

# Application of Mechanical Negative Pressure Drainage (Cupping Method) for Venous Compromise in Flap Surgery

## Flep Cerrahisinde Venöz Yetersizlikte Mekanik Negatif Basıncılı Drenaj Yönteminin (Kupa Yöntemi) Kullanımı

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### ÖZET

**Amaç:** Flep cerrahilerinden sonra ortaya çıkan venöz yetmezlik öngörülemez bir komplikasyon olup flep kaybına kadar ilerleyebilmektedir. Flep ameliyatları sonrasında karşılaşılan venöz drenaj problemlerinin ortadan kaldırılmasına yönelik çeşitli yaklaşımlar tanımlanmış olsa da halen tam anlamıyla çözülmemiştir. Bu çalışmada fleplerde ortaya çıkan venöz yetersizliğin tedavisinde kupa ile mekanik negatif drenaj yönteminin uygulanmasını göstermeyi amaçladık. Sülük ve diğer tanımlanan tedavilere kıyasla daha steril ve kontrollü drenaj sağlayarak işlem süresini kısaltmayı, dolayısıyla flebin venöz yük altında olduğu süreyi minimuma indirmeyi hedefledik.

**Hastalar ve Yöntem:** Çalışmaya fleplerinde venöz yetmezlik nedeniyle mekanik negatif basınçlı drenaj uygulanan hastalar dahil edildi. Tromboz, hematoma ve anastomoz problemlerinden kaynaklanan venöz yetersizlikli olguları çalışma dışı bırakmak için sadece pediküllü ada flebi cerrahisi uygulanan hastalar dahil edildi. Bunun dışında, serbest flepler, perforatör flepler ve cilt bağlantısı korunan flepler de örneklem dışı bırakıldı. Demografik veriler (yaş, cinsiyet), ortalama uygulama süresi ve sıklığı, komplikasyonlar kaydedildi.

**Bulgular:** Çalışmaya 8 hasta dahil edildi ve ortalama yaş 40,3 olarak bulundu. Dört hastaya paraskapular flep, üç hastaya transvers rektus abdominis kas flebi, bir hastaya ise medial gastrocnemius muskulokutan flep uygulandı. Mekanik negatif drenajın ortalama süresi 2,8 gün ve ortalama uygulama sıklığı günde 4,6 idi. İşlemin ortalama süresi ise 2.25 dakika olarak belirlendi. İki hastaya ameliyat sonrası 5. günde marjinal nekroz nedeniyle lokal anestezi altında revizyon ameliyatı uygulandı. Diğer hastaların hiçbirisinde komplikasyonla karşılaşılmadı.

**Sonuç:** Kupa ile uygulanan mekanik negatif basınçlı drenaj yöntemi literatürde açıklanan diğer yaklaşımlarla karşılaştırıldığında venöz perfüzyon problemine daha pratik ve hızlı çözüm sağlayabilir. Araştırmaya dahil edilen hasta sayısının azlığı başlıca kısıtlayıcı faktör olsa da çalışmanın ana amacı yöntemin uygulanabilir olduğunu ortaya koymaktır. Kontrollü randomize metodoloji ile yapılan geniş popülasyonlu çalışmalar literatüre olumlu katkı sağlayacaktır.

**Anahtar Kelimeler:** Kupa yöntemi; venöz yetersizlik; flep cerrahisi; mekanik negatif basınçlı drenaj yöntemi

### ABSTRACT

**Background:** Venous insufficiency after flap surgery is an unpredictable complication that can lead to flap loss. Several approaches have been described to eliminate the venous problems after flap surgery, but it still remains unsolved. In this study, we aimed to demonstrate the application of the cupping method to treat the venous compromise in the flaps.

**Patients and Methods:** Patients with flaps undergoing mechanical negative pressure drainage due to venous compromise were included in the study. Only procedures with pedicled island flaps were included to exclude cases of venous insufficiency due to thrombosis or anastomotic problems. Patients with free flaps, perforator flaps and skin-connected flaps were also excluded. Demographic data (age, sex), mean duration and frequency of application, complications were recorded.

**Results:** Eight patients were included in the study with a mean age of 40.3 years. A parascapular flap was performed in four patients, a transverse rectus abdominis flap in three patients and a medial gastrocnemius musculocutaneous flap in one patient. The mean duration of mechanical negative pressure drainage was 2.8 days and the mean frequency of application was 4.6 times per day. The mean duration of the procedure was 2.25 minutes. Two patients underwent revision surgery on postoperative day 5 under local anaesthesia due to marginal necrosis of the flap. There were no complications in the other patients.

**Conclusion:** Compared to other approaches described in the literature, the cupping method may provide a more practical and faster solution for venous congestion. Although the limited number of patients seems to be a limitation of the study, the main priority of the study was to demonstrate the applicability of the method. A large population study with a controlled randomised methodology will make a positive contribution to the literature.

**Keywords:** Cupping method, venous compromise, flap surgery, mechanical negative pressure drainage method

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## INTRODUCTION

The flap concept, which forms the infrastructure of reconstructive surgery, is the most preferred of the repair techniques. Flaps are preferred not only for functional reconstruction of difficult and complicated defects, but also for achieving good cosmetic results in appropriate cases. The techniques of flap surgery have been developed over many years of experience. However, the predictability of surgical procedures is still inadequate. Patient-related factors such as wound healing problems, comorbidities, smoking; trauma-related parameters such as type of injury, wound depth and impact of trauma energy; and surgical-related factors such as pedicle injury during harvesting, flap planning wider than the angiosome, etc. should be addressed among the reasons for flap failure (1-3).

Venous insufficiency after flap surgery is an unpredictable complication that can lead to flap loss (4,5). Venous compromise is theoretically defined as a blockage of venous outflow, although arterial perfusion remains intact for some time. The propensity for thrombosis due to low blood flow velocity and collapse during pedicle rotation manoeuvres are some of the etiological factors of venous perfusion problems. If left untreated, increased venous pressure irreversibly affects arterial flow and tissue perfusion.

Several studies have investigated venous drainage insufficiency in the flaps, but no data are available on the timing of clinical onset of venous compromise. During clinical follow-up, mauve-purple colour changes, shortening of filling time and increasing oedema are the main signs of venous outflow obstruction in the flap (6). After early diagnosis, removal of tissue tension (removal of sutures, etc.), re-adaptation of the flap to the donor area or provision of venous blood drainage from the flap are the most commonly used approaches. Application of heparin solution to the punctured tissue or leech therapy are the methods used to achieve venous drainage (7,8). However, these treatments may not be able to resolve venous compromise and flap failure, especially in the flaps with high tissue volume.

To the best of our knowledge, the treatment method of negative pressure to achieve venous blood drainage from flaps, especially those with high tissue volume, has not been described in the literature. The aim of this study was to demonstrate the applicability of negative pressure drainage tools, used in cupping therapy, in the flaps with venous compromise to provide venous blood drainage. Our aim was to obtain a more sterile and controlled drainage compared to leeches, etc., and to reduce the number and duration of procedures by draining more venous blood at one time using these tools.

## PATIENTS AND METHODS

The patients with flaps who underwent mechanical negative pressure drainage due to venous compromise were included in the study. Data were collected retrospectively from case series operated between November 2020 and May 2023. Only procedures with pedicled island flaps were included to

exclude cases of venous insufficiency due to thrombosis or anastomotic problems. Patients with free flaps, perforator flaps and skin-connected flaps were also excluded. Approval was obtained from the local ethics committee (2023-0132). Written and verbal consent was obtained from the patients. First, to ensure that the problem was not caused by the haematoma, pedicle tension or pressure in the tunnel, a few stitches were removed and the underlying wound was checked. Mechanical negative pressure drainage was then applied and followed postoperatively by the same surgeon.

### **Mechanical negative pressure drainage**

The device, which is often used for cupping therapy in traditional and complementary medicine, consists of a part that creates negative pressure with its piston and a chamber that collects the venous blood (Figure 1a). First, the area with the venous perfusion problem is prepared for the procedure by cleaning with povidone iodine. After making a tiny incision with an 11 blade scalpel, the chamber is placed centrally (Figure 1b). Vacuum is then applied to connect the parts of the tool. The plunger is pulled out maximally so that drainage can be achieved with the same pressure in all patients. As the amount of blood increases and the tissue swelling decreases, the connection between the chamber and the tissue separates. After removal of the device, bleeding is stopped by applying light pressure to the incisions. Clinical signs of venous insufficiency were the main parameter determining the number of procedures per day. Demographic data (age, sex), mean duration and frequency of use, and complications were recorded.

## RESULTS

This retrospective study included 8 patients who underwent mechanical negative pressure drainage due to venous perfusion problems (Table 1). Four of the patients underwent parascapular flap surgery for their axillary defects after removal of hidradenitis suppurativa, while three patients underwent pedicled transverse rectus abdominis muscle (pTRAM) flap after mastectomy. Venous drainage insufficiency occurred in one patient after medial gastrocnemius musculocutaneous flap for knee reconstruction.

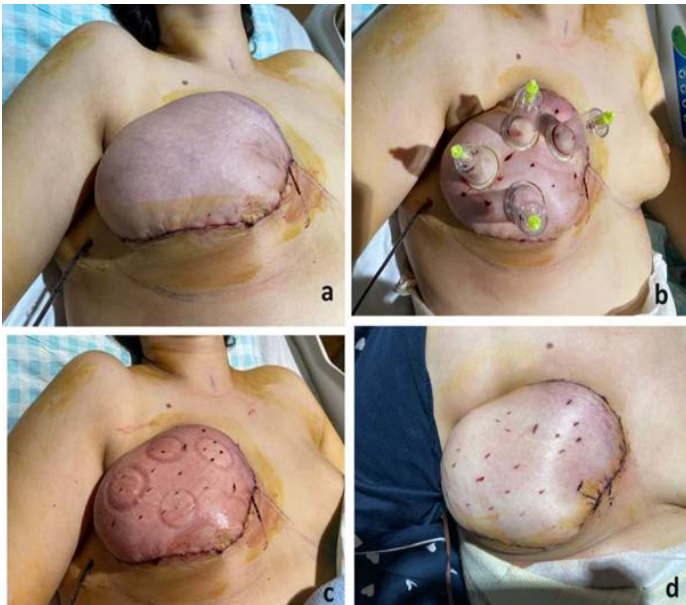
The F:M ratio was 4:4 and the mean age was 40.3 years



**Figure 1.** a-A device used in a cupping treatment; b- An application of the tool in the flap with venous compromise.

**Table 1.** Characteristic features of the patients included in the study (TRAM: transverse rectus abdominis myocutaneous).

Patients (n)	Age	Gender	Flap	Frequency of mechanical negative pressure drainage (per day)	Duration of mechanical negative pressure drainage (day)	Duration of each session (min)	Complication
1	48	F	TRAM flap	6	3 days	3 min	None
2	52	F	TRAM flap	6	4 days	4 min	None
3	32	M	Parascapular flap	4	2 days	2 min	Marginal necrosis
4	26	M	Parascapular flap	5	2 days	2 min	None
5	27	M	Parascapular flap	4	3 days	1 min	None
6	38	F	TRAM flap	5	3 days	3 min	None
7	33	M	Parascapular flap	3	3 days	2 min	Marginal necrosis
8	66	F	Medial gastrocnemius musculocutaneous flap	4	2 days	1 min	None

**Figure 2.** a- venous insufficiency was occurred immediate after the surgery of pedicled transverse rectus abdominis muscle flap for breast reconstruction; b, c- cupping treatment was applied to the several parts of flap in order to obtain adequate venous drainage from the flap; d- venous insufficiency was totally recovered in the postoperative second day.**Figure 3.** a- color changes were occurred immediate after the flap surgery of parascapular island flap; b- a distal part of the flap had venous insufficiency in the postoperative first day; c- a cupping therapy was applied and recovery was obvious in the postoperative second day; d- there was no need for venous drainage in the postoperative third day and only lateral margin of the flap was revised and restitched.

(min. 26, max. 66). Clinical signs of venous drainage problems were observed in all patients on postoperative day 1. The mean duration of mechanical negative pressure drainage was 2.8 days and the mean frequency of application was 4.6 times per day. Due to the large volume of the pTRAM flap, more than one area was used for safe drainage in each application (Figure 2 a-d). The mean duration of the procedure was 2.25 minutes.

Mean follow-up was 18.6 months. Marginal necrosis occurred in two patients in whom the parascapular flap was revised after debridement under local anaesthesia on postoperative day 5 (Figure 3 a-d). There were no complications in the other patients. After a healing period of one month, no skin deformities caused by the multiple incisions on the flaps were observed.

## DISCUSSION

Researches have been carried out to identify venous compromise in the early postoperative period of flap surgery. It has been suggested that differences between systemic and flap blood glucose levels may predict intraoperative venous compromise. It has also been reported that blood glucose >62 mg/dL measured from the flap may predict the possibility of venous compromise for the next 48 hours after surgery with 90% sensitivity (9). It has also been shown that flap perfusion problems can be analysed from photographs using various digital surface scanning software (10). However, once venous compromise has occurred, almost all approaches aim to drain the venous outflow from the flap. One of the most commonly used methods is to bleed a flap with a needle or scalpel and wash with heparinised solution to maintain bleeding for a while (11). In addition, leech therapy is also preferred by the majority of surgeons to achieve continuous bleeding from the tissue (12). This study has shown that controlled bleeding can also be achieved by the mechanical negative pressure drainage method, which appears to be more practical than the above approaches.

In their experimental study, Koh et al. found that flaps could be made more resistant to postoperative complications after preconditioning with the cupping method (13). It was reported that the occurrence of necrosis was minimised after cupping application for 30 min with continuous negative pressure of -25 mmHg for 5 days, which enriched the flaps with vascularisation. In the other study, the cyclic mode of pressure-controlled cupping (0 to -25 mmHg pressure for 30 minutes with the cyclic mode once a day for 5 days) was found to be more effective in increasing flap viability than continuous application (14). In another clinical trial, it was also found to be safe to apply the negative pressure treatments immediately after critical major replantations (15). We studied the drainage of venous blood from the area accumulated in the flap by the cupping method. Although not directly related to flap viability, we aimed to prevent arterial perfusion from being blocked by increasing venous pressure.

The salvage protocols used in venous congestion of the flaps were evaluated in the systematic review (7). According to the results, leech therapy seems to be a safer method

compared to the other protocols, as many studies present detailed and comprehensive data on leech treatments. There are several disadvantages of the leech therapy, although it is often preferred by surgeons. Patient compliance is the most important issue, as patients should be taught to adapt to leeches during treatment. Disadvantages include leech care, housing conditions, migration from the target area, infection and uncontrolled bleeding. The heparin effect in the saliva of leeches helps constant bleeding, which is sometimes necessary in certain cases. The amount of venous blood collected in the chamber per session is more than the leeches can provide, thus eliminating the need for additional bleeding after removal of the device, which makes this method safer. The method presented in our study aimed to provide a practical and quick solution for venous congestion in flaps, avoiding the above problems.

Parascapular flaps may present venous insufficiency, especially when applied to axillary defects, due to pressure in the intertriginous area (16). Inadequate venous drainage can be managed with minimal changes in surgical planning. Maintaining skin continuity in certain parts of the flap may obviously reduce the risk of venous insufficiency due to the contribution of the dermal venous plexus. Therefore, we did not include the patients who underwent reconstruction with skin-intact flaps. Patients with perforator and free flaps were also excluded in order to standardise the data, as there are more than one ethiological factors causing venous insufficiency in these cases. In addition, a delay procedure may also be used in pedicled flaps to prevent venous insufficiency (17). Several medical treatments have been proposed to increase the survival rate of flaps, but most of them have been proposed for use in arterial rather than venous problems (18,19).

There are several limitations of the approach we used to address the problem of venous perfusion in this study. Firstly, the cupping method can be described as a practitioner-related treatment, although it is practical to use. In addition, unlike the other vacuum-assisted devices, a number of negative pressure is not clear and the pressure decreases in direct proportion to the amount of blood collected in the chamber. There is no evidence on the amount of venous blood that needs to be drained in case of venous compromise. Similarly, in our study, the recovery of the clinical signs of the flap (return from purple to pink colour, normal capillary refill time, decrease in flap swelling) was the parameter that determined the need for venous blood drainage. With this type of drainage, regular control of the blood count becomes very important, especially in the cases with a high tissue volume such as TRAM or DIEP flaps.

## CONCLUSION

Venous compromise is one of the most common problems after flap surgery and should be well managed to avoid flap failure. Compared to other approaches described in the literature, the cupping method may provide a more practical and faster solution to venous compromise. Although the limited number of patients seems to be a limitation of the

investigation, the main priority of the study was to demonstrate the applicability of the method. This is a preliminary study in the clinical category and a large population study with a controlled randomised methodology will make a positive contribution to the literature.

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