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Effects of different propofol injection speeds on blood pressure, dose, and time of induction

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Aim: Blood concentration of propofol depends on many factors, such as age, gender, body weight, dose, infusion rate, and cardiac output. This study primarily investigated the effect of infusion rate on blood pressure changes. Secondarily induction time and induction dose were studied.

Materials and methods: Propofol was administered at 200 (P200), 300 (P300), or 400 mL h-1 (P400) until loss of consciousness using bispectral index (BIS) monitoring in 72 adult patients. Change in blood pressure, induction time, and dose of propofol were compared among 3 groups.

Results: The decreases in systolic and mean arterial pressure were statistically significant in the P200 group (P = 0.001, P = 0.014 respectively). Systolic blood pressure decreased significantly as the infusion rate increased. Diastolic blood pressure did not change in either group. The duration of induction was shortest with 400 mL h-1 infusion rate (177 s in P200, 182 s in P300, 134 s* in P400,*P = 0.003) and the total propofol dose was significantly higher in these patients (2.32 mg kg-1 in P200, 2.64 mg kg-1 in P300 , 2.85* mg kg-1 in P400, *P = 0.012).

Conclusion: The induction dose required for loss of consciousness increased with a faster rate of infusion while time for induction was shorter in P400 compared to P200 and P300, and the decrease in mean blood pressure was less after induction in P200. Propofol injection should be slow enough to prevent any hemodynamic deterioration in anesthesia induction.

Key words: Intravenous anesthetics; propofol, hemodynamics, induction time

Farklı propofol infüzyon hızlarının, indüksiyon dozu, süresi ve kan basıncına etkileri

Amaç: Propofolün kan konsantrasyonu, yaş, cinsiyet, vücut ağırlığı, doz, infüzyon hızı ve kalp debisi gibi pekçok faktöre bağlıdır. Bu çalışmada birincil amaç, infüzyon hızının kan basıncı değişikliklerine etkisinin incelenmesidir. İkincil olarak indüksiyon süresi ve dozu incelenmiştir.

Yöntem ve gereç: Propofol 200 (P200), 300 (P300) veya 400 (P400) mL st-1 hızlarına ayarlanmış bir perfüzör yardımı ile BIS monitorizasyonu altında, bilinç kaybı olana kadar, 72 erişkin, ASA I hastaya uygulandı. Kan basıncı, indüksiyon süresi ve propofol dozu değişimi 3 grup içinde incelendi.

Bulgular: 200 mL st-1 grubundaki sistolik ve ortalama basınç düşüşleri (P = 0,001, P = 0,014 sırasıyla) anlamlı idi. İnfüzyon hızının artması ile sistolik kan basıncındaki düşüş anlamlı bulundu. Diastolik kan basıncı her iki grupta da değişmedi. En kısa indüksiyon süresi 400 mL st-1 infüzyon hızında idi (P200'de 177 sn, P300'de 182 sn, P400'de 134 sn,*P = 0,003) ve indüksiyonda kullanılan toplam propofol miktarı da bu hastalarda anlamlı fazla idi. Vücut ağırlıklarına göre hesaplanmış indüksiyon dozları sırası ile P200'de 2,32 mg kg-1, P300'de 2,64 mg kg-1, P400'de 2,85* mg kg-1 idi, *P = 0,012.

Sonuç: Ortalama kan basıncındaki düşüş 200 mL st-1 lik grupta diğerlerine göre daha az idi. 400 mL st-1 lik grupta indüksiyon süresi daha kısa ancak total propofol miktarı daha yüksek idi. Anestezi indüksiyonunda, propofol enjeksiyonu hemodinamik bozulmaya neden olmayacak şekilde yavaş verilmelidir.

Anahtar sözcükler: İntravenöz anestezikler; propofol, hemodinami, indüksiyon süresi

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Introduction

A typical anesthetic induction dose of propofol (2 mg kg^{-1}) results in approximately 30% reduction in systolic blood pressure (1). This hypotension is mainly attributable to a decrease in sympathetic activity, direct vasodilation, and myocardial depression (2). Blood concentration of propofol depends on many factors, such as age, gender, body weight, dose, infusion rate, and cardiac output (2-4).

However, the effect of propofol injection rate on the cardiovascular system is not clear. In Gillies and Lees's study (5), in which they studied the influence of propofol injection rate on blood pressure, they found that the blood pressure decrease was more pronounced with faster injection rates. Other studies did not show differences in blood pressure for different injection rates (6,7). The mean induction time for propofol was significantly reduced with increasing speed of injection.

The effect of different infusion rates of propofol on hemodynamics and induction time has been investigated in several studies (5-8). Our primary objective in the present study was to investigate the effect of injection rate of propofol on blood pressure, and secondarily to assess the effect of dose and time of induction.

Materials and methods

After ethics committee approval and informed consent were obtained, 72 ASA I-II patients of both sexes, aged between 25 and 55 years were included in this prospective, randomized (computer generated number table), single blind study. All patients were scheduled for minor orthopedic elective surgery under general anesthesia in supine position. The exclusion criteria were emergency surgery, obesity (BMI > 35), taking any antihypertensive drug, diabetes mellitus, and any known allergy to propofol. Eighty-two patients in total were enrolled in the study but 10 patients who did not meet the inclusion criteria were excluded from the study and statistical analysis. The remaining 72 patients' data were analyzed.

They were randomly allocated into 3 groups according to different propofol injection speeds used before induction of general anesthesia: 200 mL h^{-1}, 300 mL h^{-1}, or 400 mL h^{-1}. We chose these propofol infusion rates based on previous studies (5,6).

Heart rate and electrocardiogram (ECG), pulse oxymeter, and non-invasive blood pressure were monitored in unpremedicated patients fasted for at least 8 h before the induction of anesthesia. An intravenous line with a 20 gauge cannula was inserted at the dorsum of the hand. The isotonic saline solution was started after the end of the induction with propofol. Then 2% propofol was administered to the patient with the aid of a perfusor (Alaris Medical Systems, IVAC P6000) set to deliver appropriate rate until the bispectral index (BIS) values reached 40. After that, fentanyl (1 mg kg^{-1}) and vecuronium (0.1 mg kg^{-1}) were administered and anesthesia was maintained with desflurane in 50% O_2-N_2O. All patients were intubated and ventilated in volume controlled ventilation mode.

Demographic properties of the patients and baseline non-invasive blood pressure before drug injection were recorded. Blood pressure was re-measured at the end of the infusion of propofol but before any narcotic administration. Induction interval and total amount of the propofol used were recorded by an investigator.

Statistical analysis

The results are presented as mean ± standard deviation.

The Shapiro-Wilks test was used to assess the distribution of numeric variables. When linear associations between the infusion rate and the hemodynamic parameters were observed, linear contrasts were used to analyze the statistical significance of the change in blood pressure. Otherwise, pairwise post hoc comparisons using Tukey's test was performed. The study was adequately powered to detect 9 mmHg change between the groups, at 5% type-1 and 20% type-2 error levels when 24 patients were enrolled in each group.

Results

Seventy-two patients were included into the study, data from 24 patients in each group were analyzed. There were no differences in respect to age, sex, weight, or height (Table). Systolic and mean blood pressures decreased as the infusion rate accelerated ($P = 0.001$, $P = 0.014$, ANOVA with linear contrast analysis) (Figures 1 and 2). Diastolic blood pressure was not affected by the infusion rate ($P > 0.05$).

Table. Demographic variables, induction time, and dose (mean ± standard deviation, *P < 0.05, P400 compared to P200 andP300).

	P200	P300	P400
Age (year)	38 ± 10	43 ± 11	40 ± 14
Sex (male/female)	8/16	12/12	7/17
Weight (kg)	70.7 ± 14.4	77.5 ± 14.2	75.3 ± 17.6
Height (cm)	165 ± 9	169 ± 11	168 ± 10
Induction time (seconds)	177 ± 38	182 ± 58	134 ± 38*
Propofol (2%) amount during induction (mg)	160.3 ± 42.8	205.2 ± 62.8	207.4 ± 46.8*
Calculated propofol dose during induction (mg kg^{-1})	2.32 ± 0.61	2.64 ± 0.43	2.85 ± 0.52*
Calculated rate of propofol according to body weight (mg kg h^{-1})	56.6	77.4	106.2*

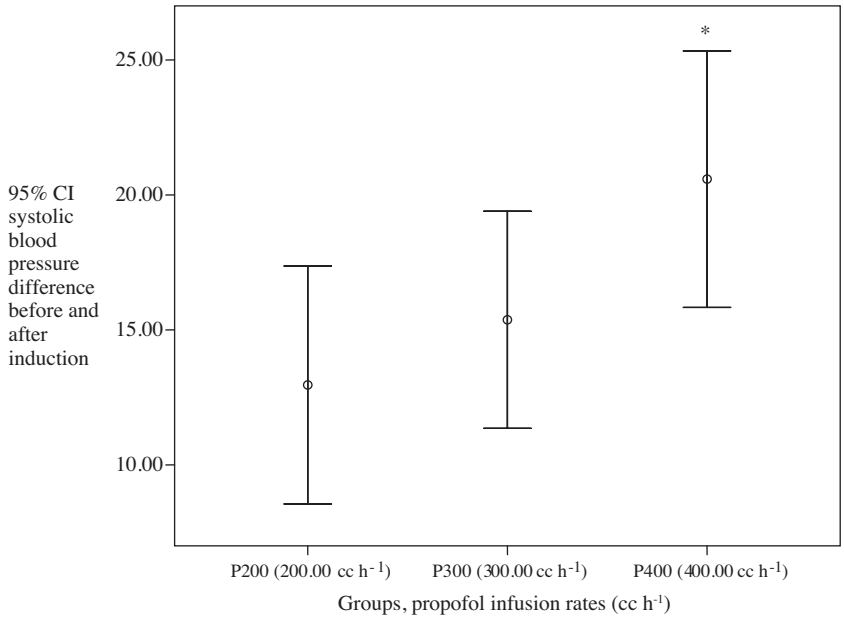

Figure 1. Mean systolic blood pressure differences before and after induction (*P < 0.05, compared to P200 and P300).

Larger propofol doses were required as the rate of infusion increased. The doses calculated according to the weight of the patients were as follows: 2.32 ± 0.61 mg kg^{-1} in P200, 2.64 ± 0.43 mg kg^{-1} in P300, and 2.85 ± 0.52 mg kg^{-1} in P400 (P = 0.012).

Induction time was shorter in P400 when compared to P200 and P300 (177 ± 38 s in P200 versus 182 ± 58 s in P300 and 134 ± 38 s in P400 (P = 0.003, Tukey's test with ANOVA). There was no difference between P200 and P300 in respect to induction time.

Discussion

In this study, different propofol injection rates (200 mL h^{-1}, 300 mL h^{-1}, or 400 mL h^{-1}) during induction were studied with respect to blood pressure change, induction dose, and time. As the propofol rate increased, systolic and mean blood pressure changes became significant. The induction dose required for loss of consciousness increased by faster infusion rates. Time for induction was shorter in P400 when compared to P200 and P300.

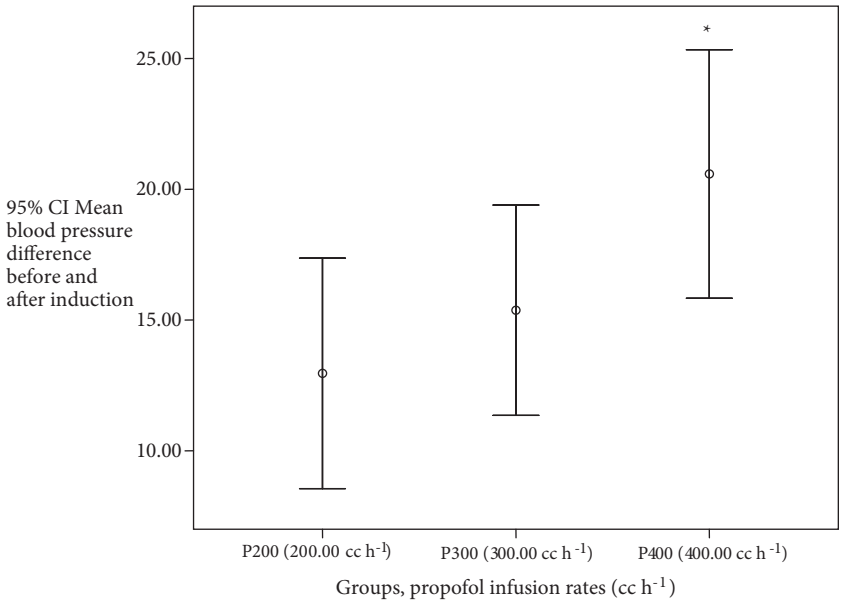

Figure 2. Mean blood pressure differences before and after induction (*P < 0.05, compared to P200 and P300).

We observed a decrease in systolic and mean blood pressures with infusion rates of 200 mL h^{-1}, 300 mL h^{-1}, and 400 mL h^{-1}. Stokes et al. (8) investigated different injection rates with 1% propofol, namely 300 mL h^{-1}, 600 mL h^{-1}, and 1200 mL h^{-1}, in younger patients aged between 18 and 55 years and did not show a significant change in blood pressure. Another study carried out in patients older than 65 years, ASA I-IV, the decrease in blood pressure was less with slower injection rates (7,9). Our study was carried out in younger patients (25-55 years) and 2% propofol was used for induction, which is more concentrated than 1% propofol. Further studies with slower injection rates should be carried out with 2% propofol.

The propofol administration rate has a critical impact on the induction dose. In our study, we found that a slower injection speed resulted in a smaller induction dose. The propofol dose was less in P200 than in the other groups. Induction doses of propofol are highly variable at administration rates slower than 20 mg kg h^{-1} (4). Stokes et al. (8) have reported that a slower rate of propofol administration for induction of anesthesia results in a smaller dose requirement and that the time necessary for induction is significantly longer at slower infusion rates. Similarly, we found that induction time in group P400 was shorter than that in P200 and P300. The relations between the rate of drug administration, induction time, and dose requirement pose interesting questions that merit further consideration because of the variety of possible relations between infusion rate, induction time, and dose (9-11). Our results also support Kazama's (4) study in which it was concluded that infusion rates greater than 80 mg kg^{-1} h^{-1} (106.2 mg kg^{-1} h^{-1} in our study) decreased the induction time and increased the dose.

In summary, we found that 2% propofol infusion of 400 mL h^{-1} (106.2 mg kg^{-1} h^{-1}, calculated according to our patients' weight) until loss of consciousness caused a marked decrease in systolic and mean blood pressures compared to slower injection rates. As the infusion rate increased, induction dose increased with shortened induction. Therefore, propofol injection should be slow enough to prevent any hemodynamic deterioration in anesthesia induction. Although this study subject is relatively old, BIS monitoring itself is a relatively new technology in anesthesia.

This study evaluated the need for and outcome of slow propofol injection, which has been in use in clinical practice for several years, by scientific and objective parameters by means of BIS monitoring.

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References

1. Sebel PS, Lowdon JD. Propofol, a new intravenous anaesthetic. Anesthesiology 1989; 71: 260-77.
2. Kazama T, Ikeda K, Morita K, Ikeda T, Kikura M, Sato S. Relation between initial blood distribution volume and propofol induction dose requirement. Anesthesiology 2001; 94: 205-10.
3. Adachi YU, Watanabe K, Higuchi H, Satoh S. The determinants of propofol induction of anaesthesia dose. Anesth Analg 2001; 92: 656-61.
4. Kazama T, Ikeda K, Morita K, Kikura M, Ikeda T, Kurika T et al. Investigation of effective anaesthesia induction doses using a wide range of infusion rates with undiluted and diluted propofol. Anesthesiology 2000; 92: 1017-28.
5. Gillies GW, Lees NW. The effects of speed of injection on induction with propofol. A comparison with etomidate. Anaesthesia 1989; 44: 386-88.
6. Rolly G, Versichelen L, Huyghe L, Mungroop H. Effects of speed of injection on induction of anaesthesia using propofol. Br J Anaesth 1985; 57: 743-6.
7. Blum J, Kochs Eberhard, Forster N, Schneider G. The influence of injection rate on the hypnotic effect of propofol during anesthesia: A randomised trial. PLoS Clin Trials 2006; 28: e17.
8. Stokes DN, Hutton P. Rate dependent induction phenomena with propofol: Implications for the relative potency of intravenous anesthetics. Anesth Analg 1991; 72: 578-83.
9. Peacock JE, Lewis RP, Reilly CS, Nimmo WS. Effect of different rates of infusion of propofol for induction of anaesthesia in elderly patients. Br J Anaesth 1990; 65: 346-52.
10. Rolly G, Versichelen L, Huyghe L, Mungroop H. Effects of speed of injection on induction of anaesthesia using propofol. Br J Anaesth 1985; 57: 743-6.
11. Cockshott ID, Douglas EJ, Prys-Roberts C, Turtle M, Coates DP. The pharmacokinetics of propofol during and after intravenous infusion in man. Eur J Anaesth 1990; 7: 265-75.