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Perioperative effects of oral midazolam premedication in children undergoing skin laser treatment. A double-blinded randomized placebo-controlled trial¹

Efeitos peroperatórios da premedicação oral de midazolam em crianças submetidas a tratamento de pele por laser. Estudo duplo-cego randomizado e controlado.

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ABSTRACT

Purpose: To investigate and compare the efficacy of oral midazolam with two different dosages in orange juice on perioperative hemodynamics and behavioral changes in children who underwent skin laser treatment in an academic educational Hospital. **Methods:** Ninety children, candidates for skin laser treatment were randomly assigned to 1 of 3 groups of 30 each: the placebo group received 0.1 ml/kg orange flavored juice, group 2 and 3 receiving 0.5 and 1 mg/kg of injectable midazolam mixed with an equal volume of orange juice, respectively. The main outcome measures included the mask acceptance, patients' behavioral scales and postoperative events. **Results:** There were no significant differences in heart rate, respiratory rate, and systolic blood pressure among the three groups. However, arterial oxygen saturation was significantly reduced in those given 1 mg.kg⁻¹ midazolam. The median scores of anxiety, separation from parent, preparing an intravenous line, acceptance of the oxygen mask, good sedation, crying reduction and consciousness level were better in midazolam group. Postoperative agitation and re-crying were also more frequent in placebo receivers. Those given 1 mg.kg⁻¹ midazolam were significantly more optimal for sedation, crying, consciousness, preparing an intravenous line, and postoperative re-crying compared with 0.5 mg.kg⁻¹ midazolam receivers. **Conclusion:** As a preanaesthetic medication, the 1 mg.kg⁻¹ dose of orally given midazolam especially in a volume of orange juice and can optimize the children's behavior during skin laser treatment with no serious adverse effects, enhancing their parents' satisfactions about the sedative protocol.

Key words: Midazolam. Premedication. Anesthesia. Laser Therapy. Skin.

RESUMO

Objetivo: Investigar e comparar a eficácia do uso oral de midazolam com duas diferentes doses de suco de laranja na hemodinâmica peroperatória e mudanças de desempenho em crianças submetidas tratamento de pele por laser em Hospital educacional e acadêmico. **Métodos:** Noventa crianças candidatas a tratamento de pele por laser foram distribuídas aleatoriamente em três grupos de 30 cada: o grupo placebo recebeu 0.1mg/kg de suco de laranja, grupos dois e três receberam 0.5 e 1mg/kg de midazolam injetável misturado em igual volume de suco de laranja respectivamente. Os principais registros incluíam a aceitação da máscara, escalas de comportamento e eventos pós-operatórios. **Resultados:** Não houve diferenças significantes cardíacas, respiratórias e pressão sanguínea sistólica nos três grupos. Contudo, o nível de saturação de oxigênio foi reduzido significativamente nos que receberam 1mg.kg⁻¹ de midazolam.

Os níveis médios de ansiedade, separação dos pais, preparo intravenoso, aceitação da máscara de oxigênio, boa sedação, redução do choro e nível de consciência, foram melhores no grupo midazolam. Agitação pós-operatória e retorno do choro foi mais frequente nos que receberam placebo. Observou-se que o grupo que recebeu 1mg.kg⁻¹ foi melhor comparado ao que recebeu 0.5mg.kg⁻¹. **Conclusão:** Como medicação pré-anestésica na dose de 1mg.kg⁻¹ de midazolam, fornecida em igual volume de suco de laranja, é satisfatória no comportamento de crianças durante tratamento de pele por laser, proporcionando satisfação dos pais.

Descritores: Midazolam. Pré-Medicação. Anestesia. Terapia a Laser. Pele.

Introduction

Preoperative adequate preparation of children can lead to improved surgical experiences and faster recovery after surgery. This protocol helps the children feel less anxious about the anesthesia induction and surgery and can reduce the post-surgical complications and maladaptive behavioral changes^{1,2}. Thus, in order to minimize the crying and struggling prior to surgery and during induction of anesthesia, pre-anesthetic medication is recommended for children who are candidates for surgery³.

Despite a number of pre-medications being advocated to facilitate the separation of children from their parents and to reduce the anxiety associated with the operation, no choice pre-medication has universal acceptance. In spite of the rare side effects such as respiratory depression, midazolam has become a commonly used agent for conscious sedation of children before diagnostic or therapeutic procedures or before induction of anesthesia. Until recently, only the intravenous form of the drug was available. However, it has been clear that the oral midazolam is very bitter even with added flavoring. The liquid form of drug has been shown to be an extremely safe premedicant for children with a dose range of 0.25 to 1.0 mg/kg^{4,5}.

Some studies showed that the premedication with midazolam could reduce pre-operative distress and facilitate patient management⁶⁻⁸. However, the effects of oral midazolam especially mixed with orange juice on hemodynamic status, anxiety level and behavioral changes of children after operation has not been clearly determined. We tried to investigate and compare the efficacy of oral midazolam with the different dosages and mixed with orange juice on both postoperative behavioral changes and hemodynamics in children who underwent skin laser treatment.

Methods

In a randomized, prospective double-blind placebo controlled study, 90 children between the ages of two and eight years with ASA I-II status presenting for under-anesthesia skin laser therapy were included the study. The study protocol was explained to the parents and informed consent was obtained from them before beginning the study. The study was approved by the Ethics Committee in Tehran University of medical sciences. Additionally, it conforms to the principles in the Helsinki Declaration.

The subjects with the hypersensitivity to benzodiazepines and who were treated with drugs that affect the nervous system were excluded. Study patients were randomly assigned to one of the three groups: 1) the placebo group (as control group) received 0.1 ml/kg orange flavored juice; 2 and 3) the midazolam groups, received injectable midazolam 0.5 mg/kg and 1 mg/kg in an equal volume of the orange juice, respectively. The placebo group was received the similar preparation. The research physician prepared the placebo or midazolam glasses labeled multi-care A, B or C to prescribe for the children. The children, their parents and the research anesthetist who assessed hemodynamics and behavioral changes preoperatively, were blinded to drug and placebo assignment. Random allocation was performed by using a randomized six-block order of A, B and C. All children were separated from their parents entered the operating room 30 min after the oral administration of placebo or midazolam containing orange juice.

Hemodynamic parameters (heart rate, respiratory rate, systolic blood pressure, and arterial oxygen saturation) were recorded immediately before the entry to operation room and also 5, 20, 25, 30, and 40 minutes after the beginning of laser therapy. A blinded observer (same observer for all patients) scored the patient's behavior during the perioperative period by using the scales assessing the level of anxiety, separation from parent, preparing an intravenous line, acceptance of the drug administration, acceptance of the oxygen mask, sedation, crying, and consciousness. A higher score on these scales indicates a better situation (Table 1).

TABLE 1 - Behavior scales.

<i>Score</i>	<i>Categories</i>
Apprehension Score (anxiety):	
1	Excessive/vocal display of fear/apprehension
2	Moderate/expresses fear/apprehension
3	Little/minimal expression of fear
4	None
Separation Score:	
1	Poor: need for restraint
2	Fair: separated without crying
3	Good: separated without crying
4	Excellent: happily separated
Preparing an intravenous line	
1	Impossibility of IV preparing
2	Possibility of IV preparing in spite of child crying
3	Possibility of IV preparing with mild resistance
4	Possibility of IV preparing without any resistance
Acceptance Score (palatability):	
1	Refuses to open mouth after tasting
2	Held down/forced to accept
3	Dislikes, but accepts
4	Readily accepts
Sedation Score:	
1	Awake/active
2	Awake/calm & quiet
3	Drowsy/readily responds
4	Asleep/not readily arousable
Crying severity:	
1	Hysterical crying
2	Severe and continuous crying
3	Mild and alternative crying
4	Without crying
Postoperative consciousness:	
1	Asleep
2	Confused
3	Awake/readily responds
4	Complete awake

Furthermore, postoperative events were recorded for each patient. They were a need to airway, nausea and vomiting, re-crying, abnormal movement, and restless. At the time of discharge from the recovery, the parents were asked to rate their satisfaction with the pre-medication on a visual analogue scale from 0 to 10 (0= extremely dissatisfied; 10= extremely satisfied).

Results were reported as mean±S.D. for the quantitative variables and percentages for the categorical variables. Non-parametric and ordinal variables were presented by median (1st, 3rd quartiles). For the difference of distribution of the scales, the groups were compared using the Kruskal- Wallis' test and differences between two treatments groups were analysed with Mann-Whitney's U-test. P values of 0.05 or less were considered statistically significant. For multiple comparisons, P values of 0.01 or less were considered statistically significant after the Bonferroni's correction. All the statistical analyses were performed using Statistical Package for Social Sciences version 16 (SPSS Inc., Chicago, IL, USA).

Results

The patients in the three treatment groups were not significantly different with regard to age and sex, but they had a different distribution of weight. There were no significant differences in heart rate, respiratory rate, and systolic blood pressure at any time before and during the operation (0, 5, 20, 25, 30, and 40 min). However, arterial oxygen saturation was significantly lower in those premedicated with 1 mg.kg⁻¹ oral midazolam (Table 2).

TABLE 2 - Demographic and hemodynamic data of children allocated to receive midazolam or placebo.

	<i>Placebo</i>	<i>Midazolam(0.5mg/kg)</i>	<i>Midazolam(1mg/kg)</i>	<i>P value</i>
Male gender	50.0	56.7	46.7	0.733
Age (year)	4.7±1.7	5.1±1.4	4.4±1.5	0.246
Weight (kg)	22.3±3.4	19.1±3.5	21.0±2.9	0.002
Heart rate (beat per min)				
0 min	103.5 (95.0, 116.5)	103.0 (96.0, 114.2)	101.5 (93.0, 119.5)	0.999
5 min	114.5 (106.0, 127.5)	114.0 (107.0, 125.2)	112.5 (104.0, 130.0)	0.996
20 min	119.5 (111.0, 132.5)	119.0 (112.0, 128.2)	117.5 (109.0, 134.2)	0.964
25 min	124.5 (116.0, 137.5)	123.5 (117.0, 131.2)	122.5 (114.0, 135.0)	0.826
30 min	122.5 (114.0, 135.5)	121.5 (115.0, 131.2)	120.5 (112.0, 134.7)	0.906
40 min	130.5 (122.0, 143.5)	128.5 (122.7, 136.0)	127.0 (120.0, 136.2)	0.434
Respiratory rate (per min)				
0 min	23.0 (20.0, 25.0)	23.0 (20.0, 25.0)	22.5 (19.7, 23.0)	0.767
5 min	24.0 (22.0, 25.2)	24.0 (22.0, 26.0)	24.0 (21.7, 25.0)	0.527
20 min	24.0 (22.0, 25.2)	24.0 (22.0, 26.0)	24.0 (22.0, 25.0)	0.901
25 min	25.0 (23.0, 25.0)	25.0 (23.0, 25.0)	24.0 (23.0, 25.0)	0.724
30 min	25.0 (24.0, 25.2)	25.0 (24.0, 26.0)	25.0 (24.0, 25.0)	0.830
40 min	24.0 (21.0, 25.0)	22.0 (20.0, 24.2)	22.5 (21.0, 25.0)	0.466
Systolic blood pressure (mmHg)				
0 min	96.0 (83.7, 99.0)	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	0.019
5 min	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	0.986
20 min	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	0.986
25 min	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	0.986
30 min	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	0.986
40 min	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	98.0 (97.0, 99.0)	0.986
Arterial O ₂ saturation (%)				
0 min	99.0 (97.7, 99.0)	99.0 (98.0, 99.0)	97.0 (97.0, 98.0)	<0.001
5 min	98.0 (97.0, 98.2)	98.0 (97.0, 98.2)	97.0 (97.0, 98.0)	0.189
20 min	98.0 (97.0, 98.2)	98.0 (98.0, 98.2)	97.0 (96.7, 98.0)	0.012
25 min	98.0 (97.7, 98.0)	98.0 (98.0, 98.0)	97.0 (96.7, 98.0)	0.031
30 min	98.0 (98.0, 99.0)	98.0 (98.0, 99.0)	97.0 (96.7, 98.0)	0.001
40 min	99.0 (98.0, 99.0)	99.0 (98.0, 99.0)	97.0 (96.7, 99.0)	0.002

The willing acceptance of the drug administration was similar between the three groups. The median scores of anxiety, separation from parent, preparing an intravenous line, acceptance of the oxygen mask, good sedation, crying reduction, consciousness, postoperative agitation and re-crying level were better in midazolam groups compared with placebo group (P<0.001). The

children premedicated with 1 mg.kg⁻¹ midazolam were sedated better than those with 0.5 mg.kg⁻¹ midazolam (P<0.01). Also, the 1 mg.kg⁻¹ midazolam group had more optimal level for crying, consciousness, preparing an intravenous line compared with other premedicated group (P<0.001) (Table 3).

premedicated group (P<0.001) (Table 3).

TABLE 3 - Data of behavioral scores of children allocated to receive with midazolam or placebo.

	<i>Placebo</i>	<i>Midazolam(0.5mg/kg)</i>	<i>Midazolam(1mg/kg)</i>
Anxiety level	2.0 (1.0, 2.2)	2.5 (2.0, 3.0)	3.0 (2.0, 4.0) ^I
Separation from parent	1.0 (1.0, 1.0)	3.0 (2.0, 3.0)	3.0 (2.0, 3.0) ^I
Preparing an intravenous line	1.0 (1.0, 1.0)	1.5 (1.0, 2.0)	3.0 (2.0, 3.0) ^{I,II}
Acceptance of the drug administration	2.0 (1.0, 3.2)	3.0 (2.0, 4.0)	2.0 (1.0, 3.0)
Acceptance of the oxygen mask	1.0 (1.0, 3.0)	3.0 (2.0, 3.0)	3.0 (2.0, 3.0) ^I
Sedation score	1.0 (1.0, 2.0)	2.0 (1.7, 3.0)	3.0 (2.0, 3.0) ^{I,II}
Crying severity	1.0 (1.0, 1.0)	2.0 (2.0, 3.0)	3.0 (2.0, 3.0) ^{I,II}
Consciousness	1.0 (1.0, 1.0)	1.0 (1.0, 2.0)	3.0 (2.0, 3.0) ^{I,II}

^I Kruskal-Wallis statistically significant between three group, P<0.001

^{II} Mann-Whitney U statistically significant between the midazolam groups, P<0.01

Adverse events after the operation in the three groups are shown in Table 4.

TABLE 4 - Adverse events after the operation in children randomly allocated to receive premedication with midazolam or placebo.

	<i>Placebo</i>	<i>Midazolam (0.5 mg/kg)</i>	<i>Midazolam (1 mg/kg)</i>
Need to airway	6.7	10.0	10.0
Nausea and vomiting	3.3	10.0	13.3
Re-crying	86.7	66.7	26.7 ^{I,II}
Abnormal movement	10.0	13.3	6.7
Restless (agitation)	76.7	36.7	20.0 ^I

^I Chi-square statistically significant between three group, P<0.001

^{II} Chi-square statistically significant between the midazolam groups, P<0.01

Postoperative assessment showed that an increased incidence of agitation and re-crying in placebo group compared with midazolam premedicated groups (P<0.001). In 1 mg.kg⁻¹ midazolam group the incidence of postoperative re-crying was comparable with 0.5 mg.kg⁻¹ midazolam receivers (P=0.002).

Discussion

Several medications are used to relax and calm patients specially children before certain procedures or before anesthesia for surgery that can help decrease memory of the events. However, clinical studies have confirmed some serious complications during the post- anesthetic period and child's discharge time in the use of these medications. Thus, the selection of the most effective preoperative sedation can accompanied with a trend towards better recovery from anesthesia and a higher degree of parental

satisfaction.

In the present study, we investigated the effects of the administration of orange juice with and without midazolam on children behavioral changes, their parents' satisfaction and the changes of hemodynamics after juice drinking. We firstly found that the increase of midazolam dosages led to the child's better behaviors and parent's satisfaction. Several studies revealed similar results, however in their studies, different dosages of oral midazolam were applied. Cote *et al.*⁹ found that the oral midazolam juice was effective for producing sedation and anxiolysis at a dose of 0.25 mg.kg⁻¹ and this dosage was led to the minimal effects on respiration and oxygen saturation. In a study by Cox *et al.*¹⁰, oral midazolam premedication in children was found to reduce the anxiety associated with separation from parents with midazolam 0.5 mg.kg⁻¹ administered 20 to 30 min preoperatively. Also, in another study by Kuganeswaran *et al.*¹¹, medicated patients reported less pain and anxiety and physicians observed less pain and anxiety compared with placebo during the procedure. Furthermore, in a study by Liacouras *et al.*¹², a significant difference was noted in the group that was administered oral midazolam for the level of sedation for intravenous placement, pre-procedural sedation, ease of intravenous insertion, ease of separation from parents, and ease of the nursing personnel's ability to monitor the patient during the procedure. These results have been also shown in McErlean *et al.*¹³, McGraw *et al.*¹⁴, Pandit *et al.*¹⁵ and Cray *et al.*¹⁶ and studies. Similar to our study, the positive relationship between the dosage of administered midazolam and reduction of abnormal behavioral changes was noted in some studies. In a study by Marshall *et al.*¹⁷, a significant linear relationship between plasma drug concentration and maximal sedation score, but not anxiety score, was observed and concluded that the sedative effects were related to plasma concentrations of midazolam and the primary metabolite, alpha-hydroxymidazolam. They confirmed that oral midazolam with the dose of 1.0 mg.kg⁻¹, administered within 30 min of the expected procedure or anesthetic induction should provide safe and effective sedation for a majority of children. In Masue *et al.*¹⁸ study, infants and children premedicated with oral midazolam 1.5mg.kg⁻¹ were better sedated than those with a standard dose of midazolam. Also, in their study, most of infants and children given 1.5 mg.kg⁻¹ of midazolam achieved satisfactory sedation in 30 min, in comparison with those given 1.0 or 0.5 mg.kg⁻¹. Besides, in some other studies, different effect of oral midazolam in sedation of children who were candidates for surgery was not proven. In a study by Fine *et al.*¹⁹, no differences in resistance, success of delivery, problems with separation and mask acceptance were found. Also, Kain *et al.*²⁰ indicated that although midazolam was an effective anxiolytic for

most children, 14.1% of children still exhibit extreme distress. In addition, in Kapur *et al.*²¹ study, there was no significant difference in the acceptability of the test solutions in the children who received 0.5 mg.kg⁻¹ midazolam mixed in strawberry juice via the oral-transmucosal route and those in control group were given the same juice diluted with normal saline. It seems that the bioavailability of midazolam in the commercial preparation was surprisingly appropriate and the results were consistently acceptable. However this favorable result can be dependant to the different dosages of drug so that the recommended dose for children is a single dose of 0.25 to 0.5 mg.kg⁻¹ to a maximum dose of 20 mg. Also, good outcome of oral midazolam administration in children can be related to the children age, obesity, level of basal anxiety, and medical need²². Thus, more studies with greater sample sizes are needed to determine the best dosages of midazolam to treat the children with variant demographic characteristics.

In our study, except for the reduction of O₂ saturation in patients received higher dosage of midazolam, other hemodynamics were not different between the three groups. Similarly, in study by Fine *et al.*¹⁹ arterial oxygen saturation and heart rate were not significant changed after the administration of 0.5 mg.kg⁻¹ oral midazolam. In another study by Masue *et al.*¹⁸ Midazolam 1.5 mg.kg⁻¹ did not cause any statistically significant decrease in blood pressure, arterial oxygen saturation and heart rate. However, in Wan *et al.*²³ study, heart rate and systolic blood pressure in intervention group who received 0.5 mg.kg⁻¹ of midazolam were much lower than that in control group. These results can indicated that the changes of vital signs are not only dependant to the dosage of oral midazolam and other variables such as the type of operation and other patients variables can predict these changes that should be considered in further investigations. Midazolam has a bitter taste that is difficult to disguise even when given in a mixture with grape juice²⁴. Whereas, we observed that acceptance rate to swallow was similar in placebo or midazolam group. In other word, children judged the taste of oral midazolam mixed with orange juice not to be different from orange juice alone.

Conclusions

In conclusion, our data suggest that in spite of some complications of midazolam premedication such as reduction of arterial O₂ saturation, the administration of 1 mg.kg⁻¹ dosage oral midazolam especially in volume of the orange juice can significantly reduce children anxiety and agitation for operation. As midazolam premedication optimized effectively the children's behavior, it will enhance their parents' satisfactions about this

sedative protocol. After midazolam medication, the more oxygen supplement may be applied during operation to resolve the blood oxygen saturation.

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