EFFECT OF DIABETES MELLITUS ON SPINAL ANESTHESIA FAILURE

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ABSTRACT

Introduction*: Spinal anesthesia (SA) is a commonly performed regional anesthesia technique in current practice. Failure of SA is observed depending different causes. We aimed to search the relationship between diabetes mellitus (DM) and SA failure. We hypothesized that DM could affect the success of SA.*

Methods*: A total of 1032 patients were included to the study. Spinal anesthesia failure was defined as absence of sensory block according to 'pin-prick test' examination despite injection of local anesthetics after free flow of cerebrospinal fluid (CSF) and Bromage scale 4 (able to move hip, knee and ankle).*

Results*: When we analysed the demographical data between successful and failed patients, no significant differences were observed (p>0.05) And also there was no difference for surgical type, puncture level, presence of DM and glucose level (p>0.05).*

Conclusion*: We concluded that DM and also demographical variables such as age, height, weight and gender were not the possible risk factors for complete failure spinal anesthesia.*

Keywords*: diabetes mellitus, spinal anesthesia, failure.*

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Introduction

Spinal anesthesia (SA) is a commonly performed regional anesthesia technique in current practice. Drops of cerebrospinal fluid during SA provide an objective criterion for application field compared to other neuraxial anesthesia procedures. Even so, failure of SA is observed depending different causes (failed lumbar puncture, dose selection, drug solution error, anatomical abnormalities, solution density, inactive local anesthestic solution and local anesthetic resistance)[(1)].

Reported rates of SA failure range from 3.1% to 17%[(2, 3)]. Failure term is defined as absence of block following the administering of subarachnoid drugs. This definition includes three components: the extent, quality, or duration of local anaesthetic action. (1) Complete SA failure is described as no block though administering local anesthetic after approval of CSF drops[(4)].

Hoppe et al.[(4)] declared diabetes mellitus (DM) as a possible cause of SA failure in a case series consisting four obstetric patients. Therefore we aimed to search the relationship between DM and

SA failure. We hypothesized that DM could affect the success of SA.

Methods

Study design

This single centre, cross-sectional trial was performed after obtaining the local ethics review board approval.

Participants

American Society of Anesthesiologist physical status I-III patients planned for lower abdominal and lower extremity surgery were scheduled for the study. Exclusion criterions were i) patients taller than 180 cm or shorter than 150 cm, ii) body mass index>30 kg/m2, iii) known an anatomical anomaly such as scolyosis or kyphosis, iv) inability to give consent, v) refusal of spinal anesthesia vi) contraindications to spinal anaesthesia (allergy to local anaesthetic or a bleeding diathesis), vii) paramedian approach and viii) emergency surgery. Patients older than 18 years old included the study. Data were collected in operating theatre.

Interventions

All participants were premedicated with 0.07 mg kg-1 intramuscular midazolam 30 minutes before surgery. Midazolam dose was reduced by 50% for geriatric patients (>65 years old). Standard monitoring (blood pressure, electrocardiography, peripheral oxygen saturation) was performed. Demographical data (age, weight, height and gender), presence of DM, preoperative level of blood glucose, level needle puncture and surgical procedures were recorded. Spinal anesthesia was performed with median approach (L3-4 or L4-5) under sitting position by anesthesiologists (expert and trainee) whose SA experiences ranged from 1 to 20 years. 25 Gauge sprotte spinal needles and 2-3 mL of 0.5% hyperbaric bupivacaine were used. No adjuvant drugs were added to local anesthetics.

End points and sample size

Primary end point of the trial was calculation the rate of failed spinal anesthesia. Secondary end point was determination the effect of DM on the failed spinal anesthesia rate. Three anesthesiologists (İ.Ö., E.O. and D.Y.) collected data. Spinal anesthesia failure was defined as absence of sensory block according to 'pin-prick test' examination despite injection of local anesthetics after free flow of CSF and Bromage scale 4 (able to move hip, knee and ankle). Sample size was calculated according to the previous trial[5] by G*Power version 3.1.3. (Heinrich Heine Universitat, Düsseldorf, Germany).

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) 16.0 package software (SPSS Inc, Chicago, Illinois, USA) was used for the statistical analysis of the data. The normality of the distribution was tested using the Kolmogorov-Smirnov Z test, and the homogeneity of the variables was evaluated using the Levene and Welch tests. The data were presented as the mean ± standard deviation, the median (interquartile range) or the percentage. Potential differences between groups were evaluated using the independent samples test, and the Mann Whitney U test was used to evaluate data. For the multivariate analysis the possible risk factors were entered into the logistic regression analysis to determine independent predictors of SA failure. P values of $\alpha<0.05$ were accepted as statistically significant.

Results

A total of 1032 patients were included to the study. Flow diagram of trial is shown in figure 1.

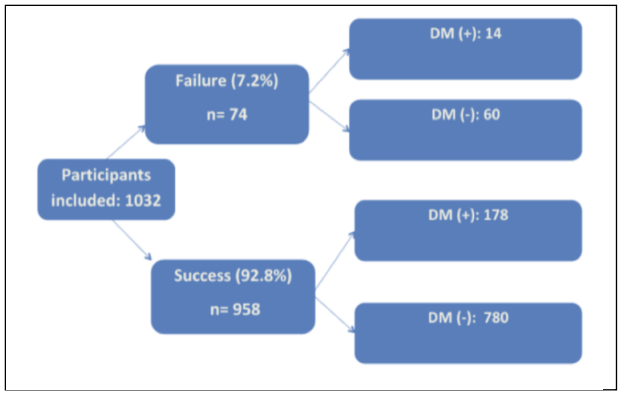

Figure 1: Flow diaphragma of trial. *DM: Diabetes Mellitus, (+): presence of Diabetes Mellitus, (-): absence of Diabetes Mellitus.*

Age of the patients was 47.95±17.5 (19-86) years, weight was 77.3±13.9 (44-116) kg, and height was 165.9±6.7 (150-179) cm. Surgical procedures were; urologic (n=168, 16.3%), abdominal/perineal (n=251, 24.3%), orthopedic (n=403, 39.1%), vascular (n=154, 14.9%) and reconstructive surgery (n=56, 5.4%). In figure 2 types of surgeries were shown. 591 participants were male (57.3%) and 441

were female (42.7%). 192 (18.6%) patients had DM and preoperative blood glucose levels determined were 106.9±21.1 mg/dL. Puncture level of spinal needle were at L4-5 (55.5%), L3-4 (39.2%) and L2-3 (5.2%). Overall rate of SA failure was 7.2% (74/1032).

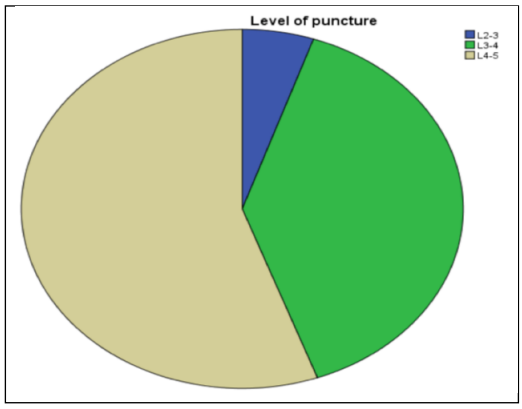

Figure 2: Level of Lumbar punctures. *L_{2-3}: insertion point of spinal needle between second and third lumbar vertebrae, L_{3-4}: insertion point of spinal needle between third and fourth lumbar vertebrae, L_{4-5}: insertion point of spinal needle between fifth and sixth lumbar vertebrae.*

When we analysed the demographical data between successful and failed patients, no significant differences were observed (p>0.05) (Table 1).

			Successful SA (n=958)	Failure SA (n=74)	p
Age (year)			48.7±8.2	46.1±7.3	0.08
Height (cm)			166.1±7.3	164.9±7.2	0.42
Weight (kg)			78.4±7.6	76.9±5.3	0.45
Gender	Male		(57.4%) 550	(55.4%) 41	0.74
	Female		(42.6%) 408	(44.6%) 33	
Diabetes mellitus			18.6% (178/780)	18.9% (14/60)	0.94
Glucose (mg dL -1)			107.1±21.1	104.2±21.3	0.27
Surgery	Orthopedic surgery		373	30	0.91
	Abdominal/Perineal		234	17	
	Urologic surgery		156	12	
	Vascular surgery		143	11	
	Reconstructive surgery		52	4	
Level of puncture		L_{2-3}	51 (5.3%)	3 (4.1%)	0.87
		L_{3-4}	375 (39.1%)	30 (40.5%)	
		L_{4-5}	532 (55.5%)	41 (55.4%)	

Table 1: Demographical and perioperative data.
SA: Spinal anesthesia

And also there was no difference for surgical type, puncture level, presence of DM and glucose level (p>0.05). We observed significant differences for age (46.08±17.08 for nondiabetics vs 58.79±15.27 for diabetics, p<0.01) and height (166.2±6.8 cm for nondiabetics and 164.7±6.1 for diabetics, p=0.04)) between diabetics and non-diabetics, but that result was not clinically significant (Table 2). Results were shown in table 2. When we applied logistic regression we could not demonstrate a relationship between failure and demographical and also procedural data (p>0.05) (Table 3).

Discussion

In previous trials, incidence of SA failure ranges from 3.1% to 17%. In our study, we observed the incidence as 7.2% (74 of 1032). The result of our analysis showed that there was no relationship between SA failure and DM. In our knowledge, this is the first trial which investigate the effect of DM on failure SA.

Usually reported rate of SA failure is approximately 3%[2, 5]. Tarkkila et al[2] found no correlation with demographical data or co-existing diseases of patients for failure.

However, Fuzier et al.[5] observed an association with a decrease failure rate in patients older than 70 years. In a retrospective study Rukewe et al.[6] showed the failure rate as 9.1% (294 of 3239). That study demonstrated that failure were related with experience of anesthesia provider, > 1 lombar puncture attempts and L4-L5 puncture level. In contrast to these studies Levy et al[3] reported SA failure rate as high as 17%. Authors attributed that high rate mainly to technical reasons.

In those studies, Fuzier et al.'s[5] study differs from the others. It was multi-center prospective trial. In our opinion, the main disadvantage of our study compared with Fuzier et al.'s[5] was the single-centered design because multi-centered design of trial has eliminated the risk of bias. Fuzier et al.[5] demonstrated relationship for failure due to number of attempts, number of adjuvants and age of patients. We could not show an effect of age and on the other hand we didn't analysed number of attempts.

In our opinion, two possible factors may be important for quality and level of SA in

		Non-Diabetic patients (n=840)	Diabetic patients (n=192)	p
Age		46.08±17.08	58.79±15.27	<0.01
Gender (M/F)		495/345	98/94	0.26
Height		166.2±6.8	164.7±6.1	0.04
Weight		77.51±14.8	76.63±8.9	0.28
Spinal anesthesia failure (%)		7.10%	7.30%	0.94
Glucose level		107.4±21.1	104.7±21.0	0.11
Types of Surgeries n (%)	**Orthopedics**	330(39.3%)	73 (38%)	0.95
	Abdominal/perineal	200 (23.8%)	51(26.6%)	
	Urologic	138 (16.4%)	30 (15.6%)	
	Vascular	130 (15.5%)	24 (12.5%)	
	Reconstructive	42 (5%)	14 (7.3%)	
Level of Puncture n (%)	**L_{2-3}**	43 (5.1%)	11 (5.7%)	0.95
	L_{3-4}	332 (39.5%)	73 (38%)	
	L_{4-5}	465 (55.4%)	108 (56.3%)	

Table 2: Comparison of diabetics and non-diabetics.
M: Male, F: Female

Risk factors	OD adjusted (95% CI)	p
Age	0.986 (0.97-1.00)	0.07
Gender	0.815 (0.49-1.33)	0.41
Height	1.082 (0.93-1.24)	0.28
Weight	0.985 (0.95-1.02)	0.42
Diabetes mellitus	0.757 (0.39-1.46)	0.4
Glucose level	0.992 (0.98-1.00)	0.16
Surgical type	0.987 (0.79-1.22)	0.9
Level of puncture	1.050 (0.70-1.57)	0.81

Table 3: Risk Factors for Spinal Anesthesia Failure.
OD (95% CI): Odds ratio 95 % coeffficient interval. Risk factors detected using logistic regression (multivariate analysis).

patients with DM. First is neuropathy and second is possible changes in composition of CSF such as density or volume secondary to hyperglicemia in blood and CSF. Kroin et al.[7] reviewed duration of block in diabetic rats at spinal anesthesia. In that experimental study, authors found duration of local anesthetic and spinal block was longer in diabetic animals than in nondiabetics. That result was correlated with a clinical study[8]. Sensory and motor block was established more rapidly in the diabetic group ($P < 0.05$), and the total duration from maximum block until regression to two dermatomes was greater ($P < 0.05$), as was the complete regression from sensory and motor block ($P < 0.05$). As a result diabetic neuropathy does not seem effective for SA failure but it can prolong the duration of block.

For composition of CSF during SA two factors are important: volume and density. Last et al.[9] demonstrated that overall regions of brain in diabetic patients had larger CSF volumes than control subjects at magnetic resonance imaging. And coexisting hypertension and DM had increased CSF volume. Döbler et al.[10] could not find a correlation between CSF glucose concentration and CSF density. And CSF density range from 1.000 to 1.003 g/cc didn't effect the blockade level in isobaric SA. When we correlated with our study's results, those possible changes in volume and density of CSF in patients with DM could not be clinically effective.

Limitations

The main limitation point of current study is lack of spinal anesthesia performance in obstetric patients who were special population for spinal anesthesia practice. Second is absence of analysis for SA experience of anesthesia providers.

Conclusion

We concluded that DM and also demographical variables such as age, height, weight

and gender were not the possible risk factors for complete failure spinal anesthesia.

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Ethical Approval
The study was carried out in accordance with the principles of the revised 2013 verison of the Declaration of Helsinki of 1975, with the approval numbered ID: NCT02294110 of Diskapi Yıldırım Beyazıt Education And Research Hospital and informed written consent from each participant between March 2013 - December 2014. The trial was registered on ClinicalTrials.gov (ID: NCT02294110).

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