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ORIGINAL ARTICLE

Effects of sugammadex on the prevention of postoperative peritoneal adhesions

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Abstract Many materials and techniques have been used to prevent and repair intra-abdominal adhesions, but an effective solution has not been found. The aim of this study is to research the effect of sugammadex on intra-abdominal adhesions in an experimentally induced intra-abdominal adhesion model. Twenty-four female Wistar albino rats were included in the study. The experimental animals were randomly divided into three groups: the sugammadex group (Group SX, $n = 8$), the control group (Group C, $n = 8$), and the sham group (Group S, $n = 8$). After starvation for 1 night, the rats were injected with a 50 mg/kg intramuscular dose of ketamine and a 5 mg/kg intramuscular dose of xylazine for anesthesia. The rats in the SX group were given 3 mL sugammadex into the peritoneal cavity, while rats in the control group were given 3 mL 0.9% sodium chloride. In the sham group, the peritoneal cavity was opened, but no chemicals were administered. All rats were sacrificed on the 10th postoperative day. The adhesions were staged as 0, 1, 2, and 3 according to Evans et al.'s model. Our evaluation of macroscopic adhesion intensity found statistically significant differences between the groups. The sugammadex group was observed to have fewer adhesions in a statistically significant manner compared with the control group ($p < 0.05$). In our experimental intra-abdominal adhesion model in rats, we observed that sugammadex prevented postoperative intra-abdominal adhesions.

Conflicts of interest: All authors declare no conflicts of interest.

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Introduction

Postoperative adhesions are frequently seen after abdominal surgery [1,2]. It is estimated that >90% of all surgical procedures may cause adhesions [3]. These adhesions are a major clinical problem after surgery [3,4]. Intra-abdominal adhesions may cause many complications such as intestinal obstruction, chronic abdominal pain, infertility, and extended hospital stays. Additionally, nearly a third of these patients require repeated operation under emergency conditions [5]. Studies have determined that the real cause of mortality and morbidity in 60—70% of patients with intra-abdominal adhesions is intestinal obstruction [6—8]. Many materials and techniques have been used to prevent and repair the problem, but an effective solution has not been found. Recent studies have focused on the formation of a mechanical barrier between peritoneal surfaces. To prevent postoperative peritoneal adhesions, the most frequently used methods involve administering a variety of fluids and drugs within the peritoneum. Many agents such as phospholipase inhibitors, dextrans, corticosteroids, phospholipids, and methylene blue have been tested according to literature [9,10]. For this mechanical barrier, gelatin-like fluids with high viscosity have been found to be more effective because these high-viscosity fluids form a layer preventing surfaces in the area of the peritoneum from contacting surrounding tissue and preventing adhesions [11,12]. Among prophylactic solutions used to prevent adhesions, the most frequently used agent is a high-molecular weight dextran solution, which covers surfaces and has a siliconizing effect that prevents contact between injured surfaces. A new agent, called sugammadex, is a water-soluble glucose polymer with a γ-cyclodextrin structure. Sugammadex selectively binds to nondepolarizing blockers with a steroid structure, like rocuronium, used as a muscle relaxant during general anesthesia. It safely and quickly reverses the deep neuromuscular blockage induced by rocuronium [13—16].

The aim of this study is to research the effect of sugammadex on intra-abdominal adhesions in an experimentally induced intra-abdominal adhesion model.

Methods

Required permissions for the study were obtained from Canakkale Onsekiz Mart University Experimental Animals Ethics Committee (2014/03-01; Çanakkale, Turkey). The study was completed in the Canakkale Onsekiz Mart University Experimental Animals Research Center in Turkey.

Experimental groups

Twenty-four female Wistar albino rats (mean weight: 300 $\pm$ 25 g; mean age: 5 months) were included in the study. The experimental animals were randomly divided into three groups: the sugammadex group (Group SX, $n = 8$), the control group (Group C, $n = 8$), and the sham group (Group S, $n = 8$).

Surgical technique

After starvation for 1 night, the rats were injected with a 50 mg/kg intramuscular (IM) dose of ketamine and a 5 mg/kg IM dose of xylazine for anesthesia. After the midline of the abdomen was shaved, antisepsis was provided with povidone iodine. With a 3 cm vertical midline incision, the peritoneal cavity was entered. The cecum and terminal ileum were found and placed on a damp gauze pad. With a dry gauze pad, the cecum and 2 cm of the terminal ileum were scraped. This procedure continued until the petechial hemorrhage foci were observed (scraping model) [17]. Later, rats in the SX group ($n = 8$) were given 3 mL (300 mg) sugammadex (Bridion, Schering-Plough Corporation, Oss, The Netherlands) into the peritoneal cavity, while rats in the control group (Group C, $n = 8$) were given 3 mL 0.9% sodium chloride. Rats in the sham group (Group S, $n = 8$) only had a 3 cm vertical incision completed and the peritoneal cavity entered, but no chemicals were administered to these animals. The incision was closed with the continuous stitch technique using propylene thread. After the 24 hour postoperative check, the rats were allowed to feed. All rats were given a 50 mg/kg IM dose of ketamine and a 5 mg/kg IM dose of xylazine for sufficient anesthesia on the 10th postoperative day and were sacrificed. To see the adhesions and to determine the correct staging, the peritoneal cavity was entered through an "inverse U" incision. Without disturbing the flap adhesions on the abdominal anterior wall, the abdominal anterior wall was pulled to caudal. Evans et al.'s [18] scoring was performed by general surgeons who were blinded to group allocation. The adhesions were staged as 0, 1, 2, and 3 according to Evans' model (Table 1).

Statistical analysis

All statistical analysis was performed using SPSS 15 (SPSS Inc., Chicago, IL, USA) statistical software for Windows. A nonparametric test, called the Chi-square test, was used to compare data from the sugammadex and control groups. A p value < 0.05 was considered significant.

Results

Our evaluation of macroscopic adhesion intensity showed statistically significant differences between the groups. When compared in terms of adhesion score 0, a limited significant difference was observed between the sugammadex group and the control group ($p = 0.05$). When compared in terms of adhesion score 1, a significant difference was observed between the sugammadex group and the control group ($p = 0.02$). When compared in terms of adhesion score 2, a significant difference was observed between the sugammadex group and the control group ($p = 0.03$). Finally, when compared in terms of adhesion score 3, a limited significant difference was also observed between the sugammadex group and the control group ($p = 0.05$).

In Table 2 the evaluation of macroscopic adhesions according to Evans et al.'s [18] model indicates that the