Original Research

The Effect Of Liberal Hydration Dextrose Saline On Postoperative Nausea And Vomiting (PONV) Following Tonsillectomy In Children 2-12 Years Old

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Abstract:

Background: PONV is one of the most unpleasant complications following surgery. Fluid therapy may be an effective strategy to reduce PONV in children. The aim of this study was to evaluate the effect of 5% dextrose-0.9% saline (DS) solution on nausea and vomiting after tonsillectomy in children aged 2-12 years old.

Method: The present study is a randomized double-blind clinical trial that was performed on children aged 2 to 12 years. Participants were randomly assigned to the three groups receiving 30ml kg-1 h-1 DS solution, 30ml kg-1 h-1 Ringer's lactate (RL), and 30ml kg-1 h-1 normal saline 0.9% (NS). After transferring the child to the operating room bed, fluid therapy was started. At the end of surgery blood sugar was checked with a glucometer. Also, the number and frequency of each episode of nausea and vomiting were observed and recorded after surgery.

Results: 60 children participated. Based on ANOVA results, a statistically significant difference was observed in the blood sugar of the three groups (p-value <0.00). Tukey's post-hoc test showed that this difference between the DS group and NS and RL groups was significant (p-value <0.00), No significant difference was observed between the effects of three types of crystalloid solution on PONV.

Conclusion: The use of three types of crystalloid solutions could reduce the overall PONV in all three groups. However, no significant difference was observed between the DS solution and other crystalloid solutions, and it caused a significant increase in blood sugar compared with the other two groups.

Keywords: PONV, Fluid Therapy, dextrose, Tonsillectomy.

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Introduction

Tonsillectomy with or without adenoidectomy is one of the most common surgeries in children all around the world (1). This surgery is associated with postoperative complications, such as nausea, vomiting, pain, and difficulty in swallowing. In addition to worsening the disability of patients (2), Postoperative nausea and vomiting (PONV) occurs in 20% -30% of patients after surgery that can increase up to 80% in high-risk patients (3) Regardless of the type of surgery and anesthesia, the rate of PONV in tonsillectomy is high. Passive ingestion of blood during surgery or swallowing of blood after surgery partly explains this higher incidence of PONV after tonsillectomy (4). Nausea and vomiting, especially in children, are associated with risks, such as pulmonary aspiration, electrolyte disturbances, dehydration, and delayed recovery time (2). Nausea is expressed by the patient himself as a state of stomach cramping and a tendency to vomit. Vomiting is the removal of the stomach contents from the mouth that is seen or expressed by the patient or is observed by the nurse within 24 hours after the operation (5). The results of studies show that when no prophylactic antiemetic drug is used, the prevalence of POV is more than 70%; thus, the use of prophylactic drugs is recommended (1). The routine use of antiemetic drugs is still controversial because its effectiveness in low-risk patients is limited. In these circumstances, pharmacologic prophylaxis increases the risk of drug side effects for patients (6). Although many antiemetic drugs are available as prophylaxis, measurable benefits are only seen in a fraction of patients. Studies have shown that preoperative intravenous fluid therapy reduces PONV, possibly via decreasing hypovolemia. High-volume fluid therapy significantly diminishes postoperative nausea, and in the absence of prophylactic treatment, the use of rescue anti-emetic drugs is cost-effective. Any fluid used during the operation should provide enough glucose to suppress gluconeogenesis and reduce fat mobilization. It should also maintain plasma osmolality, electrolyte balance, and hemodynamic stability. The most important concerns about infant fluid management are hypoglycemia, hyperglycemia, hyponatremia, and volume overload (7, 8).

Adding dextrose to fluid therapy reduces free fatty acid. In addition, dextrose diminishes the loss of nitrogen, protein, promotes glycogen storage, and prevents ketosis. Saline dextrose 5% (D/S) solution is chemically equivalent to 5% glucose and like normal saline, contains 0.9% sodium chloride. This solution is used to provide energy, water, and electrolytes to patients in parenteral nutrition and patients who have had nothing by mouth (NPO patients) (9, 10).

The present study was performed using a liberal fluid therapy approach. Aim of this study was to evaluate the effect of saline dextrose on nausea and vomiting compared with Ringer's lactate and normal saline after tonsillectomy in children aged 2-12 years old. 2.

Methods

The present study is a randomized double-blind clinical trial that was performed on children aged 2 to 12 years old in 2019-2020. After obtaining the approval of the ethics committee of University of Medical Sciences, children who were candidates for elective tonsillectomy were evaluated in order to assess the inclusion criteria for participation in the study. The day before surgery, all children were admitted to the surgery ward, and a preoperative visit was performed by an anesthesiologist. Informed written parental consent was obtained.

2.1.1. Inclusion criteria:

Age 2 to 12 years, ASA class I, informed consent from parents.

2.1.2. Exclusion criteria:

Any history or occurrence of an allergic reaction due to the use of drugs during the intervention, history of motion sickness, history of PONV in previous surgeries, disordered sleep or obstructive sleep apnea, receiving any anti-nausea medication in the last 24 hours.

Upon entering the operating room, using permuted block randomization, eligible patients were

randomly assigned to three groups receiving 30 ml/kg/h of 5% dextrose - 0.9 % saline (DS) solution, 30 ml/kg/h of Ringer's lactate (RL), and 30 ml/kg/h of normal saline (NS). According to the sample size of 20 cases in all three groups (Figure 1).

After transferring the child to the operating room, depending on his group, fluid therapy was started for the patient. Since the participants in the study were children 2 to 12 years old, all solutions were protected by a cover to blind the anesthesiologist. Consequently, after the surgery was done and the child left the operating room and entered the recovery room, the infusion of crystalloid solutions were stopped; also, the recovery nurse in the recovery room was not aware of the study groups.

From the time of transferring to the bed and throughout the surgery, patients were monitored under the supervision of an anesthesiologist according to patient monitoring instructions. All anesthesia procedures were performed by a single anesthesiologist under the same conditions and medication regimen for the participants. Induction of anesthesia was performed using 3µg kg^{-1} fentanyl, 2 mg kg^{-1} propofol, and 0.02 mg kg^{-1} Cisatracurium. Then, using a spiral endotracheal tube of appropriate size, an airway was established, and a pharyngeal packing was placed for patients. Anesthesia was continued with isoflurane (MAC=1), 50% N2O, and 50% O2. After intubation, the acetaminophen was infused for all patients at a dose of 15 mg kg^{-1}.

All patients underwent surgery by the same surgeon using the same manner. After surgery and anesthesia, the effects of Cisatracurium were reversed by 0.02 mg kg^{-1} atropine and 0.05 mg kg^{-1} neostigmine. After the surgery was done and 5 minutes after stopping the crystalloid solution infusion in each group, the patient's blood sugar was checked with a glucometer (Accu-Chek) and then recorded. Subsequently, after the return of spontaneous respiration and maintenance of SpO_2 at an acceptable level and the removal of the endotracheal tube, patients were transferred to the recovery room and remained there until the criteria for recovery were obtained. During the recovery period, patients were under respiratory-cardiovascular monitoring and the direct supervision of an anesthesiologist and a nurse responsible for recovery.

The use of any equipment was difficult in this age group after anesthesia and up to 24 hours after surgery, All episodes of nausea, retching, and emesis were recorded observationally(11). While the child was in the operating room, the recovery nurse recorded the checklist (Gathered data in the checklist included age, gender, weight, duration of the surgery, duration of stay in the recovery room, nausea and vomiting incidence during the stay in the recovery room, and after transferring him to the ward, this checklist was recorded by the relevant nurse. It was decided to use 0.15 mg kg-1 ondansetron at a maximum dose of 4 mg, as an intravenous infusion, for a maximum of 15 minutes after observing any episode of nausea and vomiting or both, and in case of recurrence of nausea or vomiting, 0.1 mg kg-1 dexamethasone (intravenously) at a maximum dose of 4 mg was considered.

Oral intake was started with limited water after the children were fully awake, and after tolerating it, the fluid diet was continued. All patients received oral nutrition in the first six hours after surgery. Also, after discharge from the hospital, all families were instructed to contact the surgeon and anesthesiologist if they observed any problems with breathing, consciousness, and other problems to get the necessary guidance. Since there were no available and accurate records of variance values of nausea and vomiting in children due to the use of three DS, LR, and NS solutions, the present study as a pilot study was performed on 60 participants (20 cases in each study group).

Results

Participants in the study were 60 children aged 2 to 12 years, of whom 32 patients (53.3%) were female. The Chi-square test showed that the three groups had no statistically significant differences regarding gender (Table 1).

One way ANOVA test showed no significant difference between the mean age, weight, duration of anesthesia and recovery time of the three groups (**Error! Reference source not found.**).

The mean and standard deviation of patients' blood sugar at the end of the surgery was 168.30 ± 66.80. Upon entering the recovery room, 6 patients (27.7%) had blood sugar above 300 mg/dl in the DS group, and 8 patients (36.36%) had blood glucose above 200 mg/dl.

The ANOVA test showed a statistically significant difference between the mean blood sugar of the three groups (p-value <0.00). The Scheffe post hoc test showed that this difference between the DS group and NS and RL groups was significant (p-value <0.00); no significant difference was observed between NS and RL groups (Table 3).

3.2.1. Evaluation of episodes of nausea, retching, and emesis complications at the end of surgery

Generally, in the first 24 hours after the intervention, nausea and vomiting were observed and recorded only twice in all patients. The first time was after the surgery, while the patients were in the recovery room. These observations showed that in the NS group, one person suffered from nausea and retching, and one person also experienced nausea, retching, and emesis, and in the RL group, two cases experienced nausea, retching, and emesis. Also, in the DS group, one person experienced nausea, retching, and emesis. 0.15 mg kg^{-1} of ondansetron used for all patients who had these complications.

The second time when nausea and vomiting were observed and recorded in patients was during their stay in the ward. One person in each of the NS and RL groups suffered from nausea, retching, and emesis, and no particular complication was observed in children of the DS group. Fisher's exact test did not show a significant difference between the three groups. Also, no complications due to high-volume fluid therapy were observed in patients after the intervention.

Discussion

The results showed that the DS solution was not significantly different from other solutions in reducing nausea and vomiting. The liberal fluid therapy approach reduced nausea and vomiting in all three groups without the use of prodrugs but the DS group showed no more favorable effects.

Many drugs are used to prevent PONV. These drugs are relatively expensive and are associated with side effects, such as excessive sedation, changes in blood pressure, dry mouth, and restlessness (12). Non-pharmacological methods, such as oral carbohydrates (13) or intravenous fluid therapy have been studied to reduce the cost and possible side effects of drugs. However, there is still limited evidence of non-pharmacological antiemetic therapies for PONV (12).

In this study, in the recovery room at the first record of complications in the NS group, one person had nausea and one person had nausea and vomiting two people in the RL group had nausea and vomiting and one person in the DS group had nausea and vomiting, and there was no significant difference between the three groups. Meanwhile, in all the three groups, no specific complication due to fluid therapy was observed in the first record.

In the second recording of the rate of nausea and vomiting, which was performed during the children's stay in the ward, one person in each of the NS and RL groups suffered from nausea and vomiting, and no specific complication was observed in children in the DS group. It should be noted that only one of the patients (in the RL group) who experienced nausea and vomiting suffered from nausea and vomiting simultaneously on two occasions. After the administration of the protocol-specified drug following the observation of nausea and vomiting after the first episode, the patient's problem was resolved. In addition, all patients underwent cardiorespiratory monitoring during their stay in the ward, and consequently, no complications due to liberal fluid therapy were observed in children.

The results of a study done by Heshmati et al. (2007) showed that hydration in children reduced the incidence of nausea and vomiting after tonsillectomy (11). Moreover, in a review by Apfel et al. (2012), the effectiveness of crystalloid hydration on reducing the occurrence of nausea and vomiting in recovery and 24 hours after surgery was reported (3). The results of these studies are consistent with the present study. In a study conducted by Elegueta et al. (2013), children aged 1 to 12 years undergoing selective tonsillectomy under general anesthesia, without adenoidectomy, were examined. The first and second groups received 10 ml kg-1 h-1 and 30ml kg-1 h-1 of RL solution, respectively. The researchers found that the intraoperative administration of 30ml kg-1 h-1RL solution significantly reduced POV incidence in the first 24 hours after the surgery (1). These results were also shown in a study by Ashok et al. (2017)(14).

The above citations all support the use of liberal fluid therapy to reduce vomiting and nausea, as the results of our study showed; however, some studies suggest that excessive volume (30 ml/kg) may lead to unwanted side effects(15, 16). Nonetheless, in the present study, due to the volume of fluids administered, according to cardiorespiratory monitoring, no complications regarding the volume of the administered fluids were observed. Furthermore, the ear, nose, and throat (ENT) surgeon was satisfied with the comfort of patients in the ward after surgery.

Although the findings suggest that, unlike adults, the administration of liberal fluids in children is generally helpful in preventing PONV (15), despite the existing guidelines for isotonic solutions, the preferred intravenous preservative for children has not yet been introduced (17).

Due to the importance of hypoglycemia following prolonged fasting before surgery in children, the activation of the lipolysis process, and the formation of ketone bodies, followed by the risk of PONV, children compared with adults are at a higher risk of blood flow changes and cerebral metabolism (18). Recently, it is suggested to use NS with dextrose to prevent hypoglycemia. Furthermore, to prevent hyperchloremic acidosis, RL solution has been studied as an isotonic buffer (19-21). Decreased perfusion of gastric mucosa following hypovolemia, which can occur after prolonged, fasting, may be an important factor for PONV (22). Accordingly, one of the hypotheses of the study was the greater effect of the DS solution on nausea and vomiting than NS and RL solutions. It has been hypothesized that dextrose consumption releases insulin in dehydrated children with acidosis, leading to breaking down free fatty acids, which may help to rapidly improve ketosis and clinical outcome (23). Although the results were not significantly different among the three groups in the observations made to record the complications, in the second observation, none of the patients showed any particular complication in the DS group. In a study by Mirsha (2017), all patients who were candidates for laparoscopic surgery received Ringer's acetate solution as a maintenance fluid. During surgery, 100 ml h-1 of 5% dextrose and 250 ml h-1 0.9% NS were administered to the intervention and control groups, respectively. The results showed that adding 5% dextrose to the patient preservative solution could significantly reduce PONV, and even if PONV occurred, it could considerably reduce the antiemetic amount (24). In a study conducted by Firouzian (2017), the results showed that the addition of 5% dextrose to lactated Ringer's solution in adult patients could reduce the risk of nausea in the recovery room (25).

The results of a systematic review and meta-analysis study showed that the usage of dextrose solution in the control group could not reduce the risk of PONV, but it decreased the use of antiemetic drugs after general anesthesia. It seems that the effect of dextrose solution is different depending on the type of surgery, and more studies are needed to determine the benefits of dextrose solution for the prevention of PONV.

In the present study, upon entering the recovery room, the patients' blood glucose after the

intervention in the NS, RL, and DS group ranged 86-230 mg dl-1, 70-195 mg dl-1, and 76-325 mg dl-1 respectively, but after transferring to the ward and stabilization of the patients' condition, their blood sugar was within the normal range. In another study by Mierzewska (2015), the blood sugar levels of the three studied groups of 5% dextrose (DW5%), NS + glucose (gNaCl), and 5% dextrose + Ringer's acetate were significantly different. Also, 93.3% of the DW5% group had a blood sugar level of above 200 mg dl-1 (175-625 mg dl-1) after the intervention and 36% of the gNaCl group had blood sugar level of above 200 mg dl-1 (123-345 mg dl-1). Nevertheless, patients' blood sugar tends to normalize within an hour after surgery in most patients. The researchers reported that because Ringer's acetate did not significantly change glucose and electrolyte concentrations, it appears to be a good choice for hydration and PONV reduction for children undergoing elective surgery (26). In the present study, although the DS solution was effective in reducing nausea and vomiting like other solutions, but caused a transient increase in patients' blood sugar, considering that patients had ASA class I and had no accompanying disease, and no side effects, such as osmotic diuresis were observed.

Conclusion

From a patient perspective, vomiting can be a worse experience than postoperative pain (27). The high prevalence of PONV in children is very worrying. Nausea, vomiting, and dehydration are some of the leading causes of hospitalization in children. It seems that fluid therapy can be a low-cost and effective method for preventing nausea and vomiting in pediatric surgeries that are associated with a high risk of these annoying complications. Accordingly, to select the best solution with the least complications, studies should be done using different solutions and at different doses.

Limitation

One of the limitations of the present study was the lack of fluid therapy studies in children with various types and volumes of crystalloid solutions, due to which we conducted a pilot study. Another issue was the lack of measurement of electrolytes in patients before and after surgery. More studies using a larger sample size are suggested to be done with different fluid therapy regimes and various types of solutions.

Clinical Trial Registration Code: The study registered at the Iranian Registry of Clinical Trials under the code of IRCT was IRCT20170413033408N1.

Ethical statements: This study was approved by the Ethical Committee Golestan University of Medical Sciences (IR.GOUMS.REC.1397.201).

Competing Interests

The authors declare that they have no conflict of interest

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Table & Figure:

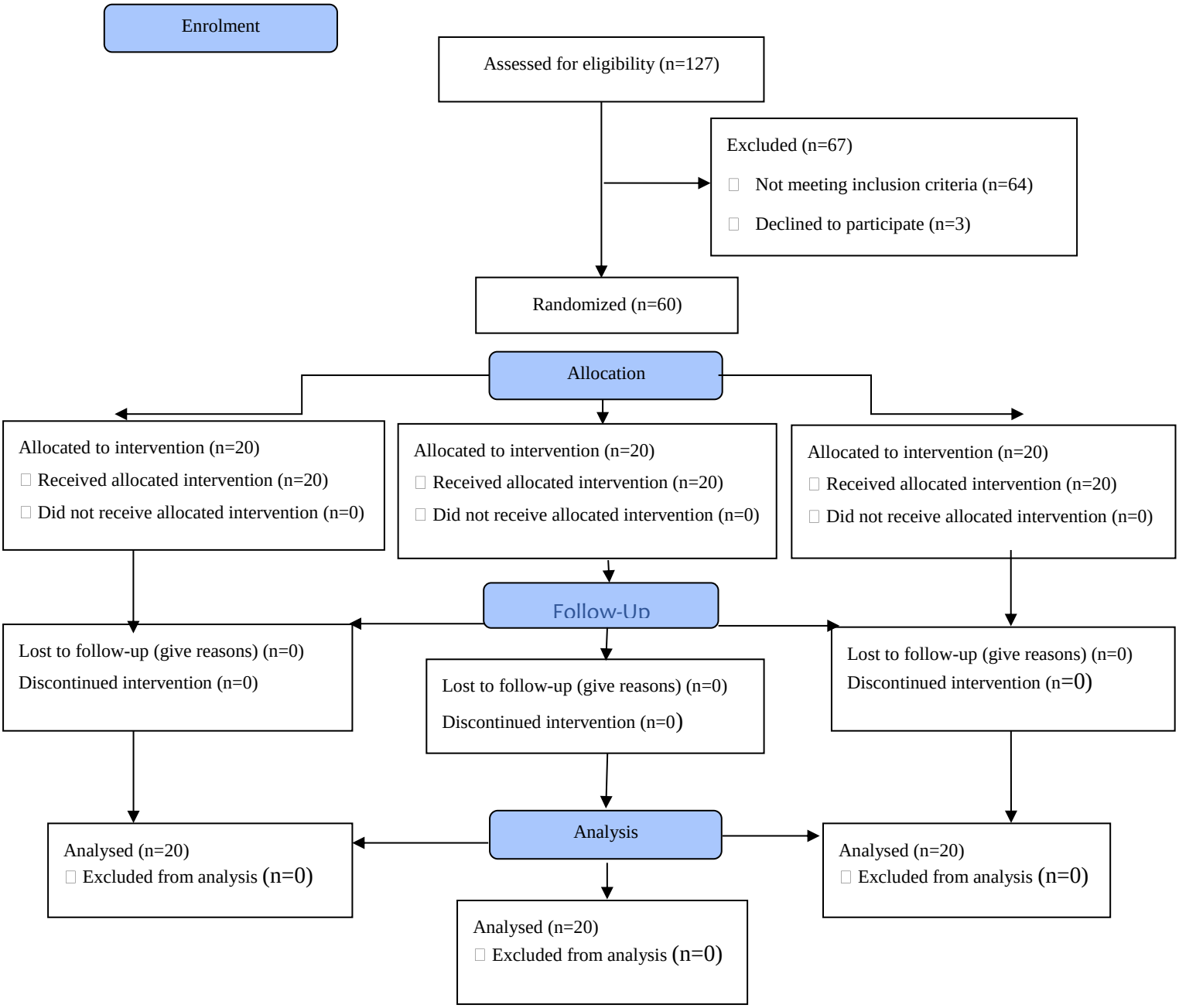

Figure 1. The Consort Flow Chart Describing the Progress of Subjects through the Study The effect of Liberal hydration dextrose saline on (PONV) following tonsillectomy in children 2-12 years old

Table 1: Comparison of sex distribution in the three groups studied; Dextrose saline, Ringer's lactate and normal saline

Group		NS	RL	DS	P-value
Gender	Male	11	9	11	0.85 *
	Female	9	11	9	
	Total	20	20	20	

* Chi-square

Table 2: Comparison between age, weight, anesthesia and recovery duration in the three groups of dextrose saline, Ringer's lactate and normal saline

Variable N=20	Group	Mean	Std. Deviation	P-value*
Age (year)	NS	6.52	1.80	0.86
	R.L	6.82	2.49	
	DS	6.45	2.55	
Weight (kg)	NS	22.82	6.84	0.75
	R.L	24.07	9.78	
	DS	25.25	12.93	
anesthesia duration (h)	NS	1.28	0.15	0.18
	R.L	1.19	0.14	
	DS	1.28	0.19	
Recovery duration (h)	NS	0.72	0.43	0.52
	R.L	0.82	0.39	
	DS	0.86	0.35	

*one way Anova

Table 3: Mean and standard deviation of blood sugar (mg/dl) of the three groups studied: dextrose saline, Ringer's lactate and normal saline after the intervention

Group	N	Minimum	Maximum	Mean	Std. Deviation	P-value
NS	20	86.0	230.0	148.4	42.1	0.000*
RL	20	70.0	195.0	132.0	30.7	
DS	20	76.0	352.0	224.8	77.6	

* One-way ANOVA

Table 4: observed and recorded Nausea and vomiting (nausea, retching, and emesis) in the three study groups: DS, RL and NS

Group		First record	Second record
NS	vomit	1(5%)	-
	nausea	-	-
	combination	2(10%)	1(5%)
	nothing	17(85%)	19(95%)
RL	vomit	-	-
	nausea	-	-
	combination	2(10%)	1(5%)
	nothing	18(90%)	19(95%)
DS	vomit	-	-
	nausea	-	-
	combination	1(4.5%)	-
	nothing	19(95.5%)	20(100%)
P-value*		0.86	ns

*Chi-square