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Corset trunkoplasty is able to preserve postoperative abdominal skin sensation in massive weight loss patients

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ABSTRACT

Conventional abdominoplasty techniques commonly cause postoperative peri- and infraumbilical skin hypesthesia due to abdominal skin flap undermining. The aim of this study was to evaluate abdominal skin sensation after corset trunkoplasty in massive weight loss patients. Forty-nine massive weight loss patients suffering from excess skin underwent corset trunkoplasty between April 2017 and July 2021. Patient demographics and perioperative complications were recorded. Sensibility of the abdominal skin was measured in three qualities postoperatively using a Semmes-Weinstein monofilament, Tip-Therm[®] device for thermal sensation and a cotton wooden stick for sharp/blunt discrimination. Results were compared with a control group of healthy individuals to create a baseline. Revision surgery for major complications was necessary in five cases (10%) including hematoma and major wound healing disturbances. Minor complications that did not require surgical intervention were observed in eight cases (16%). Postoperative abdominal sensibility did not show any significant difference between the patient and the control group in all 16 measured areas. Sharp/blunt and thermal discrimination was positive in all patients for the whole abdominal surface area. The corset trunkoplasty technique is able to address both horizontal and vertical soft tissue excess in massive weight loss patients and at the same time limits loss of sensibility of the abdominal skin. Compared to conventional abdominoplasty techniques the abdominal sensation can mainly be preserved due to absence of undermining abdominal skin flaps.

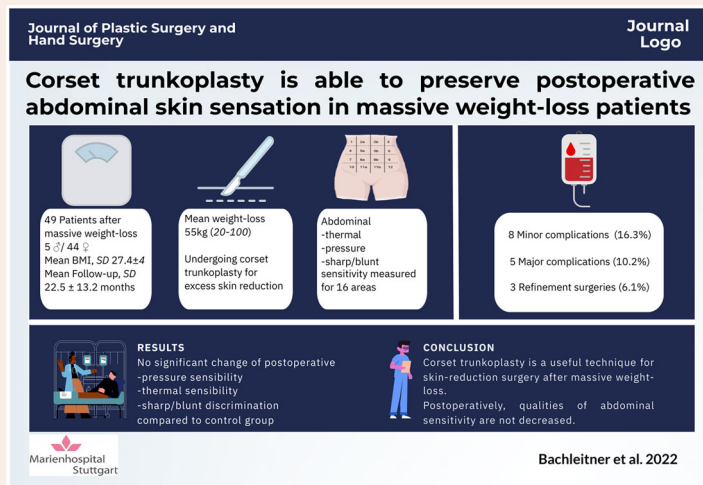
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GRAPHICAL ABSTRACT



Introduction

Obesity and its comorbidities represent one of the most prevalent public health issues today. Bariatric surgery can be an effective treatment for this patient collective resulting in massive weight loss and improvement of overall health. Remission of many obesity-related comorbidities, such as type 2 diabetes mellitus or elevated blood pressure levels and an overall increased life

expectancy can be achieved by bariatric surgery [1,2]. Skin redundancy represents a well-known consequence of bariatric surgeries and massive weight loss. Recurrent rashes and intertrigo due to overlapping skin folds and poor hygiene as well as impaired mobility lower patients' quality of life and self-reliance [3]. Abdominal skin aprons and skin atony of the thighs limit post-bariatric patients ability to participate in normal everyday life. Skin tightening and body lifting operations are known to be able

to address these concerns and help to improve quality of life [4,5]. Today body contouring surgery plays an instrumental role in the completion of the entire weight loss process for patients and is therefore frequently covered by insurances and health care providers, depending on the degree of disability caused by the excess skin [6].

Classical abdominoplasty techniques using a single transverse lower abdominal incision often insufficiently address the entire skin excess in patients after massive weight loss. Since the single lower abdominal transverse incision is unable to address excess skin laxity in the upper abdomen and flank roll area, it does not provide adequate skin tightening and satisfying results. Both the horizontal and vertical skin redundancies have to be corrected in order to achieve sufficient aesthetic and functional results. The inverted-T or similar fleur-de-lis type abdominoplasty techniques are well known since the 1970s and are potent enough to correct horizontal and vertical skin laxity as well as supraumbilical dermatochalasis or fullness in most cases [7,8]. An important drawback of conventional abdominoplasty techniques with a horizontal scar pattern is the associated sensibility deficit below the area of the umbilicus [9]. Burn injuries from using hot-water bottles due to the loss of protective sensibility are not uncommon after abdominoplasties [10]. Additionally, the disturbed lower abdominal sensibility can affect patients' intimacy and love life since the area below the umbilicus represents an erogenous zone extending cranially from the mons pubis [11].

More recently, the so-called corset trunkoplasty was introduced by Moya et al. [12] in 2006 and is able to lift and tighten redundant lateral flank skin and excessive tissue in the upper abdomen. The corset trunkoplasty represents one of the most powerful techniques to address both horizontal and vertical skin excess in post-bariatric patients who lost a third up to a half of their original bodyweight. In addition to the horizontal scar in the bikini-zone, a midline scar similar to the fleur-de-lis abdominoplasty and a transverse breast fold scar are created. Together resembling an eponymous, 90° rotated letter H-pattern scar. No undermining of the tissue is needed in corset abdominoplasty techniques, as the entire anterolateral skin is reduced through elliptical excision and the lateral skin is advanced to the midline, creating an hourglass torso shape similar to wearing a corset. Since the resection is performed without undermining of the adjacent skin, the sensibility of the abdominal wall should be preserved.

The purpose of this study was to objectively evaluate the postoperative sensibility in our corset trunkoplasty patient collective compared to non-operated patients. To our knowledge, this is the first study analyzing the postoperative sensibility of the abdomen in a large patient collective undergoing corset trunkoplasties.

Materials and methods

Between April 2017 and July 2021, 49 consecutive corset trunkoplasty procedures were performed at our department and the postoperative sensibility of the abdominal skin was evaluated postoperatively using a Semmes-Weinstein-Test. Hot/Cold (Tip-Therm® device) and sharp/blunt discrimination (cotton wooden stick) were also analyzed to objectively evaluate the individual patients sensation. Institutional ethical review board approval was given prior to the study and all participants gave their written consent to use of their anonymized data.

Demographics for analysis included age, sex, comorbidity, body mass index (BMI), previous bariatric surgery, number of prior abdominal procedures, operative time, complications, revision surgery, and smoking. Statistical analysis was conducted using Microsoft Excel Software (Microsoft Corp., Redmond, Wash.). Data were checked for consistency and normality. Mean values for intervention and control group were compared issuing independent student's *t*-Test. *p* Values <0.05 were considered statistically significant.

Surgical technique

The planned skin resection was marked prior to surgery in all patients in an upright position using a skin pinch test. Detailed markings of the planned skin resection were made on the operating table, while the patients were under general anesthesia. Preoperative markings include a vertical tapered elliptic midline resection and bilateral tapered curved resections on the level of the pubic line about 8 cm above the vaginal introitus and in a similar curved resection in the bilateral inframammary fold tapering laterally. The inframammary folds (IMF) are marked on the standing male or female patient. Since mastopexy or reduction of the breast is often performed as a separate procedure, the IMF can be used for both procedures, limiting the amount of necessary scars. The lateral end of the horizontal scar depends on



Figure 1. Preoperative markings include a vertical elliptic- as well as a superior and inferior laterally tapered belt-lipectomy. The superior belt-lipectomy lies in the inframammary fold and its bilateral extension, while the inferior one is placed similar to a standard abdominoplasty incision. Markings are performed using a skin pinch test in a standing position and are double checked and adapted in a supine position with both legs in hip flexion.

the access tissue, but usually ends at the posterior axillary line similar to a standard abdominoplasty incision or belt-lipectomy. Intraoperative markings are shown in Figure 1. While the difference in male and female body composition and tissue distribution needs to be accounted for, the same 'landmarks' are used in male and female patients. The vertical resection lines are determined again on the operation table using a skin pinch test. To evaluate this, the redundant tissue was pulled toward the midline and the



Figure 2. Vertical resection.



Figure 3. Horizontal resection of the cranial skin redundancies.



Figure 4. Horizontal resection of the caudal skin redundancies.

skin edges were temporarily stapled together demonstrating the potential wound edge. The provisionally stapled skin edges are then marked with a continuously drawn line and the staples are removed to reveal the resection template. After all markings are double-checked, the planned incision lines are infiltrated with a tumescent solution (500 ml NaCl + 20 ml 7.5 mg/ml Ropivacainhydrochlorid + 2 ml Adrenaline 1:1000) to minimize blood loss. The first surgical step consists of a circular incision around the umbilicus and its dissection down to the superficial abdominal fascia. Then the vertical skin resection, reaching from the xiphoid down to the pubic area, is made without any lateral undermining (Figure 2). In case of rectus diastasis, surgical repair using long lasting resorbable suture material (0-PDS/0-Vicryl) is performed. After precise hemostasis using bi- and monopolar cautery the skin edges are approximated subcutaneously using single 2-0, and 3-0 Vicryl sutures. The skin excess leaves dog-ears on the superior and inferior end of the vertical incision, which is consequently addressed with the laterally tapered and curved horizontal resections in the upper and lower abdomen.

The upper abdominal apron is resected first using a pinch test and adjusting the markings. Depending on the amount of redundant skin the incision reaches back to the posterior axillary line. The resection is performed en-bloc without undermining the surrounding tissue.

In order to contour the lower waistline, the patients are brought into a beach chair position flexing the hip up to 60 degrees. Then the horizontal bilateral skin redundancy is marked again using a skin pinch test and resected accordingly (Figures 3 and 4). After hemostasis, the umbilicus is incorporated in the midline scar at its anatomical position and wound closure is performed using single interrupted inverted subcutaneous 3-0 Vicryl and intracutaneous 3-0 Monocryl sutures. Between three and five closed suction drainages are used, depending on the individual wound surface area. Dressing includes skin closure strips and an abdominal binder, which should be worn for six weeks postoperatively. A pre- and six-month postoperative result is shown in Figure 5.

Sensibility evaluation

The same examiner (K.B.) carried out all sensibility examinations. The postoperative examinations were carried out in supine position three to six months postoperatively. The abdominal surface area was divided into 16 sensibility areas. The areas flanking the



Figure 5. A 41-year-old female patient, before and 6 months after corset trunkoplasty.

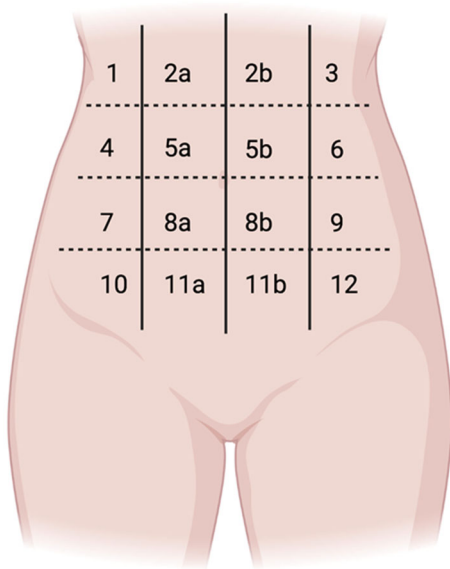


Figure 6. Abdominal areas for sensibility assessment.

vertical midline incision area were subdivided into left and right sides (Figure 6). Three different sensorial tests were conducted on each surface area to evaluate sharp/blunt discrimination, hot/cold temperature and pressure touch.

To evaluate pressure-sensitivity, Semmes-Weinstein monofilament test (Gills W Long, Hansen's Disease Centre, Carville, LA) was used [13]. Semmes-Weinstein monofilaments were applied perpendicularly in the central point of each test site using light pressure until bending of the probe was observed. The timeframe for sensorial stimulation was five seconds and the contact was repeated three times. The smallest perceived monofilament was recorded for each abdominal area. Semmes-Weinstein monofilaments in sizes 6.65, 4.56, 4.31, 3.61 and 2.83 (logarithm of 10 times the force in tenths of milligrams required to bow the monofilament), corresponding to cutaneous pressure thresholds of 439, 47.3, 33.1, 17.7 and 4.86 g/mm², respectively.

Sharp/blunt discrimination was evaluated by touching the skin surface with a cotton stick, either with its soft or wooden end. Thermal sensibility was measured using the Tip-Therm® device (AXON GmbH Dusseldorf, Germany) [14]. Data were recorded as positive if the patient was able to feel the stimulus and negative if the patient was unable to feel anything.

Results

Study sample characteristics

Forty-nine patients (44 female, 5 male) were included in our study (Table 1). The mean follow up was 22.5 months (SD 13.2) and mean age was 46.8 years at time of surgery (SD 11.8). Twenty-eight (57.1%) patients had undergone bariatric surgery (gastric sleeve or gastric bypass) prior to the abdominoplasty and the mean weight loss was 55.5 kg (SD 17.1, Range 20–100 kg). Average BMI at the time of surgery was 27.4 kg/m² (SD 4.0) and 17 (22.5%) patients were active smokers while five (10.2%) patients were diabetics. Thirty-one patients underwent prior abdominal surgeries including appendectomy (9/18.4%), caesarean (9/18.4%) or cholecystectomy (13/26.5%). Mean operating time was 132 min (SD 27.5).

The control group consisted of 15 healthy volunteers (10 female, 5 male) without prior abdominal surgeries. Mean age was

Table 1. Overview of patient demographics.

Characteristic	Number (%)	Mean	SD (Range)
Cases included	49 (100)		
Sex			
Female	44 (89.8)		
Male	5 (10.2)		
Age, years		46.8	11.8
BMI at time of surgery		27.4	4.0
Weight loss, kg		55.5	17.1 (20–100)
Previous bariatric surgery			
Yes	28 (57.1)		
No	21 (42.9)		
Follow-up, months		22.5	13.2
Hospital stay, days		7.8	2.1
Smoking			
Yes	17 (22.5)		
No	32 (77.5)		
Diabetes			
Yes	5 (10.2)		
No	44 (89.8)		
Operating time, minutes		131.8	27.5

Table 2. Comparison of average cutaneous pressure thresholds in each abdominal area.

Zone	Sensitivity threshold (g/mm ²)				p
	Intervention		Control		
	Mean	SD	Mean	SD	
1	6.17	3.93	6.57	4.52	0.379
2a	5.38	2.57	6.57	4.52	0.172
2b	5.91	3.55	6.57	4.52	0.303
3	5.38	2.57	6.57	4.52	0.172
4	5.65	3.11	6.57	4.52	0.234
5a	5.65	3.11	5.72	3.32	0.471
5b	5.91	3.55	6.57	4.52	0.303
6	5.65	3.11	7.43	5.32	0.117
7	5.38	2.57	4.86	0	0.079
8a	7.53	6.07	6.57	4.52	0.257
8b	6.75	5.49	6.57	4.52	0.451
9	5.65	3.11	7.43	5.32	0.117
10	6.75	5.49	5.72	3.32	0.190
11a	6.43	4.25	5.72	3.32	0.250
11b	5.38	2.57	6.57	4.52	0.172
12	6.48	5.26	7.43	5.32	0.276

37.7 years (SD 12.8) and mean BMI was 25 kg/m² (SD 3.5). Two (16.6%) were active smokers while none of them had known comorbidities.

Thermal and pain sensibility

All 49 (100%) patients reported positive hot/cold and sharp/blunt discrimination in all 16 areas tested.

Cutaneous pressure threshold

The smallest perceived fiber of the Semmes-Weinstein test for each abdominal area was recorded and means were compared between the subjects and the control group. The average pressure threshold after surgery ranged between 5.38 and 7.53 g/mm² versus 4.86 and 7.43 g/mm². While the postoperative sensibility was lowest in the infraumbilical areas, no statistical differences were shown for any of the tested areas between the interventional group and the control group (Table 2).

Complications

Complications were analyzed using the Clavien–Dindo classification (Table 3) [15]. Major complications (Class IIIa–IIIb) needing a

Table 3. Overview of complications by Clavien–Dindo classification [15].

	n	
	Yes (%)	No (%)
Class I	2 (4.1)	47 (95.9)
Class II ^a	4 (8.2)	45 (91.8)
Class IIIa	6 (12.2)	43 (87.8)
Class IIIb	5 (10.2)	44 (89.8)
Hematoma	3 (6.1)	46 (93.9)
Wound dehiscence	2 (4.1)	47 (95.9)
Touch-up procedure ^b	3 (6.1)	46 (93.9)

^aPostoperative anemia needing blood transfusion.

^bDog ear excision, Correction of the umbilicus, Correction of persisting loose skin.

revision surgery were observed in five (10.2%) patients and included three (6.1%) hematomas and two cases of wound dehiscence (4.1%). Six (12.2%) patients received needle punctures due to seroma formation. Postoperative hypovolemic anemia needing a blood transfusion was recorded in four (8.2%) patients and other minor complications (Class I–II), that did not require any surgical intervention, were observed in two (4.1%) patients. No class IV or V complications were recorded. Minor operative corrections such as dog-ear resection or correction of the umbilical scar were necessary in three (6.1%) cases postoperatively.

Discussion

The number of people undergoing bariatric surgery is rapidly increasing and so do the numbers of patients in need for post-bariatric surgery. The benefits of massive weight loss include a significant reduction of the overall risk for coronary heart disease, Diabetes mellitus type 2, herniated vertebral discs and osteoarthritis of the lower extremity together with an increased life expectancy. Unwanted side effects of massive weight loss include consequent skin excess with overhanging skin aprons causing intertrigo, a missing body contour and psychological suffering including social anxiety. Body contouring surgery is able to address these problems, alleviate patients suffering and increase quality of life [4,5].

Traditional abdominoplasty techniques often fail to address the adjacent tissue in the upper abdomen and flanks and due to excessive undermining of the abdominal flaps patients frequently suffer from a lack of sensation, especially in the area between the umbilicus and the mons pubis [9,16].

New modifications have been postulated to address these shortcomings. The corset trunkoplasty described by Moya et al. creates an hourglass torso shape and improves the overall anterior truncal contour [12]. Acevedo et al. further evaluated the benefits of this technique and recommends the procedure in patients who had previous open cholecystectomy with an oblique scar in the upper right abdomen [17]. Using the corset trunkoplasty incision technique without any undermining of the abdominal flaps has fewer adverse outcomes compared with traditional abdominoplasty techniques according to their study [17].

Several studies have demonstrated that the periumbilical area are most affected by altered sensibility in patients after abdominoplasty [9,18–21]. Ducic et al. report that 7.67% of patients do suffer from a decreased sensation of the abdominal skin following abdominoplasty surgery [22]. The decreased postoperative sensibility can cause discomfort and even make patients prone to burns with hot-water bottles, heating pads or electric blankets [10]. Furthermore, the loss of skin sensation in the lower abdomen, or dysesthesia due to lateral femoral cutaneous nerve entrapment affects an important extended erogenous zone in some patients and affects patients' love life to a certain degree [23].

Farah et al. report a statistically significant number of patients with decreased sensibility in various sensibility modalities in the hypogastric area, inferior to the umbilicus, after conventional abdominoplasty surgery. Decreased sensibility to hot and cold temperature was observed in the pubic area, and the sensibility to pressure decreased significantly in all areas of the abdomen when compared with a control group [20]. These results were confirmed by various other studies. Fels et al. report a significant difference ($p < 0.05$) between people without surgery and those who had undergone a classic abdominoplasty for all regions tested. The regions of the abdominal skin surrounding the umbilicus presented the highest index of analgesia and thermal anesthesia, as well as higher cutaneous pressure thresholds. This significant reduction in all qualities of sensation are still present up to an average of 6.8 months after surgery [19]. Novais et al. report that at 3.5 years after surgery, a high percentage of patients still did not recover touch (26%), pain (44%) or sensibility tested by the Semmes-Weinstein 5.07/10-g monofilament (68%). A considerable proportion of patients (68%) still presented sensibility alterations in the infraumbilical area 3.5 years after the abdominoplasty operation [17]. Presman et al. report abnormal abdominal skin sensation in 81% of patients, including hyposensitivity and hypersensitivity. Many patients were not (32%) or only minimally (44%) affected by sensory abnormalities, but (24%) were at least moderately bothered of which 7% were bothered a lot [24]. Even if an abdominoplasty with preservation of scarpa's fascia was performed, no significant difference of sensation in the lower abdomen could be found compared to conventional abdominoplasty techniques [18].

Thirty-one patients in our sample reported minor previous abdominal surgeries. From experience with our patients we know that especially after c-sections there can be reduced sensibility of the abdomen, whereas smaller laparoscopic surgery mostly only result in reduced or altered sensibility directly on the scar. Since we did not collect preoperative data on abdominal sensitivity, we theorize that removing the skin and underlying tissue beneath the scar and moving the healthy tissue in their place without undermining the tissue preserves the nerves and potentially improves sensibility.

The loss of sensibility after a conventional abdominoplasty including undermining of the upper abdominal soft tissue flap can be explained by innervation and anatomy of the abdominal wall. The anterior branches of the 6th–12th intercostal nerves travel in a plane between the internal oblique and transverse abdominis muscles accompanied by artery and vein. These nerves penetrate the internal oblique fascia and separate into two individual branches, which enter the posterior sheath of the rectus abdominis muscle, resulting in segmental motor nerve supply. Sensitive innervation is supplied through separate perforating branches ultimately arborizing in the skin [19]. During conventional abdominoplasty skin flap elevation the anterior branches are inevitably severed, causing sensibility loss in the midline and lower abdominal region. The laterally extending suprapubic incision furthermore contributes to impairment of any additional sensory innervation from the branches of the iliohypogastric and ilioinguinal nerves and thus further decreases sensibility around the infraumbilical region. The preserved sensation in the upper abdomen can be explained by the lack of undermining in this area in conventional abdominoplasty techniques and sparing of the lateral cutaneous branches of the intercostal and subcostal nerves in this area. The extent of undermining of the abdominoplasty skin flaps represents the main determining factor of decrease in sensibility [19]. The lack of undermining of skin flaps in corset abdominoplasty techniques, therefore,

contributes to maintenance of normal sensation of the abdominal skin in all areas.

These observations were also confirmed in fleur-de-lis or anchor-line abdominoplasty techniques, which avoid abdominal skin flap undermining likewise and therefore skin sensorial function [20,25]. Our data results resemble a similar preservation of sensation as seen in these modified abdominoplasty techniques. Avoiding undermining furthermore preserves normal blood supply through abdominal wall perforators resulting in decreased inverted T-junction wound dehiscence or wound-healing problems compared to conventional abdominoplasty techniques [17]. The corset trunkoplasty technique has also been associated with fewer wound complications when pre-existing abdominal scars were present [17]. Combinations of hernia repair and corset trunkoplasty procedures did not show an increased rate of major wound complications and provided a higher quality of life in this group of patients as well [26].

Besides all the advantages regarding abdominal surface skin area sensibility in all qualities of sensation, the corset trunkoplasty technique ensures an improved hour-glass-like definition of the torso and is able to achieve an improved harmony of the entire trunk's aesthetic unit [12,27]. Since massive weight loss does not only cause excess skin in the anterior trunk but circumferentially, body contouring surgery has to address both upper abdominal skin and the waist, using two directions for skin tensioning in a perpendicular orientation. The corset trunkoplasty technique uses the horizontal as well as the vertical axis to redistribute the skin after dermatolipectomy, which enables maximum tightening of the skin to create a more harmonic body shape. The en-bloc skin excisions, resembling a perpendicular letter 'H' incision pattern, allows a unique redistribution of the skin on the flanks, thereby tightening and flattening the back rolls as well. The technique furthermore enables an improvement of mons pubis ptosis in one stage without any change of patient positioning [27].

Our study confirms that the corset trunkoplasty technique is able to address horizontal and vertical skin excess after massive weight loss and at the same time loss of sensibility. Compared to conventional abdominoplasty techniques, abdominal skin sensation can mainly be preserved due to absence of undermining of abdominal skin flaps. A limitation of this study is its retrospective design and potential unwanted selection bias, although consecutive cases were included. Second, the operations were not carried out by a single surgeon, but different surgeons from the department including consultants and residents. Prospective studies with pre- and post-operative sensibility measurement are needed, potentially comparing different abdominoplasty techniques.

Conclusion

The corset trunkoplasty technique is able to address both horizontal and vertical soft tissue excess in massive weight loss patients without impairing the sensibility of the abdominal skin. Compared to conventional abdominoplasty techniques the abdominal sensation can mainly be preserved due to absence of undermining of abdominal skin flaps.

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The authors report there are no competing interests to declare.

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