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Editorial

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A Modified Sidewall Adhesion Model: Hypothesis-Building and Testing Tool for a Surgical Experimental Research

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Abstract

This editorial opinion article is based on our own experience and literature review. The NESA adhesion formation study team members recommend an unique model as a hypothesis building and testing tool in a surgical experimental research.

Body text

Postsurgical adhesions are believed to be the result of surgical tissue trauma in presence of multi factorial etiology of excessive healing, which may interfere with the physiological mechanisms at any stage [1]. The key points of postsurgical adhesions includes firstly the fixation of the intra-peritoneal structures to the parietal and/or visceral peritoneum, keeping them attached longer than in physiological wound healing [2] and secondly the initiation of excessive healing, caused by inflammation [3], which in turn may be triggered by surgical factors [4].

Postsurgical adhesions have evoked hard-to-cure and high-costly problems for the healthcare systems overall with such frequent complications such as small bowel obstructions with negative effects on patients' health, and increased workloads in clinical practice [5].

High-costs were associated with postsurgical adhesion complications as demonstrated in an analysis of annual inpatient care and expenditures based on a national hospital discharge data which were used to identify all abdominal adhesion related procedures performed in the United States in 1994 [6]: validated data with a ten-year follow-up of 12,584 patients undergoing lower abdominal surgery from the Scottish National Health Service Medical Record Linkage Database in UK [7] and in a study aimed to examine the natural course of patients following surgery for small bowel obstruction with a 14 year-follow-up in Sweden [8]. Under the evidence-based assumption that the risk of adhesions in colorectal surgery called for the necessity of opportunities and strategies for improvement the team of distinguished surgeons 'called for action' in their paper [9] to colorectal surgeons "to make prevention of adhesions more of a priority and importantly to inform patients of the risks associated with adhesion-related complications during the consent process".

From this view long lasting attempts of researchers and surgeons to find an optimal adhesion preventing adjuvant have legitimated their expectations and the expenses were well worth it. Unfortunately until now most of suggested adhesion preventive adjuvant have shown their efficiency only in experimental models and failed in clinical trials.

Previously we demonstrated key steps of surgical research, namely the selection of the research questions, hypothesis building to set goals as well as the elaboration of a study design and interpretation of results based on our experimental studies and a systematic review of literature [10]. In our experimental researches we aimed to study an impact of surgical trauma and CO_2-insufflation on adhesion formation [3,10] to demonstrate the developing of research questions, the building of a hypothesis, and the setting of goals and the elaboration of a study design as well as the interpretation of results.

Therefore in this an editorial opinion paper we would like to demonstrate a rabbit sidewall adhesion model as a hypothesis building and testing tool. Because in the area of translational medicine and globalization an increased amount of information is required to apply state-of-the art methods based on results of evidence-based medicine in surgery.

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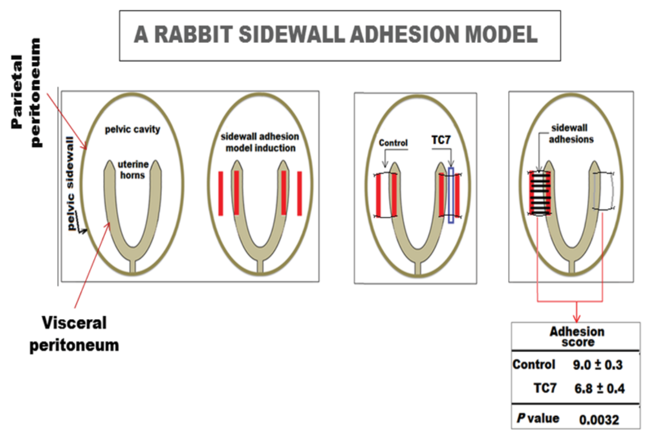

Figure 1: An original rabbit sidewall adhesion model: a low midline laparotomy incision; traumatization of sidewall peritoneum and ipsilateral uterine horns; tacking together traumatized sidewall peritoneum and ipsilateral uterine horns and TC 7 application; adhesion evaluation in control and treated sites by Diamond et al. [11].

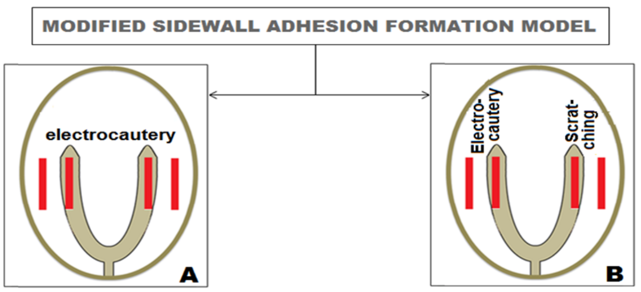

Figure 2: A-modifications in rabbits [12,13] and mice [14,15] were done by the coagulation of sidewall peritoneum and ipsilateral uterine horns via a laparoscopic approach, B-modifications in rats were performed in one site by electrocautery and in the opposite site by scratching through open laparoscopy [4].

Worldwide, experienced surgeons-practitioners and residents have also been involved in clinical trials of state-of-the art technologies and the evaluation of new surgical techniques. Key steps in the acquisition of clinically relevant results are the statement of questions and hypothesis building to set research goals as well as the elaboration of a study design.

As a prototype of our hypothesis building and testing tool we used a rabbit sidewall adhesion model [11]. Briefly, in their model Diamond et al. [11] performed a low midline laparotomy incision and exposed the uterine horns and abdominal/pelvic sidewalls. After several unsuccessful attempts with scraping or excisions of the peritoneum, and a combination of excisions of a 2 × 2-cm area of peritoneum and both layers of underlying muscle in conjunction with scraping of a contiguous 2-cm length of the uterine horn, the standardized postsurgical sidewall adhesion model was created by tacking together traumatized sidewall peritoneum and ipsilateral uterine horns using two interrupted sutures in each site (Figure 1). A piece of an absorbable adhesion barrier - Intercede (TC 7) was placed between these damaged lesions where opposite site was used own control. An evaluation of postsurgical adhesions was done after 2 weeks by scoring of adhesion extent, type and tenacity with successful improvements in sites with TC 7 application. Then this model and principle was used to evaluate many other adhesion barriers.

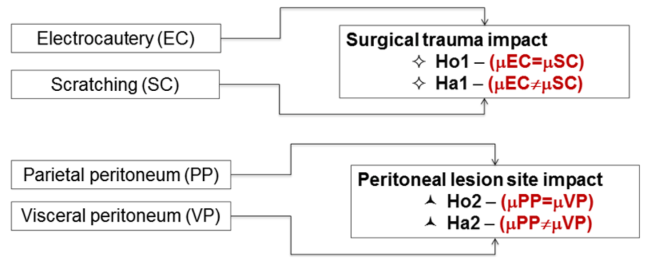

Figure 3: Hypothesis framing to test impacts of surgical trauma and lesion sites: Ho-null hypothesis; Ha-alternative hypothesis [4].

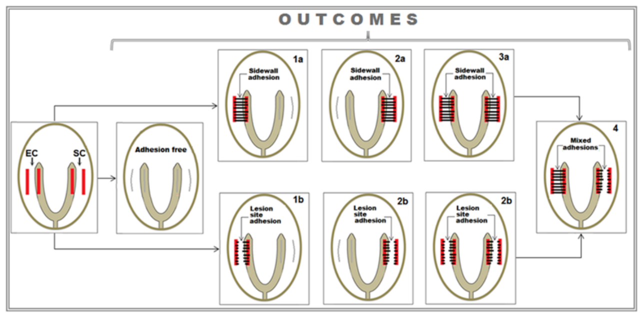

Figure 4: Possible outcomes of our modified sidewall adhesion model [4]: a model and adhesion free cases; sidewall adhesions occurred only in one site either after EC (1a) or SC (2a) and in both sites (3a); lesion site adhesions analogously – only in one site either after EC (1b) or SC (2b) and in both sites (3b); mixed adhesions or combined sidewall and lesion site adhesions (4).

Working hypotheses					Ho/Ha	Testing outcome
Sidewall adhesions	Surgical trauma impact (EC vs SC)				Ho1	+ or -
					Ha1	
Lesion site adhesions	Surgi-cal trauma impact	EC-PP	vs	SC-PP	Ho2	+ or -
					Ha2	
		EC-VP	vs	SC-VP	Ho3	+ or -
					Ha3	
		EC-PP+VP	vs	SC-PP+VP	Ho4	+ or -
					Ha4	
	Lesion site impact	PP-EC	vs	VP-EC	Ho5	+ or -
					Ha5	
		PP-SC	vs	VP-SC	Ho6	+ or -
					Ha6	
		PP-EC+SC	vs	PV-EC+SC	Ho7	+ or -
					Ha7	

Notes: EC – electrocautery, SC-scratching, PP-parietal peritoneum, VP-visceral peritoneum (uterine horns), vs-versus.

Table 1: Types, framing and testing of working hypotheses.

This model has been modified to evaluate an impact of CO_2-pneumoperitoneum (Figure 2) by laparoscopic approach in rabbits [12,13] and in mice [14,15] at KULeuven and through open laparoscopy in rats [4] by our team at Moscow State University.

By application of one surgical damaging factor-electrocautery it was possible to test only an impact of CO_2-pneumoperitoneum [12-15]. Our model with two surgical factors such as electrocautery and scratching allowed us in addition to CO_2-pneumoperitoneum impact to test an impact of surgical trauma type and peritoneal lesion sites (Figure 3) with fraiming subsequent working hypotheses.

Our modified sidewall model increases our ability to make a comprehensively simultaneous analysis of an impact of several factors at the same experiment. An application of two different surgical trauma types in opposite sites in the same animal model allowed us to observe sidewall or lesion site adhesions occurring only in one site or both sites and a combination of these adhesions (Figure 4).

Subsequently, the types of working hypotheses, their framing and testing are presented in Table 1.

By evaluation of sidewall adhesions alone we could test an impact of type of surgical factor on postsurgical adhesion parameters. Additional evaluation of lesion site adhesions increased our ability to compare types of surgical factors such as dependence on lesion sites for instance, impact of surgical factor only on parietal peritoneum lesions or analogously on uterine horns (visceral peritoneum) or a combination of these factors. An impact of lesion sites was also studied in detail depending of the type of lesion sites by the same surgical factor and their combination.

In conclusion, based on our own experience and literature we recommend our modified model as a hypothesis building and testing tool in surgical experimental research.

Contributors

In design and description of this editorial opinion article all authors contributed equally.

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