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Comparison of barbed and conventional sutures in adhesion formation and histological features in a rat myomectomy model: randomized single blind controlled trial

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ABSTRACT

Objective: To compare the adhesion and histologic scoring of barbed and standard suture material after incision and serosal closure of both uterine horns for myomectomy model in rats.
Study design: In this single blind randomized controlled trial, one cm incisions were performed on the right and left uterine horns of ten non-pregnant rats, and these incisions were randomly allocated for closure by a suture material with either polyglyconate (V-Loc™) or polyglactin-910 (Vicryl®). Each rat served as its own control. Six weeks after the operation, the abdomen was re-opened and the abdominal and surgical sites were evaluated by a researcher blinded to the side of the suture materials in the first operation. Adhesions were scored according to their severity, and specimens were also evaluated and scored histologically according to the following features: collagen deposition and inflammatory reaction.
Results: The median macroscopic adhesion scores in the barbed and standard suture group were 3.5 and 2, respectively ($p = .008$). There was significant difference between the barbed and standard suture group with regard to the median inflammatory cell scores for macrophages-foreign body giant cell (1 vs. 3, respectively, $p = .01$) and mononuclear cell (2 vs. 3, respectively, $p = .04$).
Conclusion: Based on the results of the present study, we suggest that in the rat model, the type of the suture used for myometrial closure has an effect on subsequent adhesion formation, and this adverse outcome was more frequently observed with the barbed suture.

Introduction

Barbed sutures have recently been introduced in gynecology practice to facilitate suturing especially in laparoscopic procedures. Polyglyconate barbed suture material (V-Loc™, Covidien, Mansfield, MA) was approved by the US Food and Drug Administration for soft tissue approximation in 2009. The barbes allow approximating the tissues without the need to tie the surgical knots. Several studies were published to describe the effectiveness of barbed suture and it was reported that the barbed sutures decrease the operation time and the amount of intraoperative bleeding [1,2]. In spite of several potential advantages of barbed sutures which make it more preferable, when it is used intra-abdominal surfaces, the adhesion formation or inflammation due to the barbes has not been adequately studied. Some case reports revealed that this barbed suture material can cause small bowel obstruction or volvulus after its intra-abdominal placement [3–5]. Nevertheless, Einarsson et al. recently published two articles investigating macroscopic and microscopic effects of barbed suture material on 23 sheep uterus, which were operated laparoscopically, the results revealed that no statistically significant adhesion formation was shown when using barbed suture material in comparison to standard suture material [6,7].

Postoperative intra-abdominal adhesions are important health problems which subsequently occur in more than 90% of all patients after undergoing major abdominal surgery [8]. These adhesions usually involve the peritoneum, bowel, and omentum which may cause adverse outcomes such as bowel obstruction, chronic postoperative pain, and injury to the intra-abdominal organs [9–12]. This mechanical barrier increases the risk of infertility [13]. The barbed sutures were commonly preferred in laparoscopic closure of myomectomy procedures or cuff suturing after hysterectomy because of decreasing the operation time and

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easing the use of suture. In most theoretical pathways discussing adhesion formation, the inflammatory reaction is considered to be an important aetiological factor [14–16]. Sutures used in pelvic surgery may cause macroscopic adhesions which increase the risk of infertility and also may induce cellular and humoral immunity which results in postoperative adhesion and pain. Therefore, besides macroscopically observed adhesions, there are also histologic changes hidden under the adhesions which should be also taken into consideration in abdomino-pelvic surgery.

The aim of the present study is to compare the unidirectional barbed suture with standard suture in a rat myomectomy model with regard to macroscopic adhesion formation and histologic changes.

Materials and methods

Our animal model consists of non-pregnant rats with an intact uterus. The study was approved by Marmara University Animal Care, Use and Ethics Committee (No: 38.2014.mar). All aspects of the animal use were in accordance with the guidelines for ethical conduct in the care and use of animals.

Ten sexually mature, non-pregnant, female Sprague Dawley albino rats (weight, 196–281 g) were caged under conditions of constant temperature (21–22 °C) and humidity (40–50%), with a 12-hour darklight cycle. The rats were numbered sequentially and provided free access to water and standard rodent chow.

All rats were anesthetized via intraperitoneal injection of 100 mg/kg ketamin and 10 mg/kg xylazine hydrochloride. The abdominal skin was shaved, and 10% povidone iodine was applied for antisepsis. Sterile latex gloves were used during all surgical procedures. Researchers (M.A. and M.S.C.) made a midline abdominal vertical incision approximately 5 cm long to expose the uterine horns. Scalpel (No. 15) was used to create a 1.5 cm incision on the anti-mesosalpingeal side of both uterine horns to mimic a myomectomy wound. The decision determining which side of the uterine horn will be sutured with which type of suture material was provided using a computerized random-number generator. The uterine horns of the bicornuate uterus were sutured by using 3-0 polyglactin 910 (Vicryl®) on one side and 3-0 polyglyconate unidirectional barbed suture (V-Loc™) on the other side (Fig. 1). Three times continous unlocked manner suturing was performed without any knot, on the both uterine horns. Blood and fibrin material were removed by rinsing with serum pyhsiologic solution from the surgical site after confirming that hemostasis had been achieved, and the abdominal wall was closed in a double layer using 3-0 polyglactin 910 suture.

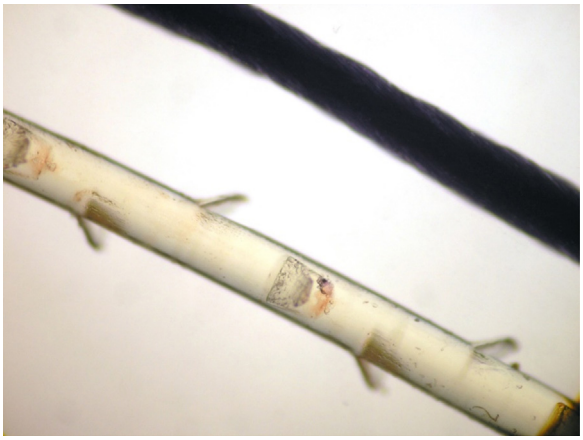

Fig. 1. Photographic illustration of suture materials under 40× high power field light microscope (upper is polyglactin-910 No: 3-0 and lower is polyglyconate barbed No: 3-0).

Six weeks later, all rats were sacrificed with penthobarbital 300 mg/kg, and a second look laparatomies were performed. The intra-peritoneal and surgical site macroscopic adhesions were identified and scored using an established adhesion scoring system [17] by the researcher (A.B.) blinded to the previous allocation of suture sides in each animal. Adhesion scoring was graded with 1–4 scale as showing no adhesion (score = 1) and very dense adhesion requiring sharp dissection (score = 4) (Fig. 2). In the fresh tissue at second look operation, A.B. examined all intra-abdominal possible adhesion locations; under the laparotomy incision, between the intestinal loops, omentum, uterine horns, etc. by careful manipulation with a fine tissue holder. Under the laparotomy incisions and at the site of operative fields, panoramic views from the most highlighted demonstration of adhesions have been photographed to record for the study archives. For the intra-observer variability, 30 photographic images were randomly selected among the archive and re-evaluated by A.B. in two different occasions; in the 1st observation photographs were consecutively numbered and the 2nd observation they were shuffled. The results of two observations scored by A.B. were statistically analyzed by Cohen's Kappa test.

After completing macroscopic scoring, the left and right horns were completely excised and prepared for tissue section and staining with hematoxylin–eosin for inflammatory cell reaction and Masson's trichrome stains for estimation of collagen fibers. The histologists (M.O. and F.V.A.) blinded to the suture sides evaluated the specimens under a light microscope and scored them. A 0–3 scale (0 = none, 1 = minimal, 2 = mild, 3 = extensive) was used to score the inflammatory cells (eosinophils, neutrophils, mononuclear cells and foreign body giant cells) and collagen fibers [18]. The presence of the part of sutures remained without being absorbed was evaluated under a light microscope by using both polarized and non-polarized filter. Digital images were obtained using an Olympus BX 53 Light microscope (Fig. 3).

All statistical analyses were performed using SPSS software (version 15; SPSS Inc., Chicago, IL) and STATA (version 13, StataCorp LP, Texas USA) was used for power calculation. Median adhesion and histologic scores within the groups were compared by using the Mann–Whitney *U* test. The Fisher exact test was used to compare the proportion of the presence of adhesions between the groups. Values of $p < .05$ were considered statistically significant. Since the sample size is decided by the Animal Care and Use Committee with the maximum number of 10 rodents allowed, power calculation was performed retrospectively using the following parameters. By choosing type 1 error .05 based on a two-sided test, with known mean adhesion scores and standard deviations (3.3 and .94 for barbed suture group; 2.1 and .87 for standard suture group), we calculated a power of 79%.

Results

All 10 rats were included to the final analyses without any drop-out. The macroscopic adhesion scores were evaluated and recorded for each horn seperately. The median macroscopic adhesion scores at the suture side in the barbed and standard suture group were 3.5 and 2, respectively ($p = .008$) (Fig. 4). Intestinal involvement in the adhesions was 20% and 10% in the barbed and standard suture group, respectively ($p = .5$). Intra-rater (A.B.) agreement on macroscopic adhesion scores (obtained from the 30 randomly selected still images) had a Kappa value of .82 ($p < .001$).

Histologic scores were investigated in the pieces of tissues removed from the suture sides (Table 1). Collagen deposition was equally observed between the groups. The median scores of inflammatory cell reaction as shown by eosinophil-neutrophils;