

Brief Communication

The Effect of Perioperative Dimethyl Sulfoxide Efficacy on Regional and Local Flaps Viability

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Abstract

Background: The purpose of this study was to analyze the effects and results of dimethyl sulfoxide (DMSO) usage on viability and perfusion of local and regional flaps in rabbits, via this study we are going to conclude whether DMSO could be effective after flap operations in human or not.

Materials and Methods: Local and regional DMSO spray was used on rabbit's dorsum flaps immediately after the operation and once per day up to 7 days post-op in 14 rabbits, divided equally to control group (saline solution spray) or experiment group (DMSO spray). The results were compared 3 and 7 days after operations.

Results: There were improved results attributed to the DMSO effects regarding flap survival

Conclusion: We concluded that topical application of DMSO reduces skin flap ischemia in rabbits and we highly advise the use of it after operations in which skin flaps are created.

Keywords: DMSO, Regional flap, Perfusion, Ischemia

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Introduction

Tissue circulation has been a favorite for plastic surgeons, especially due to its role in decreasing the chance of tissue flap ischemia. In several studies, following abdominoplasty and facelift operations topical Dimethyl sulfoxide (DMSO), have improved chances of success to increase skin perfusion; so they have advised DMSO in procedures with risks for ischemia (1-3). DMSO has several applications in medicine and also, in industry. Though controversial, using DMSO in flaps has been quoted frequently; however, the last word is to be said yet (4, 5).

Furthermore, the mechanism of DMSO action

rarely has been discovered; the role of DMSO in tissue histamine release has been quoted by some authors, leading to vasodilation of flap vessels. Different use forms of DMSO (injectable, topical, intravenous) have been studied on animal and human models (6).

This experimental study was performed on rat tissue flaps to assess the role of perioperative local DMSO on cellular and tissue viability (7-9).

Methods

The study protocol was assessed and approved by the Research Ethics Committee of Shahid Beheshti

University of Medical Sciences (IRB Ethics Code: IR.SBMU.RETECH.REC. 1399.262; June 30, 2020). This study was performed in the animal lab, 15 Khordad Center (a referral hospital dedicated to plastic and reconstructive surgery affiliated to the Shahid Beheshti University of Medical Science).

To investigate the efficacy of perioperative application of DMSO on regional and local flaps viability, we designed an experimental study, consisting of 14 rabbits, of which seven were allocated to the control group (just Saline solution sprayed on the tissue); however, the other group included 7 rabbits, which received DMSO spray on the tissue cells. We used DMSO spray-on local and regional flaps in rabbits' dorsum immediately after an operation and once per day up to 7 days postop.

In the next study step, we cut elevated cutaneous flaps with diameters about 8*2 cm on the dorsum of each rabbit and sutured it again; afterward, we followed up the flaps by applying saline in one group and DMSO in another group, with especial concern on ecchymosis, edema, and necrosis. Topical DMSO with a density of 60% in combination with 10% urea and 30% water was applied for skin flaps in examined group 3 times per day up to 7 days; whereas in the control group, we applied saline on the skin flaps similarly. Therefore, we examined flaps every day till 1 week regarding flap perfusion, color, and secretion around flaps.

Allocation of the animals to each of the study groups was performed using a random table of numbers. All steps in the application of DMSO and saline were performed by just one of the members of the team; while, all the perioperative assessments were performed by another member of the team who was unaware of the study group. The post-op status of the flaps was compared using the Chi-square test. All statistical analyses were performed by SPSS; while a p-value less than 0.05 was considered statistically significant.

Results

In our study, we compared the results of two groups after 7 days of applying DMSO for examined group and saline in the control group. Among 7 rabbits in the examined group, just 1 of them had necrosis around the

flap on 3th day and also infected flap in this case; however, the rest of them had viable flaps. Meanwhile, among the other 7 rabbits in the control group, 3 rabbits had flap necrosis after 3 days of surgery, which one infected rabbit was observed. So the survival of flaps in the examined group was 86% in comparison with 57% in the control group (P value<0.05). In each group, only one case of infection (odor, secretion, and erythema) was observed (15%); demonstrating no significant difference between the two groups. Also, no other flap-related complication was reported in the two groups.

Discussion

In our study, the use of DMSO 60% decreased ischemic flaps in the examined group (86%), the results in our study are considered similar to the results of other previous studies which had applied topical DMSO with a variety of concentrations from 50% to 95%. More knowledge about skin circulation and physiology causes surgeons to perform the best methods and techniques for surviving microscopic anastomosis of flaps and prevent flap necrosis, especially considering the role of cellular and molecular mechanisms of organ protection and the potential role of DMSO (10).

The previous studies have shown that the ability of DMSO to cross all membranes varies according to DMSO strength. The most effective DMSO strength for penetrating the skin is a solution between 70-90%. For reasons unknown, concentrations higher than 90% are less effective. Much lower concentrations of DMSO -in the range of 1% to 8%- are sufficient for crossing membranes other than skin. McFarlen et al (1968) reported the DMSO effect on preventing experimental pedicle flaps. One study of abdominal island flaps in rats compared control animals that received saline injections with rats injected with intraperitoneal DMSO. Flaps in the treatment group showed significantly increased blood perfusion by postoperative day 3 as measured by laser velocimetry and perfusion fluorometry (11-12).

In another study on rats, 9*4 cm pedicle abdominal flaps were assessed. Occlusion of the epigastric vein was done for 8 hours and then, the flap was resutured to its bed. Two groups received

intraperitoneal saline; while three others received intraperitoneal DMSO at different time points:

- only reperfusion time
- at reperfusion time and then every day for 5 days
- before the operation, at operation, and till 5 days after the operation.

A sonic digitizer was used for the assessment of results (flap survival). Two groups that received DMSO at reperfusion and 5 days after surgery had better outcomes regarding flap survival (13).

In one study topical DMSO efficacy was examined on 10* 2.5 cm elevated and resutured flaps of rabbit dorsum, as 4 groups:

- saline control group
- DMSO 50% treated group
- H₂O₂ 8% treated group
- DMSO and H₂O₂ treated group.

Flap survival was compared using planimetry 7 days after surgery. There were no differences among the groups' survival that received saline, H₂O₂, or DMSO alone; however, flaps treated with DMSO+H₂O₂ had a greater area of survival; also, the PtcO₂ amount had improved for the DMSO+H₂O₂ group (14).

Rand Luby et al performed prospective research for skin flap viability in patients who had undergone a mastectomy, using topical 60% DMSO. The mean area of ischemia for the DMSO group was significantly smaller than the control group (15).

Rasposio and Santi performed a study on 40 patients who had undertaken immediate breast reconstruction (tissue expansion) following mastectomy. Twenty patients had standard tissue expansion while another 20 patients received DMSO 60% sponges on the skin overlying the expander 30 minutes before the expansion. A significant difference was found in the number of expander filling sessions and the mean inflated volume for each session (16).

Vinnik had a study on mastectomy patients, which applied topical DMSO immediately after placement of large permanent expanders; they observed great results after surgeries. Similar results regarding flaps perfusion were seen in patients under abdominoplasty (17).

Different types of free radicals are mediators for cell damages and are produced in ischemic or reperfused tissues due to the structure of DMSO

(Figure 1); on the other hand, DMSO has a proper structure in oxidizing and scavenging free radicals, and theoretically, DMSO could be effective in scavenging free radicals in skin and island flaps, leading to increased flap survival. However, the main drawbacks of DMSO are:

- hemolysis after intravenous use (less than 2g/Kg) and rapid injection of it (30 min>) (18)
- chance of ophthalmologic toxicity (18, 19)
- DMSO could penetrate from the Stratum Corneum (upper layer of skin) and it performs as a carrier, which also, increases the substances penetrations (20-22)
- some studies have cited the potential effects of DMSO regarding its effects on cellular proteomics, epigenomics, and microRNAs; which might affect the role of cell fate in its future life (23, 24)

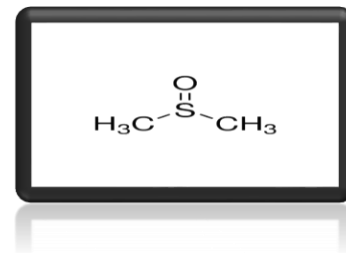


Figure 1. chemical formulation of Dimethyl sulfoxide (DMSO).

Conclusion

In our study, we observed significant results after topical DMSO 60% on skin flaps, which had a substantial impact on reducing tissue damages due to loss of perfusion and surgery trauma. Based on the results of this study we suggest that topical DMSO is an appropriate and effective solution for the protection of cutaneous flaps in the perioperative period; a result supported by prior researches.

It is considered wise to apply DMSO on cutaneous or pedunculated flaps while other traditional methods for flap perfusions such as tension releases on the pedicle, decrease kinks, and remove load pressure on flaps have been defeated. By appearing some signs of ischemia in flaps, topical DMSO might be effective to improve tissue perfusion. This product is not expensive and could be reachable for patients at home,

even though it cannot repair necrosis areas of flaps and recur the circulation of these regions; though some controversies exist (7-9, 23, 24). More sophisticated studies are still needed.

Acknowledgment

None.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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