

Effect of hydroxyethyl cellulose soluble hemostatic gauze on hemostasis in facial contouring surgery

Hong Du, MD, Dong Zhang, MD, Guodong Song, MD, Xianlei Zong, MD, Xiaolei Jin, MD* 

Abstract

Background: In facial contour surgery, due to the narrow field of vision in the oral approach and the abundant blood supply to the maxillofacial area, hemostasis is not easy. The purpose of this study was to evaluate the hemostatic effect of soluble hemostatic gauze.

Methods: We organized a prospective randomized study of 282 patients receiving facial contouring surgery (4 types of procedures in total) during 2016.1.1 to 2018.12.30. For each type of procedure, patients were randomly divided into study group (received hemostatic gauze) and control group (received sterile gauze). Two groups were compared for each type of procedure regarding 5 major perioperative variables: intraoperative blood loss, operation time, 24-hour postoperative drainage volume, total postoperative drainage volume, and postoperative drainage time. Correlation between variables was analyzed.

Results: Compared with control group, the study group had higher amount of intraoperative blood loss in mandibular angle ostectomy (MAO) ($P < .01$) and mandibular angle-body-chin curved ostectomy procedures ($P < .05$), less total postoperative drainage volume in MAO ($P < .01$) but not in malarplasty with MAO and partial masseter muscle resection along with MAO procedures. No significant difference was observed between respective study and control groups regarding operation time, 24-hour postoperative drainage volume, and postoperative drainage time in any of the 4 types of surgery. In all 4 types of procedures, a strongly positive correlation was observed between total drainage volume and 24-hour drainage volume in both the study and control groups ($r: 0.88-0.97, P < .01$).

Conclusion: The effect of hydroxyethyl cellulose soluble hemostatic gauze on hemostasis in facial contouring surgery is associated with the type of surgery, which can reduce the risk of postoperative bleeding in MAO. However, for surgery with relatively large amount of intraoperative and postoperative bleeding, the hemostatic gauze had a limited postoperative hemostasis efficacy, which needs further evaluation.

Abbreviations: DT = postoperative drainage time, 24-DV = postoperative drainage volume within 24 hours, i-BD = intraoperative blood loss, MAO = mandibular angle ostectomy, MABCCO = mandibular angle-body-chin curved ostectomy, MP + MAO = malarplasty with mandibular angle ostectomy, MM + MAO = partial masseter muscle resection along with mandibular angle ostectomy, ORC = oxidized regenerated cellulose, OT = operation time, t-DV = postoperative total drainage volume.

Keywords: facial contouring surgery, haemostasis, hydroxyethyl cellulose, malarplasty, mandibular angle ostectomy, masseter muscle resection, soluble hemostatic gauze

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

16th Department, Plastic Surgery Hospital, Chinese Academy of Medical Sciences, Peking Union Medical College, Shijingshan District, Beijing, China.

* Correspondence: Xiaolei Jin, 16th Department, Plastic Surgery Hospital, Chinese Academy of Medical Sciences, Peking Union Medical College, #33 Badachu Road, Shijingshan District, Beijing 100144, China (e-mail: professor.jin@yahoo.com)

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1. Introduction

Due to differences in cultural backgrounds, Eastern and Western peoples' aesthetic appreciation towards facial contour is slightly different. Broad chin, hypertrophic masseter, prominent mandibular angle, and malar are typical of a less attractive square face in the oriental settings. To acquire a softer and more attractive facial contour, there are several procedures that can change facial skeletons, that is, reduction malarplasty, mandibular angleplasty, mandibular angle-body-chin curved osteotomy (MABCCO), and partial masseter muscle resection. Regarding surgical approaches, intraoral or extraoral were the main options.^[1] The former approach is superior to the latter in that it neither leaves scar nor easily damages facial nerves.^[2] However, in the case of intraoral approach, intraoperative bleeding is difficult to stop due to narrow visual field and rich regional blood supply, which may in turn lead to complicated surgery, airway obstruction, postoperative swelling, or even death.^[3] Effective hemostasis, therefore, is of great significance in ensuring surgical safety and efficacy.

Both local and systemic interventions can be applied to reduce bleeding. Systemic measures include antifibrinolytic drugs,^[4] desmopressin,^[5] aprotinin,^[6] and hypotensive anesthesia.^[7–10] Local interventions like suture ligation, electrocoagulation, packing compression, and local hemostatic agent can also achieve efficient hemostasis. However, suture ligation primarily works against bleeding of large facial vessels, and is insufficient against blood ooze in the surgical area. Blind repeated clamping of electric coagulation, on the other hand, can lead to accidental injury of facial nerves, expand the bleeding point sometimes, and may even cause fatal massive hemorrhage. Additionally, topical hemostatic agents, which generally refer to scaffolding agents, biologically active agents, and vasoconstrictive agents,^[11] are reasonable and effective hemostasis actor as well. And the most widely used scaffolding agents are modified collagen, oxidized regenerated cellulose (ORC), absorbable gelatin, and chitosan dressing.^[12–14]

An ideal hemostatic agent must be efficient, safe, and meanwhile easily available.^[15] Since being introduced first-time by literature in the 1940s, ORC has been widely used for intraoperative hemostasis.^[16,17] However, the acidic products generated by ORC degradation are hostile to wound healing,^[17] and can potentially damage peripheral nerves.^[18] In this study, we adopted a soluble hemostatic gauze for intraoperative hemostasis, of which the primary content is sodium hydroxyethyl cellulose, a nonionic cellulose with good water solubility and safety.^[19,20] So far, compared with more studies on hydroxymethyl cellulose gauze, there are fewer clinical studies on the hemostatic effect of gauze with hydroxyethyl cellulose as the main component. Therefore, we try to investigate the hemostatic efficacy of this hydroxyethyl cellulose soluble hemostatic gauze in facial contouring surgery.

2. Methods

2.1. Materials and ethics statement

The hydroxyethyl cellulose soluble hemostatic gauze was supplied by the Yunnan Dehua Biopharmaceutical Co.,Ltd (Kunming, Yunnan, China) and was approved for clinical use by the Food and Drug Administration of China (12100000400266049B). Approval was acquired from the ethics committee of Plastic Surgery Hospital of Peking Union Medical

College, Chinese Academy of Medical Sciences (12100000400266049B). All patients signed detailed informed consents.

2.2. Patients

We organized a single-blind, randomized, controlled trial of 282 patients who received 4 types of facial contouring surgeries between January 2016 and December 2018. The 4 types of surgeries are mandibular angle osteotomy (MAO); MABCCO; malarplasty with MAO (MP+MAO); partial masseter muscle resection along with MAO (MM+MAO). For each type, patients were randomly divided into study group (received hydroxyethyl cellulose soluble hemostatic gauze) and control group (received sterile gauze). Patients aged ≥ 18 years and scheduled for facial contouring surgery were eligible for inclusion in the study. Patients who underwent unilateral osteotomy, with evidence of congenital deformity, coagulation disorders, history of hypertension, and taking medication such as anticoagulant drugs or blood thinners or with 2 or more soluble hemostatic gauze were excluded.

2.3. Surgical procedure

Sufficient preoperative communication and design were conducted. All patients were performed under general anesthesia. Four types of techniques (MAO, MABCCO, MP+MAO, MM+MAO) were selected for each patient based on respective indications. Introduction of specific operation can be referred to in our previous work.^[21–24]

As one of the most important step of the surgery, the surgical area was thoroughly rinsed, and hemostatic gauze was placed on the MAO area after removal of bones. Details of this procedure are as follows: a piece of soluble hemostatic gauze (Fig. 1) was cut into several pieces with each piece approximately 2 to 3 cm². After cleaning and drying the osteotomy area with sterile dry gauze, compress several pre-cut hemostatic gauzes onto the bilateral osteotomy area of mandibular angle. The movement should be accurate, rapid, and gentle. In the control group,



Figure 1. The soluble hemostatic gauze with the size of 50 mm × 60 mm. The primary content is nonionic sodium hydroxyethyl cellulose.

Table 1
Comparison of preoperative characteristics between the 2 groups.

		Study group	Control group	P-value
Number of cases	Total cases	122	160	
	MAO	40	51	
	MABCCO	25	37	
	MP+MAO	35	42	
	MM+MAO	22	30	
Age (yr)		27.57 ± 0.37	27.49 ± 0.33	>.05
PT (s)		11.41 ± 0.05	11.30 ± 0.06	>.05
APTT (s)		31.82 ± 0.33	31.69 ± 0.36	>.05
INR		0.94 ± 0.01	1.25 ± 0.31	>.05
Fbg (g/L)		2.44 ± 0.04	2.56 ± 0.20	>.05
TT (s)		18.37 ± 0.13	18.36 ± 0.13	>.05
Hb (g/L)		135.13 ± 0.99	134.75 ± 0.81	>.05

APTT = activated partial thromboplastin time, Fbg = Fibrinogen, Hb = hemoglobin, INR = international normalized ratio, MAO = mandibular angle osteotomy, MABCCO = mandibular angle-body-chin curved osteotomy, MM+MAO = partial masseter muscle resection along with mandibular angle osteotomy, MP+MAO = malarpplasty with mandibular angle osteotomy, PT = prothrombin time, TT = thrombin time.

common sterile gauze was pressed onto the osteotomy area for several minutes and then be removed.

Periosteum and soft tissue were closed with 4-0 absorbable and 1-0 silk sutures layer by layer, a drainage tube was placed along the inferior mandibular border on each side. Bandages with sufficient pressure were applied immediately and the content and color of drained fluids was closely monitored. Patients without complications were discharged 4 or 5 days after surgery.

2.4. Definitions and criteria

Blood loss was calculated from the difference between the fluid in the suction canisters and the irrigation fluid used plus the amount of blood in the surgical gauze estimated by weight^[2,5]; operation time (OT) refers to the duration from incision to the last suture.

Drainage tube could be removed when following criteria were satisfied:

- (1) no significant blockage of drainage;
- (2) the drainage fluid was clear;

- (3) the color of the drainage was light yellow or light red;
- (4) daily drainage volume was lower than 3 mL for 2 consecutive days.

2.5. Statistics

All statistical data analyses were performed with SPSS version 22.0 (SPSS Inc., Chicago, IL). Continuous variables are presented as mean ± standard deviation. Independent samples *t* test was adopted to compare the variables between groups. Correlation between perioperative variables were analyzed with Pearson correlation test. Threshold of statistical significance was set at 0.05.

3. Results

3.1. Patient characteristics

A total of 282 patients were included in the study. No significant differences were found between 2 subgroups regarding demographic characteristics, prothrombin time, activated partial thromboplastin time, international normalized ratio, fibrinogen, thrombin time, or hemoglobin (Table 1) in all 4 surgical techniques. No severe bleeding, seroma, hematoma, thromboembolic event, infection, facial nerve injury, or condylar fracture occurred. All patients were satisfied with the outcome.

3.2. The differences of perioperative variables

The mean intraoperative blood loss (i-BD) in study group was significantly higher than that in control group in both MAO (*P* < .01) and MABCCO (*P* = .04) techniques. However, no statistically significant differences were observed in blood loss between subgroups in MP+MAO and MM+MAO techniques. The total drainage volume was significantly reduced in the study group among patients undergoing MAO procedure (*P* = .0023). In patients receiving other 3 types of procedures, there was no significant difference in OT, 24-hour drainage, and drainage time between 2 subgroups. The amount of 24-hour drainage, total drainage as well as drainage time also did not differ significantly between 2 subgroups (Fig. 2).

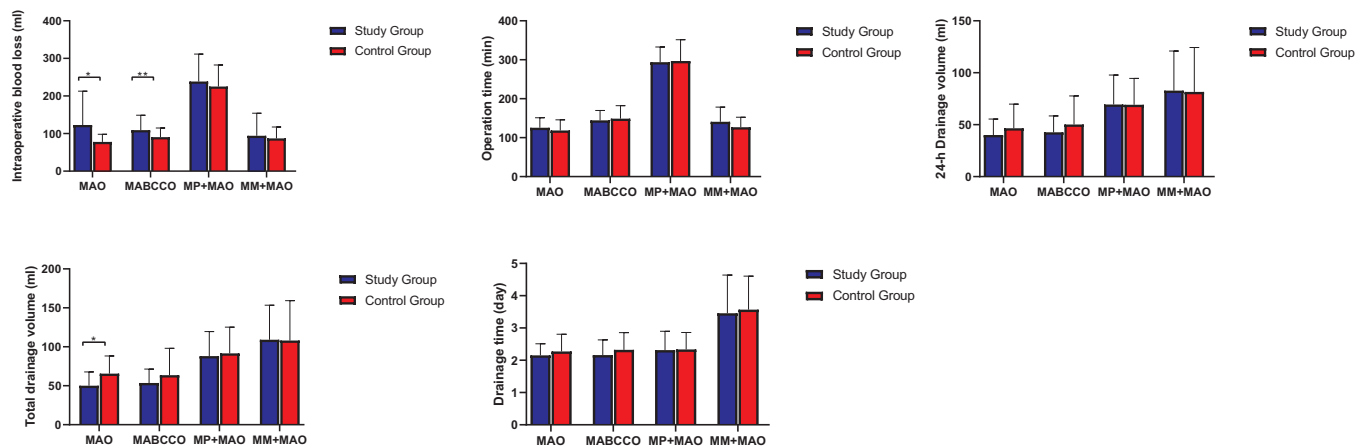


Figure 2. Comparison of perioperative parameters between the 2 groups undergoing different surgery. Study group, with hydroxyethyl cellulose soluble hemostatic gauze. Control group, with sterile gauze. **P* < .01, ***P* < .05. MABCCO = mandibular angle-body-chin curved osteotomy, MAO = mandibular angle osteotomy, MM+MAO = partial masseter muscle resection along with mandibular angle osteotomy, MP+MAO = malarpplasty with mandibular angle osteotomy.

3.3. Correlation analysis

3.3.1. MAO procedure. In study group, postoperative drainage within 24 hours was strongly positively correlated with total drainage volume, and was moderately positively correlated with drainage time (postoperative drainage volume within 24 hours [24-DV] and postoperative total drainage volume [t-DV], $r=0.9$, $P<.01$; 24-DV and postoperative drainage time [DT], $r=0.4$, $P<.01$); meanwhile total drainage volume and drainage time were also moderately positively correlated (t-DV and DT, $r=0.45$, $P<.01$). The same correlations were also found in the control group (24-DV and t-DV, $r=0.97$, $P<.01$; 24-DV and DT, $r=0.35$, $P<.05$, t-DV and DT, $r=0.48$, $P<.01$). Additionally, in the study group, volume of i-BD was moderately positively correlated with total drainage volume (i-BD and t-DV, $r=0.33$, $P<.05$); and in the control group, volume of i-BD was strongly positively correlated with postoperative drainage time (i-BD and DT, $r=0.56$, $P<.01$). Other than the above, no additional correlations were found between any other variables within respective groups.

3.3.2. MABCCO and MP+MAO procedures. Patients received MABCCO in study group with more postoperative drainage within 24 hours had more total drainage, but the drainage time was not prolonged (24-DV and t-DV, $r=0.93$, $P<.01$; 24-DV and DT, $r=-0.04$, $P>.05$); While in control group, the larger the amount of drainage volume within 24 hours, the longer the drainage time (24-DV and t-DV, $r=0.95$, $P<.01$; 24-DV and DT, $r=0.44$, $P<.05$). No correlations among other variables were found within the 2 respective groups. The results of correlation analysis of patients undergoing MP+MAO procedures were identical to the results found in patients receiving MABCCO procedure.

3.3.3. MM+MAO procedure. In study group, postoperative drainage within 24 hours was strongly positively correlated with total drainage volume, but not correlated with drainage time (24-DV and t-DV, $r=0.91$, $P<.01$; 24-DV and DT, $r=0.30$, $P>.05$); The OT was moderately positively correlated with the drainage time (DT and OT, $r=0.43$, $P<.05$). The same correlations were also found in the control group (24-DV and t-DV, $r=0.92$, $P<.01$; 24-DV and DT, $r=0.30$, $P>.05$; DT and OT, $r=0.39$, $P<.05$). In study group, the total amount of drainage was moderately positively correlated with the duration of drainage (t-DV and DT, $r=0.46$, $P<.05$), but this correlation was not found

in the control group (t-DV and DT, $r=0.31$, $P>.05$). No correlation was found among other variables within the 2 respective groups (Table 2).

4. Discussion

Maxillofacial hemorrhage includes intraoperative hemorrhage, delayed postoperative hemorrhage, and hematoma formation. Blood supply is excessively abundant in the maxillofacial region, meanwhile the field of vision in the oral approach is narrow and space for maneuvering is limited, all of which are reasons for the easy damage of blood vessels during operation. Specifically, the most frequently injured blood vessels were the inferior alveolar vessel, maxillary vessel, and vessel in the masseter.^[3] Once injured, massive bleeding will occur. Thus, caution should be emphasized during operation and prevention measures should be adopted. Additionally, extensive subperiosteal dissection before osteotomy and bleeding at the osteotomy surface after osteotomy can also lead to hemorrhage. And the bleeding point in this case is widespread and ligation will be very difficult. Therefore, we should ensure the integrity of the periosteum and gently pull it so as to minimize the injury of muscle and soft tissue during the subperiosteal dissection.

Regarding MAO procedure, the amount of i-BD in the study group (122.75 ± 90.16 mL) was more than that in the control group (77.84 ± 20.33 mL). Volume of i-BD was positively correlated with total drainage volume (i-BD and t-DV, $r=0.33$, $P<.05$) in the study group. However, compared with the control group, the total drainage volume of the study group was significant reduced ($P<.01$). Hence, the administration of hemostatic gauze in MAO is beneficial to decrease total postoperative drainage.

For patients with prominent mandibular angle and broad chin deformity, we adopted a single-stage en-bloc MABCCO technique instead of the standard MAO.^[22] The operation of MABCCO procedure is more complicated than MAO, and has a higher risk of intraoperative bleeding due to increased osteotomy area. Concerning MABCCO procedure, no correlations was found between volume of i-BD and any of the 3 indicators of postoperative bleeding variables (24-DV, t-DV, and DT) in the study group ($P>.05$). And the study group (109.20 ± 39.68 mL) had larger amount of i-BD than the control group (90.00 ± 25.28 mL). There was no significant difference in postoperative

Table 2
The correlation between variables in each group of different type of surgery.

Type of osteotomy	Group	r (24-DV and t-DV)	r (24-DV and DT)	r (24-DV and i-BD)	r (24-DV and OT)	r (t-DV and DT)	r (t-DV and i-BD)	r (t-DV and OT)	r (DT and i-BD)	r (DT and OT)	r (i-BD and OT)
MAO	A	$r=0.90^*$	0.40^*	0.26	0.01	0.45^*	0.33^\dagger	0.17	0.18	0.16	0.23
	B	0.97^*	0.35^\dagger	0.11	0.16	0.48^*	0.20	0.19	0.56^*	0.17	-0.05
MABCCO	A	0.93^*	-0.04	-0.06	-0.11	-0.05	-0.09	0.05	-0.22	0.10	0.13
	B	0.95^*	0.44^*	0.10	0.21	0.45^*	0.14	0.18	-0.17	0.05	-0.03
MP+MAO	A	0.93^*	-0.02	-0.16	0.12	0.17	-0.08	0.18	0.16	0.07	0.14
	B	0.88^*	0.37^\dagger	0.07	0.04	0.56^*	0.08	0	0.08	-0.01	0.30
MM+MAO	A	0.91^*	0.30	-0.09	-0.03	0.31	-0.13	0.10	-0.04	0.43^\dagger	0.30
	B	0.92^*	0.30	-0.18	0.23	0.46^\dagger	-0.22	0.29	0.06	0.39^\dagger	0.02

Group A: Study group, with hydroxyethyl cellulose soluble hemostatic gauze.

Group B: Control group, with sterile gauze.

24-DV = postoperative drainage volume within 24h, DT = postoperative drainage time, i-BD = intraoperative blood loss, OT = operation time, t-DV = postoperative total drainage volume.

* $P<.01$.

† $P<.05$.

bleeding variables between the 2 groups, indicating that hemostatic gauze cannot decrease the risk of postoperative bleeding in MABCCO procedure.

Some patients with hypertrophic mandibular angle are accompanied by protruding zygoma, which is considered to be inaeesthetic and unpleasant.^[23] Thus, combined MM+MAO is performed to change the facial contour. The amount of blood loss and OT during this operation are 2 to 3 times that of the other 3 types of surgery, and accordingly the risk of bleeding is higher. In MM+MAO, there was no difference between the study group and the control group regarding perioperative variables ($P > .05$), which suggested that the hemostatic gauze had limited postoperative hemostatic effect for operations with larger amount of blood loss and longer operative time. In this case, we should avoid complications through improving surgical skills and paying extra attention rather than fully relying on hemostatic gauze.

Due to different chewing habits or other unknown reasons, certain patients with mandibular angle hypertrophy are accompanied by masseter hypertrophy, which results in a square facial outline.^[24,26] We will usually conduct partial masseter muscle resection along with mandibular angle reduction to improve the esthetics of the face. For this type of procedure, we have found that there was a drastic increase in the postoperative drainage volume and drainage time compared with the other 3 types, which may be caused by the excision of the medial masseter muscle that possesses rich blood supplies. When comparing patients receiving hemostatic gauze with those receiving regular gauze, no statistical difference in the major variables were found, indicating that hemostatic gauze did not significantly reduce the risk of postoperative bleeding in MM+MAO.

In all 4 types of procedures, the postoperative drainage volumes within 24 hours were all positively correlated with the total postoperative drainage volume in both study and control groups. In MABCCO, MP+MAO, and MM+MAO, there was no correlations between the drainage time and the total drainage volume in the study group while in the control group there were positive correlations. Moreover, the correlation between total postoperative drainage volume and drainage time was weaker than that between total postoperative drainage volume and drainage volume within 24 hours. This indicates that the 24-hour postoperative drainage volume was the main reason for the differences in postoperative drainage, and that the first 24 hours were the high-risk period for postoperative bleeding. Therefore, we should pay close attention to patients with larger drainage volume at the first day after surgery, because more postoperative drainage volume is correlated with higher risk of bleeding. However, drainage time should not be over-extended so as to achieve more thorough drainage, as it will greatly increase patients' discomfort and the risk of postoperative infection.

For wounds with severe intraoperative bleeding, the use of hydroxyethyl cellulose hemostatic gauze can effectively and quickly stop the bleeding, ensuring a clear surgical field of vision and facilitating a safe and rapid operation.^[25,27] But its postoperative hemostatic effect vary significantly across different types of procedures: For MAO alone, which has less intraoperative and postoperative bleeding than other operations, the use of hydroxyethyl cellulose hemostatic gauze can reduce the total postoperative drainage and reduce the risk of postoperative bleeding; for patients with partial masseter muscle resection along with mandibular angle reduction, there was a larger amount of postoperative bleeding due to the removal of muscles,

where the hemostatic gauze has no significant effect; for MAO combined with other facial contouring operations, the OT and the amount of bleeding increased correspondingly. When the amount of intraoperative bleeding reaches a certain limit, the hemostatic gauze has a limited effect on postoperative hemostasis. Therefore, hemostatic gauze is not a replacement for meticulous intraoperative hemostasis, and skillful surgical technique as well as auxiliary procedural steps such as hypotensive anesthesia, appropriate pressure dressing, smooth drainage, and adequate analgesia after the surgery are essential to lowering the risk of bleeding.

5. Conclusion

For facial contouring surgery with relatively less intraoperative bleeding, the use of hydroxyethyl cellulose soluble hemostatic gauze demonstrated significant hemostasis efficacy. However, for combined procedures with larger amount of intraoperative and postoperative bleeding, the effect of hemostatic gauze requires further evaluation.

Author contributions

Conceptualization: Hong Du, Dong Zhang, Xianlei Zong, Xiaolei Jin.

Data curation: Hong Du, Dong Zhang.

Formal analysis: Hong Du.

Investigation: Guodong Song.

Methodology: Dong Zhang.

Resources: Guodong Song, Xianlei Zong.

Software: Dong Zhang, Guodong Song, Xianlei Zong.

Supervision: Xiaolei Jin.

Validation: Xianlei Zong.

Writing – original draft: Hong Du.

Writing – review & editing: Xiaolei Jin.

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