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Original Article

Therapeutic effect of ultrasound-guided rotary cutting on benign breast tumors and factors related to postoperative hematoma

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Abstract: *Background:* The ultrasound-guided rotational cutting of benign breast tumors is widely accepted by many patients, but the postoperative hematoma is the most common complication. This study aimed to investigate therapeutic effect of ultrasound-guided rotary cutting on benign breast tumors and analyze the factors related to postoperative hematoma. *Methods:* Four hundred and twelve patients with 516 benign breast masses were enrolled in this study. The ultrasound-guided rotary cutting of breast masses was performed. The surgical outcome was evaluated, and occurrence and prognosis of postoperative hematoma were observed. The binary logistic analysis and Pearson correlation analysis were performed on the factors influencing the postoperative hematoma formation. Results: All 516 masses were completely removed using ultrasound-guided rotary cutting, without any residue. The success rate of surgery was 100%. The ultrasound examination at postoperative 24-48 h showed that, the hematoma with diameter ≥ 1.0 cm was seen in the surgical area in 43 patients, but after 6 months, the hematoma was completely absorbed in all 43 cases. Binary logistic analysis showed that, the cutting times, mass volume, mass depth, resected mass number and postoperative bandage compression time had significant influence on the occurrence of postoperative hematoma ($P < 0.05$). Pearson correlation analysis showed that, the cutting times, mass volume, mass depth and resected mass number were positively correlated with the hematoma formation, respectively ($P < 0.05$), and the postoperative bandage compression time was negatively correlated with the hematoma formation ($P < 0.05$). Conclusion: The ultrasound-guided rotary cutting can obtain satisfactory therapeutic effect on benign breast tumors. In this technique, the cutting times, mass volume, mass depth, resected mass number and bandage compression time are the major risk factors for postoperative hematoma formation. The screening of enrolled patients and taking targeted measures during the surgery can effectively reduce the occurrence of postoperative hematoma.

Keywords: Rotary cutting, breast, mass, hematoma, factors

Introduction

With the change of lifestyle, the incidence of breast disease in women gradually increases. Benign breast tumor is one of the most common breast diseases in women. With the extensive application of various imaging techniques to clinical practice, the detection rate of breast masses is higher and higher [1]. The majority of breast masses are benign, and the surgical resection is the commonly used treatment method [2]. However, the surgery treatment has its limitations. On the one hand, some small lesions cannot be found in conventional palpation. Due to the bleeding after surgical resection, the lesions are difficult to be found with the naked eye, and are difficult to be treated. On the other hand, these lesions often occur in young women, even in unmarried girls. The traditional surgical procedures, especially the multifocal treatment, will cause the scar which leaves a long-term psychological shadow in patients, and seriously affects the mentality and life quality of patients [3]. Therefore, it is difficult to meet the current requirement of patients. Minimally invasive rotary cutting is a new way of

Table 1. Characteristics of patients

Index	Range	Average
Age (years)	20-54	31.0±4.3
Tumor diameter (cm)	0.7-3.6	1.8±0.4
Tumor volume (cm^3)	0.1-10	4.1±2.9
Tumor depth (cm)	0.5-2.2	1.1±0.4

Table 2. Postoperative pathological findings

Pathological type	Number	Percentage (%)
Fibroadenoma	342	66.3
Adenosis	138	26.7
Breast cyst	17	3.3
Intraductal papilloma	19	3.7
Total	516	100.0

diagnosis and treatment of breast tumors [4]. It has unique advantages both in biopsy and resection, and is widely welcomed by patients and clinicians in clinical application. The ultrasound-guided rotary cutting of benign breast tumors is safe, convenient and fast, without leaving scar, and is widely accepted by many patients [5]. However, the postoperative hematoma is the most common complication of rotational cutting of breast masses [6]. This study investigated the therapeutic effect of ultrasound-guided rotary cutting on benign breast tumors and analyzed the factors related to postoperative hematoma. The objective was to provide the guidance for further application of ultrasound-guided rotary cutting to treatment of benign breast tumors, and reducing the postoperative complications.

Subjects and methods

Subjects

Four hundred and twelve patients receiving ultrasound-guided rotational cutting of benign breast tumors in Zhejiang Xiaoshan Hospital (Hanzhou, China) from January 2011 to December 2015 were enrolled in this study (Supplementary Data). The breast imaging reporting and data system (BI-RADS) suggested the grade 2 or type grade 3 breast masses, which were further confirmed as benign lesions by aspiration biopsy. There were totally 516 breast masses. All patients were female. The age was 20-54 years, with average age of 31.0±4.3 years. The tumor diameter was 0.7-3.6 cm, with average diameter of 1.8±0.4 cm. The tumor volume was 0.1-10 cm^3, with average volume of 4.1±2.9 cm^3. The tumor depth was 0.5-2.2 cm, with average depth of 1.1±0.4 cm (**Table 1**).

Treatment method

The ultrasound-guided rotary cutting of breast masses was performed using EnCor vacuum assisted breast minimally invasive rotary cutting system (Senorx Inc., CA, USA). The 7G and 10G rotary cutting needle were selected. Mylab-90 color Doppler ultrasonic diagnostic apparatus with LA523 probe (Esaote China Lid., Shanghai, China) was used to guide the surgery. The patients were in the healthy-lateral decubitus position or supine position. The position of mass was determined using conventional ultrasound. A 2-3 cm incision was made according to the position of mass. The appropriate needling point and the needling route were determined with the angle of the needle and chest wall of 30°. If there were more than one mass, the needling point and needling route should be designed for removing multiple tumors with one needling point. In addition, according to the principle of safety beauty, the needling points should be in the axillary fold area or areola area as far as possible. The needling point and the mass location were marked, followed by conventional disinfection. Under the guidance of ultrasound, the suspension of 1% lidocaine with 0.1% epinephrine was injected into the area surrounding the mass for the wide infiltration anesthesia. In addition, the masses were fully separated from the surrounding soft tissues. Under the guidance of ultrasound, the rotary cutting needle was sent into the rear of the mass through the predetermined needling point. The concave of rotary cutting needle was aligned to the lesion. The rotary cutting system was started. Partial mass was sucked into the concave of rotary cutting needle and was cut-off. The cut tissue was automatically sent to the tissue collection box outside the body. The rotary cutting was repeated until the ultrasound showed the complete removal of masses. Finally, the blood in the residual cavity of mass was sucked out, and the rotary cutting needle was withdrawn. If there were more than one mass, the remaining masses were removed using to the above methods until the whole surgery plan was implemented. The residual cavity of mass was locally compressed for 5 min, followed by compression using elastic bandage for 48 h. The length of tissue obtained by rotary

Table 3. Multivariate logistic regression analysis of factors related to postoperative hematoma

Factor	B	S.E.	Wals	Sig.	Exp (B)	95% C.I.	
						Upper	Lower
Rotary cutting needle thickness	-0.591	0.555	1.137	0.286	0.554	0.187	1.642
Rotary cutting times	0.209	0.037	32.354	0.000	1.232	1.147	1.324
Mass volume	0.397	0.087	20.807	0.000	1.488	1.254	1.764
Blood stream grade of mass	0.060	0.593	0.010	0.920	1.062	0.332	3.397
Mass depth	2.273	0.685	11.005	0.001	9.710	2.535	37.196
Resected mass number	1.309	0.620	4.455	0.035	3.701	1.098	12.475
Bandage compression time	-1.358	0.643	4.461	0.035	0.257	0.073	0.907
Constant	-13.149	1.758	55.921	0.000	0.000		

cutting was about 2 cm, and its thickness was determined by the type of selected rotary cutting needle. The pathological examination was performed in all tissues.

Observation indexes

The ultrasonic examination was performed at postoperative 24-48 h, 1 week, 1 month, 3 month and 6 month. The examination issues include complete resection of mass, tumor recurrence, hematoma formation and hematoma size. The anechoic region showed by ultrasound with diameter greater than 1 cm was defined as hematoma.

Statistical analysis

SPSS 20.0 software (SPSS Inc., Chicago, IL, USA) was used for data processing. The logistic regression analysis was performed on the factors related to postoperative hematoma, including rotary cutting needle thickness, rotary cutting times, mass volume, blood stream grade of mass, mass depth, resected mass number, bandage compression time, etc. The logistic regression equation was established, and the receiver operating characteristic (ROC) curve was obtained. According to the results of logistic regression analysis, Pearson correlation analysis was carried out. $P < 0.05$ was considered as statistically significant.

Results

Surgical outcome and pathological findings

At the postoperative 24-48 h, the ultrasonic examination was performed on all masses. Results found that, all 516 masses were completely removed by the rotary cutting, without any residue. The success rate of surgery was 100%. The average times of rotary cutting were 21.8±8.4. Only about 2 mm incision scar was remained the breast skin. After 3 months from surgery, the scar basically disappeared. After 6 months, there was no obvious tumor recurrence. The pathological findings showed that, all the resected lesions were benign (**Table 2**).

Occurrence and prognosis of postoperative hematoma

The ultrasound examination at postoperative 24-48 h showed that, the hematoma with diameter ≥ 1.0 cm was seen in the surgical area in 43 cases, with the hematoma rate of 8.3% (43/516). After 1 month, the hematoma was completely absorbed in 32 cases, and the hematoma rate was 2.1% (11/516). After 3 months, only 1 case of hematoma existed, with hematoma rate of 0.2% (1/516). After 6 months, the hematoma was completely absorbed in all 43 cases.

Multivariate analysis of factors related to postoperative hematoma

The binary logistic analysis of multiple factors related to postoperative hematoma showed that, the rotary cutting times, mass volume, mass depth, resected mass number and bandage compression time had significant influence on the occurrence of postoperative hematoma ($P < 0.05$). The OR values of them were as follows: rotary cutting times, 1.232 (1.147-1.324); tumor volume, 1.488 (1.254-1.764); mass depth, 9.710 (2.535-37.196); resected mass number, 3.701 (1.098-12.475); bandage compression time, 0.257 (0.073-0.907). The rotary cutting times, mass size, mass depth and resected mass number were the risk factors of

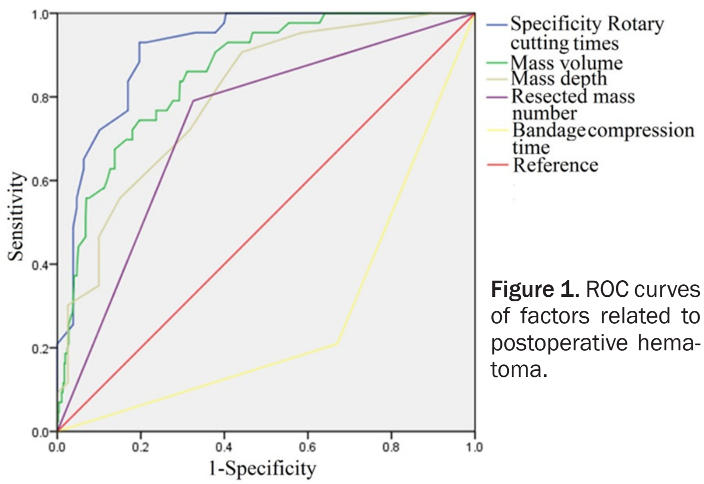

Figure 1. ROC curves of factors related to postoperative hematoma.

Table 4. AUC and 95% C.I. of factors related to postoperative hematoma

Factor	AUC	S.E.	Sig.	95% C.I.	
				Upper	Lower
Rotary cutting times	0.916	0.017	0.000	0.883	0.949
Mass volume	0.858	0.026	0.000	0.807	0.908
Mass depth	0.802	0.032	0.000	0.739	0.864
Resected mass number	0.733	0.038	0.000	0.657	0.808
Bandage compression time	0.270	00.038	0.000	0.194	0.345

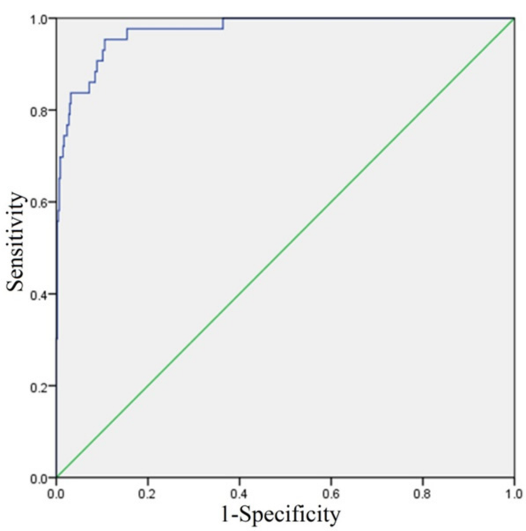

Figure 2. ROC curves of the regression equation.

postoperative hematoma formation. The bandage compression time was the protective factor of postoperative hematoma formation. The rotary cutting needle thickness and blood stream grade of mass had no significant influence on the occurrence of postoperative hematoma (P > 0.05), with OR value of 0.554 (0.187-1.642) and 1.062 (0.332-3.397), respectively (**Table 3**).

According to binary logistic regression analysis results, the logistic regression equation was established as follows: P = Exp (-13.149 + 0.209 × rotary cutting times + 0.397 × mass volume + 2.273 × mass depth + 1.309 × resected mass number -1.358 × bandage compression time). The ROC curves of these five variables were obtained (**Figure 1**). The area under the curve (AUC) and 95% C.I. of these five variables were shown in **Table 4**. The rotary cutting times had the most significant influence on the formation of postoperative hematoma. The mass volume, mass depth and resected mass number had certain influence on the postoperative hematoma formation. The effect of bandage compression time on postoperative hematoma formation was relatively poor.

The ROC curve of the regression equation was shown in **Figure 2**. The AUC was 0.973, with 95% C.I. of 0.953-0.992, which had improved the judgment accuracy of postoperative hematoma. The Youden index was calculated as 0.848, with the corresponding to *P* value of 0.818. According to this, the sensitivity and specificity of regression equation in predicating postoperative hematoma were 95.3% and 89.4%, respectively.

Pearson correlation analysis of factors related to postoperative hematoma

Pearson correlation analysis was performed on five factors which had significant influence on the occurrence of postoperative hematoma. Results showed that, the rotary cutting times was positively correlated with mass volume (r = 0.198; P < 0.001), mass depth (r = 0.147; P < 0.001) and resected mass umber (r = 0.154; P < 0.001), respectively, but negatively correlated with bandage compression time (r = -0.155; P < 0.001). The mass volume was positively correlated with mass depth (r = 0.110; P = 0.012) and resected mass umber (r = 0.123; P

Table 5. Pearson correlation analysis of factors related to postoperative hematoma

Index		Hematoma	Cutting times	Mass volume	Mass depth	Resected mass umber	Bandage compression time
Hematoma	r	1	0.489	0.397	0.321	0.267	-0.264
	P	-	0.000	0.000	0.000	0.000	0.000
Rotary cutting times	r	0.489	1	0.198	0.147	0.154	-0.155
	P	0.000	-	0.000	0.001	0.000	0.000
Mass volume	r	0.397	0.1980	1	0.110	0.123	-0.122
	P	0.000	0.000	-	0.012	0.005	0.006
Mass depth	r	0.321	0.1470	0.110	1	0.085	-0.152
	P	0.000	0.001	0.012	-	0.053	0.001
Resected mass number	r	0.267	0.154	0.123	0.085	1	-0.516
	P	0.000	0.000	0.005	0.053	-	0.000
Bandage compression time	r	-0.264	-0.155	-0.122	-0.152	-0.516	1
	P	0.000	0.000	0.006	0.001	0.000	-

= 0.005), but negatively correlated with bandage compression time (r = -0.122; P = 0.006). The mass depth was negatively correlated with bandage compression time (r = -0.152; P = 0.001). The resected mass umber was negatively correlated with bandage compression time (r = -0.516; P < 0.001) (**Table 5**).

Discussion

The most obvious advantages of breast rotary cutting technology include the accurate mass positioning under ultrasound, convenient and safe surgical operation and almost without scar formation [7, 8]. Especially for multiple masses, the technique using only one needling point can basically remove all the lesions [9]. The present study has confirmed that, the rotary cutting surgery is fast and simple, with little injury and quick recovery. The scar after incision healing is almost invisible. The patient identification rate is 100%. However, the postoperative hematoma is the most common complication in rotary cutting. There are various factors causing the hematoma formation after rotary cutting. Therefore, it is a hot spot to reduce the occurrence of hematoma under the premise of effective and complete resection of the tumors.

In this study, the main influencing factors of hematoma formation after rotary cutting have the features as follows: i) The hematoma formation is positively related to the tumor volume. The larger the residual cavity formed after resection of large tumor is, the larger the blood oozing is. The larger residual cavity will causes local skin sag, resulting in poor bandage compression of the surgical area, which increases the probability of hematoma formation. ii) There is a positive correlation between the rotary cutting times and hematoma formation. The main reason is that, the cutting times are positively related to the tumor volume. In addition, the larger rotary cutting times indicate the longer surgical time, which increases the probability of hematoma formation. iii) The bleeding rate of using 7G needle is higher than that using 10G needle. The main reason is that, the 7G needle is easy to cause injury in needle channel, and damage the small blood vessels in the needling channel. Moreover, the thick needle is easy to increase the wound and increase the bleeding rate. However, in this study, from the OR value, the thickness of rotary cutting needle is protective factor, and does not increase the risk of postoperative haematoma. This needs to be further verified. iv) The mass depth is positively related to hematoma formation. The mass in deeper position requires the increased needling channel, which increases the probability of blood vessel damage, thus increasing the risk of postoperative haematoma formation. v) The increase of resected mass number mass will lead to the increased probability of hematoma formation, which is related to the increased needling channel and increased puncture injury. vi) There is a negative correlation between postoperative bandage compression time and hematoma formation. In partial patients, the frequent activities cause the bandage curl. So the compression time is not enough, leading to the postoperative hematoma. vii) The blood stream grade of mass has no significant influence on the occurrence of postoperative hematoma formation. The mass has rich blood flow and any internal vascular branches. After mass resection, the probability of bleeding from the external vessels into the residual cavity is not high, which cannot increase the incidence of postoperative hematoma.

In this study, the perfect preoperative evaluation and examination were performed in all patients. The preoperative blood pressure, routine blood indexes and coagulation indexes were in normal range. In addition, the surgery was avoided during the menstrual period. It is found that, the incidence of hematoma formation in the menstrual period is much higher than that in non-menstrual period. The main reason is that, in the menstrual period, the menstrual blood viscosity decreases and the coagulation function drops [10]. In addition, in this study, the patients were anaesthetized with 1:10000 epinephrine and 1% lidocaine suspension. Previous study has shown that, the infiltration anesthesia using epinephrine and lidocaine can significantly reduce the probability of hematoma occurrence [11, 12]. However, the optimal ratio of epinephrine and lidocaine for reducing the formation of hematoma needs to be further studied.

Results of this study indicate that, the hematoma formation after rotary cutting of masses is mainly affected by many factors including the rotary cutting times, mass volume, mass depth, resected mass number and bandage compression time. Based on this, more stringent requirement is asked on the patient enrollment. For patients who have larger mass, the higher incidence of hematoma should be informed in advance as far as possible. At the meantime, the targeted measures can be taken to prevent the hematoma. For example, the injection of hemostatic drugs (1:20000 epinephrine + hemagglutination enzyme) into the residual cavity can reduce the occurrence of hematoma [13]. For the smaller mass, it is better to use 10G rotary cutting needle for reducing the hematoma occurrence. For the deep mass, the bandage dressing pattern should be changed to reduce the hematoma. Due to the special shape of breast, the parallel dressing cannot cause the effective oppression of the residual cavity, leading to the hematoma. The "8"-shaped bandage dressing pattern can obtain a good oppression of the residual cavity. Moreover, the activities of patients should be avoided, for reducing the occurrence of hematoma due to decreased effective compression time caused by bandage displacement.

In conclusion, as a minimally invasive method for treatment of benign breast tumor, the ultrasound-guided rotary cutting can completely resect the lesions, and does not damage the appearance of breast. In this technique, the rotary cutting times, mass volume, mass depth, resected mass number and bandage compression time have significant influences on the postoperative hematoma formation. The screening of enrolled patients and taking targeted measures during the surgery can effectively reduce the occurrence of postoperative hematoma.

Disclosure of conflict of interest

None.

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