

Results: HR in Group M showed significant increase at 5,10,15 minutes, immediately before and after i-gel® insertion which was followed by significant decrease compared to Group D which significantly decreased relative to the baseline at all intervals. SBP, DBP and MAP displayed significant decrease relative to baseline in both groups. BIS significantly decreased relative to baseline in each group. Group D showed significant decrease of RSS compared to baseline and also versus Group M starting at 5 minutes after infusion till the insertion. CO showed statistically significant decrease in Group D throughout the study period when compared to the preoperative level and to Group M. SV showed significant decrease when compared to baseline earlier in Group D throughout all readings and after insertion in Group M.

Conclusion: Both Dexmedetomidine and magnesium facilitated insertion however, dexmedetomidine revealed more sedative effect. As regards hemodynamics, dexmedetomidine showed more reduction in heart rate, MAP as well as CO and SV as measured by ICON®.

Keywords: Dexmedetomidine; Magnesium sulphate; I-gel®; ICON®

Abbreviations: SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; HR: Heart rate; BIS: Bispectral index; CO: Cardiac output; SV: Stroke volume; SVR: Systemic vascular resistance.

Introduction

Proper airway management with minimal complications is the main task of the anesthesiologist. Endotracheal intubation, which is considered the gold standard for airway management, can trigger sympathetic reflex response, and hemodynamic derangement [1]. Attempts to prevent these complications led to the introduction of supraglottic devices [2,3]; one of them is the i-gel® (Intersurgical Ltd., Wokingham, UK). It is a single-use device having a non-inflatable soft cuff offering a better anatomical seal over the larynx without inflation [4-6]. Propofol is suitable as an induction agent during insertion of a supraglottic device without the use of a muscle relaxant since it minimizes the reactivity of the airways [7,8]. Muscle relaxants eliminate body movements as well as cough and gag reflexes, yet they are inappropriate especially in short procedures. Although opioids can also facilitate i-gel® insertion through deepening the level of anesthesia, they can cause muscle rigidity, delayed recovery as well as postoperative apnea [9,10]. Dexmedetomidine is an alpha-$_2$ agonist [11,12] having unique properties as analgesia, hemodynamic stability and sedation [13]. It can also diminish airway reflexes as well as the stress response of intubation and extubation [14,15]. It has the advantage of lacking respiratory depression even with accidental over dosage when compared with other agents as benzodiazepines and opioids [12]. Magnesium has muscle relaxant properties as it inhibits calcium channels within the airway smooth muscles, Ca^{+2} release from the sarcoplasmic reticulum as well as calcium-mediated smooth muscle contraction [16,17]. Magnesium also inhibits cholinergic neuromuscular transmission, stabilizes mast cells, and enhances the production of nitric oxide and prostacyclin [18].

Therefore; we hypothesized that premedication with dexmedetomidine or magnesium before propofol induction of anesthesia might be attractive substitutes to both analgesic and muscle relaxant drugs for facilitating rapid and efficient insertion of the i-gel® with minimal complications.

Thus, this prospective double-blind randomized study is designed to compare the effects of adding either dexmedetomidine or magnesium before propofol anesthetic induction on the ease of i-gel® insertion. The primary outcome of this study is to assess the ease of insertion of i-gel® by comparing the use of either adjuvant with propofol. Secondary outcomes are evaluation of sedation level and hemodynamics parameters using non-invasive electric cardiometry (ICON®).

Materials and Methods

This prospective, double-blind randomized comparative study was conducted in Theodor Bilharz Research Institute after approval by the Local Research Ethics Committee and written informed consents were obtained from all patients before participation in this trial. 60 adult patients of either sex, ASA physical status I–II aged between 20–50 years receiving general anesthesia for elective procedures were included. Patients with anticipated difficult airway; Mallampati score (III or IV), mouth opening less than 2.5 cm, short neck, body mass index more than 30 $Kg.m^{-2}$ were excluded. No premeditations were given. Patients were randomized to one of two groups 30 patients each using a computer generated list: Dexmedetomidine group (D) and Magnesium group (M). At the operating theatre, 5-lead ECG, noninvasive blood pressure, SpO_2, as well as BIS electrodes (Infinity Kappa®, Dräger, Lübeck, Germany) were attached. The electric cardiometry (EC) device (ICON®, Osypka Medical, Berlin, Germany) was connected to the patient to record: cardiac output (CO), stroke volume (SV) and systemic vascular resistance (SVR).

Preoperative data were recorded; two intravenous cannulae 18 and 20 gauge were inserted, patients received 500 ml crystalloid slowly as a preload as well as $3L.min^{-1}$ oxygen via a nasal catheter. Groups D and M received either intravenous Dexmedetomidine (Precedex; Hospira, Inc., Lake Forest, IL60045 USA) 1 $\mu g.kg^{-1}$ or Magnesium sulphate (Magnesium sulfate BP, E.I.P.I.CO. Egypt) 50 $mg.kg^{-1}$ both in 100 ml of normal saline 0.9% given over 15 min before induction of anesthesia. The infusions were prepared by an anesthesiologist not involved in the study and the anesthesiologist recording the details was unaware of the infusion type. Then, hemodynamic parameters, BIS reading as well as Ramsay Sedation Score (RSS) were documented (Table-1) [19].

Anesthesia was then induced by propofol in a dose of 40 mg every 10 seconds titrated until the BIS reaches 40. Appropriate size of i-gel® was chosen either (size 4) for patients weighing 50–90 kg or (size 3) for those weighing less than 50 kg. After ventilation with 100% oxygen for three minutes, lubricated i-gel® was inserted by an expert staff member; the i-gel® insertion conditions were classified by the anesthesiologist as excellent, good or difficult according to body movement, coughing, gagging, and jaw mobility [20].

Measurements

Systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR) and bispectral index (BIS) as well as Ramsay Sedation Score (RSS) [19] were measured immediately before loading (baseline) and every 1 min for the first 15-min.Then before and immediately after i-gel® insertion and every 1 min for another 15 min. Cardiac data derived from EC were detected before and after adjuvant infusion as well as before and after i-gel® insertion.

Hemodynamic derangements as hypertension, hypotension, and bradycardia as well as tachycardia were managed accordingly.

Anxious and agitated	1
Cooperative, tranquil, oriented	2
Responds only to verbal commands	3
Asleep with brisk response to light stimulation	4
Asleep without response to light stimulation	5
Non responsive	6

Table 1: Ramsay Sedation Score (RSS) [19].

Statistical Analysis

As no previous study is available comparing the effects of dexmedetomidine versus magnesium as premedication before propofol induction of anesthesia on the ease of insertion of i-gel® to calculate sample size, we consider this research as a pilot study and 30 patients in each group would be suitable.

The data were analyzed using Microsoft Excel 2010 and statistical package for social science (SPSS version 24.0) for windows (SPSS IBM., Chicago, IL). Continuous normally distributed variables were represented as mean ± SD. with 95% confidence interval and using the frequencies and percentage for categorical variables; a P-value < 0.05 was considered statistically significant. To compare the means of normally distributed variables between groups, the Student's t test was performed, and χ^2 test or Fisher's exact test was used to determine the distribution of categorical variables between groups. Spearman's rank correlation coefficient (*r*) was done to show the correlation between different parameters in this study.

Results

Demographic data showed no statistical difference between the two groups as regards age, weight, height, BMI and gender. Insertion conditions of i-gel® in 60 patients using both magnesium and dexmedetomidine were comparable (Table 2).

		Magnesium *(n=30)*	**Dexmedetomidine *(n=30)***	**P-value**
Age (year)		35.5±8.7	39.7±5.1	0.1
Weight (kg)		77.2±8.4	80.7±4.1	0.2
Height (cm)		165.3±17.0	172.5±9.7	0.1
BMI (kg,m^{-2})		44.3±6.0	46.9±3.0	0.3
Gender (M/F)		10/20 (33.3/66.7)	13/17 (43.3/56.7)	0.4
Insertion Condition	Easy	0 (0.0)	4 (13.3)	0.1
	Good	25 (83.3)	22 (73.3)	
	Difficult	5 (16.7)	4 (13.3)	

Table 2: Demographic data and insertion condition.
Data are presented as mean±SD or number (percent). BMI: body mass index.
P-value > 0.05 is non-significant.

Regarding hemodynamic parameters, when compared to the base line, heart rate in magnesium group showed significant increase at 5 ,10,15 minutes, immediately before and after i-gel® insertion which was followed by significant decrease in contrast to dexmedetomidine which significantly decreased relative to the baseline at all the intervals. SBP, DBP and MAP displayed significant decrease relative to baseline in both groups (Table 3).

Comparing both groups heart rate, systolic blood pressure and MAP both were comparable before infusion however dexmedetomidine group showed significant decrease at various intervals before i-gel®, immediately and 15 min after insertion. Concerning DBP Magnesium group showed significant decrease at first 5 min reversed after that showing significant decrease in the dexmedetomidine group (Table 3).

Timing		Before					After			
		Baseline	5 min	10 min	15 min	Immed. Before i- gel	Immed. After i-gel	5 min	10 min	15 min
HR	M	80±18.7	81.2±15.3 aa	81.5±15.5 aa	82.0±17.6 aa	83.0±16.2 aa	83.3±13.3 aa	74.0±11.2 aa	71.2±11.9 aa	73.0±8.8 aa
	D	79.1±9.9	66±11.1 aa, ##	59.2±7.2 aa, ##	58.6±6.5 aa, ##	56.9±7.1 aa, ##	61.2±6.7 aa, ##	56.4±2.7 aa, ##	53.9±1.6 ##	53.1±3.9 a, ##
SBP	M	128.2±11.3	122.3±7.1 aa	123.2±8.9 aa	119.7±7.4 aa	117.8±6.6 a	122.5±10.3 aa	104.2±5.5 a	96.5±5.5 a	99.7±6.8 aa
	D	130.6±5.7	123.8±6.7 aa	114.3±5.0 aa, ##	105.8±4.3 aa, ##	103.0±4.0 aa, ##	102.8±5.6 aa, ##	102.9±4.3 aa, #	103.7±2.2 a, ##	104.7±0.9 aa, ##
DBP	M	82.2±5.6	68.5±4.0 aa	70.2±7.7	68.2±10.0 a	68.7±10.3 a	74.7±5.5	58.5±11.3 aa	52.5±3.8 aa	53.3±5.7 aa
	D	83.5±6.3	74.1±5.1 aa, ##	66.2±6.9 aa, #	59.3±8.2 aa, ##	59.0±7.5 aa, ##	55.1±10.9 aa, ##	51.8±5.8 aa, #	52.1±2.4 aa	49.3±1.1 aa, ##
MAP	M	94.8±8.1	87.0±6.2 aa	87.5±5.7 aa	84.0±5.8 aa	85.0±4.8 aa	89.2±5.1 aa	72.0±3.4 aa	70.3±3.0 aa	69.2±5.1 aa
	D	94.7±5.4	84.9±1.1 aa	79.0±3.3 aa, ##	75.3±4.6 aa, ##	73.3±5.0 aa, ##	72.1±4.4 aa, ##	71.6±1.3 aa	69.6±1.7 aa	66.4±2.4 aa, #

Table 3: Hemodynamic data.
Data are presented as mean ± SD. HR: heart rate, SBP: systolic blood pressure, DBP: diastolic blood pressure, MBP: mean blood pressure. Immed: immediately. M: Magnesium group, D: Dexmedetomidine group.
[a]P-value ≤ 0.05 significant
[aa]P-value ≤ 0.01 highly significant compared to baseline within each group.
[#]P-value ≤ 0.05 significant
[##]P-value ≤ 0.01 highly significant compared to M group at the same timing.

BIS showed significant decrease relative to base line in each group. Comparing both groups, dexmedetomidine group showed significant decrease versus magnesium group starting at 5 minutes before i-gel® insertion which continued up to 5 minutes after insertion then after that the readings were comparable. (Table 4).

Dexmedetomidine group showed significant decrease of RSS compared to base line and also versus magnesium group starting at 5 minutes after infusion up to i-gel® insertion which reinforcing its sedative effect. After that the readings were comparable (Table 4).

Timing		Before					After			
		Baseline	5 min	10 min	15 min	Immed. Before i-gel	Immed. After i-gel	5 min	10 min	15 min
BIS	M	98.2±0.7	95.0±0.6 aa	94.5±0.5 aa	94.5±0.5 aa	45.8±3.3 aa	41.0±1.6 aa	40.2±5.6 aa	48.3±9.2 aa	44.7±3.0 aa
	D	98.2±3.4	88.3±4.1 aa, ##	80.3±1.4 aa, ##	73.9±2.0 aa, ##	43.5±2.9 aa, #	42.9±3.4 aa, #	49.5±3.4 aa, #	48.9±1.9 aa	43.9±1.4 aa

RSS	**M**	2.0±0.0	2.0±0.0	2.0±0.0	2.3±0.5 aa	2.3±0.5 aa	5.3±1.1 aa	6.0±0.0 aa	6.0±0.0 aa	6.0±0.0 aa
	D	2.0±0.0	2.1±0.3 a, #	3.3±1.1 aa, ##	3.8±1.3 aa, ##	4.2±1.5 aa, ##	5.6±1.0 aa, ##	6.0±0.0 aa	6.0±0.0 aa	6.0±0.0 aa

Table 4: Data are presented as mean ± SD. BIS: Bispectral index, RSS: Ramsey sedation score, Immed. immediately. M: Magnesium group, D: Dexmedetomidine group.
[a]P-value ≤ 0.05 significant
[aa]P-value ≤ 0.01 highly significant compared to baseline within each group.
[#]P-value ≤ 0.05 significant
[##]P-value ≤ 0.01 highly significant compared to M group at the same timing.

CO showed statistically significant decrease in dexmedetomidine group throughout the study period when compared to preoperative level and to magnesium group despite all readings were within clinically acceptable range. SV showed significant decrease when compared to baseline earlier in dexmedetomidine group throughout all readings and after i-gel® insertion in magnesium group. Comparing both groups, dexmedetomidine group showed significant decrease at 10 minutes after infusion and 15 minutes after i-gel® insertion versus magnesium group.

SV was more or less statistically decreased also in dexmedetomidine group going in accordance with the decrease in heart rate and cardiac output while SVR showed statistically significant decrease in the Magnesium group when compared to the baseline and versus dexmedetomidine group at various intervals (Table 5).

Timing		**Before**					**After**			
		Baseline	**5 min**	**10 min**	**15 min**	**Immed. Before i- gel**	**Immed. After i-gel**	**5 min**	**10 min**	**15 min**
CO	**M**	7.1±2.3	7.2±2.0	7.0±2.0	7.3±2.3	7.3±2.0	7.4±1.6	6.3±1.6 aa	6.0±1.3 aa	6.0±1.1 aa
	D	6.8±0.9	5.8±1.1 aa, ##	5.3±0.8 aa, ##	5.3±0.7 aa, ##	5.3±0.8 aa, ##	5.4±0.7 aa, ##	5.0±0.8 aa, ##	4.9±0.8 aa, ##	2.7±2.7 aa, ##
SV	**M**	86.8±8.7	86.5±9.6	86.3±8.5	86.8±9.2	86.5±8.0	88.0±7.6	83.5±9.5 aa	83.7±5.6 aa	82.2±4.9 aa
	D	86.9±3.2	85.5±2.0 a	83.0±2.2 a, #	84.7±1.0 aa	84.3±1.6 aa	87.6±2.0	82.1±5.7 aa	82.3±4.7 aa	79.6±5.0 aa, #
SVR	**M**	1107.7±309.8	986.3±250.7 aa	1014.6±298.1 aa	947.6±269.9 aa	945.0±261.3 aa	959.3±229.4 aa	906.2±209.5 aa	914.2±213.2 aa	874.8±156.7 aa
	D	1081.6± 171.4	1137.8± 201.3 #	1133.1± 173.0	1085.1± 168.8 #	1051.0± 156.3	1017.6± 157.8	1082.9± 133.7 ##	1063.6± 125.4 ##	584.1± 489.3 aa, ##

Table 5: ICON® readings
Data are presented as mean ± SD/. CO: cardiac output, SV: stroke volume, SVR: systemic vascular resistance. Immed.: immediately. M: Magnesium group, D: Dexmedetomidine group.
[a]P-value ≤ 0.05 significant
[aa]P-value ≤ 0.01 highly significant compared to baseline within each group.
[#]P-value ≤ 0.05 significant
[##]P-value ≤ 0.01 highly significant compared to M group at the same timing.

Discussion

In this study, we investigated the effect of using a bolus dose of 1μg.Kg^{-1} dexmedetomidine versus 0.5 mgKg^{-1} magnesium over 15 minutes to facilitate insertion and their impact on hemodynamic parameters guided by electric cardiometry (EC). Magnesium and dexmedetomidine were comparable regarding insertion conditions performed by an expert anesthesia stuff member. Reda, et al. [21] compared the effects of dexmedetomidine, magnesium sulphate and fentanyl as sedatives in awake fiberoptic intubation for patients undergoing cervical spine surgeries. They found that dexmedetomidine provided optimum sedation with favorable intubation time and less attempts in comparison to both magnesium sulphate and fentanyl. This discrepancy from our results may be attributed to different sample size, device used and the dose regimen [21].

Amin and Mohamed compared the conditions for insertion using 0.5 $ug.kg^{-1}$ dexmedetomidine versus 0.2 $mg.kg^{-1}$ nalbuphine over 10 minutes followed by propofol infusion without muscle relaxant. The dexmedetomidine group revealed better insertion conditions, with more hemodynamic stability when compared to nalbuphine group. The superiority of dexmedetomidine in their results may be related to different studied drugs, the dose used, duration of infusion as well as number of patients [22].

The present study showed significant heart rate reduction in dexmedetomidine group compared to magnesium. Oommen, et al. [23] revealed the same results when comparing the effect of 1$ug.kg^{-1}$ dexmedetomidine followed by 0.4$\mu g.kg^{-1}.h^{-1}$ versus 30 $mg.kg^{-1}$ magnesium bolus followed by 10 mg/kg/h on the heart rate despite being given after induction of anesthesia and endotracheal intubation with continuous infusion and during lumbar spinal surgeries [23].

Compared to baseline, heart rate in Magnesium group showed significant increase after 15 minutes till insertion which was clinically irrelevant followed by significant decrease. In contrast, Dexmedetomidine group showed significant HR decrease relative to preoperative reading, this goes in accordance with Bayram, et al. [24] who compared magnesium sulfate versus dexmedetomidine in controlled hypotension during functional endoscopic sinus surgery. They reported earlier and greater HR reduction in dexmedetomidine group relative to magnesium group [24].

Chaithanya, et al. [25] compared the effect of magnesium sulphate with dexmedetomidine in attenuating the stress response to laryngoscopy and endotracheal intubation. They displayed that dexmedetomidine reduced the heart rate while magnesium sulphate maintained it at patient's baseline level over 10 minutes. Their study similar to ours verifies more rapid onset of dexmedetomidine given at1 $\mu g.kg^{-1}$ versus magnesium sulphate at variable dosage [25].

Blood pressure readings were significantly lowered than baseline in both groups with greater reduction in dexmedetomidine group. Similar to our results, Bayram, et al. [24], reported lower SBP, DBP and MAP in dexmedetomidine group versus magnesium group despite different regimen dose. Also, Bayram, et al., Srivatsava, et al. found that hemodynamic parameters; HR, SBP, DBP and MAP readings were lower in dexmedetomidine group compared to magnesium sulphate in spine surgery [24,26].

Comparing both groups, the reduction in DBP was greater in magnesium group at first 5min reversed after that to be lower in the dexmedetomidine group. Contrary to our results, Oommen, et al. reported a lower diastolic blood pressure in magnesium sulphate group compared to dexmedetomidine at different timings. This discrepancy may be attributed to different bolus, maintenance time and dose [23].

Compared to base line, RSS showed significant increase 5 minutes post infusion in dexmedetomidine group and 15 minutes in magnesium group up to the end of the study being higher in dexmedetomidine group till insertion. Our study also revealed that dexmedetomidine decreased BIS significantly relative to both base line reading and magnesium group. Reda, et al. displayed similar results in elective cervical spine surgeries comparing dexmedetomidine to both magnesium and fentanyl groups [21].

CO and SV showed decrease in dexmedetomidine group all through when compared to preoperative level and to magnesium group despite all readings were within clinically acceptable range. This goes in accordance with Lee, et al. [27] who investigated the effects of dexmedetomidine on cardiac function using trans-esophageal echocardiography performed just before and 20, 40 and 60 min after administration of dexmedetomidine or saline. They reported decrease in cardiac output in dexmedetomidine group relative to both baseline and saline group. In both studies, this was correlated with reduction in heart rate [27].

The current study showed significant SVR decrease in Magnesium group versus dexmedetomidine group at various intervals. Pypendop, et al. [28] studied the cardiovascular effects of intravenous administration of dexmedetomidine (25 $\mu g.kg^{-1}$) in cats. They showed that the administration of dexmedetomidine resulted in significant decreases in HR and CI, and significant increases in SVR despite being conducted on animals with a high dexmedetomidine dose. Friesen, et al. [29] studied the effect Dexmedetomidine in children with cardiac disease undergoing cardiac catheterization showed that initial loading doses were associated with significant systemic vasoconstriction and hypertension.

Conclusion

Both Dexmedetomidine and magnesium facilitated insertion however, dexmedetomidine revealed more sedative effect. As regards hemodynamics, dexmedetomidine showed more reduction in heart rate, MAP as well as CO and SV as measured by ICON®. Further studies are recommended to select an optimum dose of dexmedetomidine with minimal sedative and hemodynamic effects since the drug proved to be promising as an adjuvant to propofol for supraglottic device insertion like i-gel®.

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