

EVALUATION OF THE RESULTS OF DIFFERENT MODALITIES OF TREATMENT OF INTRACRANIAL ANEURYSMS

By

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ABSTRACT

Background: Intracranial aneurysm is a common medical problem affecting people of both sexes. Diagnosis of intracranial aneurysm is critical and the management differs according to many factors to be either surgical clipping or endovascular coiling.

Objective: To evaluate the effectiveness, advantages and risks of different modalities of treatment of different types of intracranial aneurysms.

Patients and methods: The study has been conducted on patients presented with intracranial aneurysms in Al-Azhar University hospitals and Damanhur Medical National Institute, from July 2019 to June 2021. In this study, there were 48 patients with intracranial aneurysms either ruptured or not: 26 patients have been treated with endovascular coiling, and 22 patients had surgical clipping. All patients in the study have been subjected to complete history and clinical examination. Radiological investigations were done using either Computed Tomography (CT) of the brain, CT Angiography or digital subtracting angiography.

Results: The mean admission period for endovascular coiling was 4.5 days, while for clipping was 6.27 days, and 46.2% of endovascular cases had intraoperative complications compared to 50% of clipping cases. The rates of post-operative complications were 42.3% and 45.5% for endovascular coiling and clipping respectively. Complete occlusion was achieved in 76.9% of endovascular cases, and 86.4% of clipping cases. 88.5% of endovascular cases had favorable clinical outcome compared to 90.9% of clipping cases.

Conclusion: Surgical clipping has a better occlusion rate, lower rate of recurrence and re-bleeding. It has the advantage of lower direct and total cost of the intervention. Endovascular coiling has a shorter period of hospital stay and fewer symptoms during follow up period. Both techniques were similar regarding the rate of perioperative complications and clinical outcome.

Keywords: Aneurysm, clipping, coiling, endovascular, subarachnoid hemorrhage.

INTRODUCTION

Intracranial aneurysms are usually divided into ruptured and unruptured as the management might differ. Management differs according to patient and aneurysm characteristics as well as surgical facilities and expertise. The natural history of any disease is weighted

against the risk of any intervention (*Zanaty et al., 2014*).

The management of unruptured aneurysms is either, to treat or observe. The most important factors in assessing the aneurysm risks are size, location, shape, and aspect ratio, which is the height/width ratio (*Loewenstein et al., 2012*).

Increasing size or size >7 mm, AR of 3 or higher, posterior location (*Chalouhi et al., 2011*), and presence of daughter sac is expected to get a higher risk of rupture. Medical history of hypertension or smoking and family history of SAH increases the risk, as it has been shown by many studies. There is limited data suggesting that race and female gender may increase the risk (*Ryu et al., 2011*).

The choice of the modality of treatment either surgical clipping or endovascular intervention is dependent on aneurysm size, location, morphology, and rupture status. However, in specific situations, one of the modalities may be more advantageous than the other. Institutional caseload is another important factor as it affects success and complications rates (*McNeil et al., 2013*).

Endovascular technique and surgical clipping can be either, reconstructive or deconstructive. The reconstructive approach targets the aneurysm occlusion with preservation of the parent artery. The deconstructive approach occludes the aneurysm indirectly by sacrificing the parent vessel. The reconstructive endovascular approach is based on the use of coils, balloons, stents, or a combination of them. Endovascular coiling is considered as an alternative minimally invasive modality of treatment. Although it has decreased morbidity and shorter hospital stay, there are concerns regarding the mass effect and the possibility of recanalization (*Güresir et al., 2011*).

The present work aimed to evaluate the effectiveness, advantages and risks of different modalities of treatment of different types of intracranial aneurysms.

PATIENTS AND METHODS

The study has been conducted on patients presented with intracranial aneurysms in Al-Azhar University hospitals and Damanhur Medical National Institute, from July 2019 to June 2021. This study was done on 48 consecutive cases to compare the results of different modalities of treatment of intracranial aneurysms. During the period of the study, we collected data from admission sheets, radiology films, videos or photos taken during endovascular coiling and from patients themselves. Personal data, preoperative clinical condition, radiological characteristics of the aneurysm and SAH, operative data, cost of the operation and post-operative status of both the patient and the aneurysm were recorded.

Ethical approval: The study was approved and accepted by the ethical committee in Al-Azhar University without any limitations or instructions.

Informed consent: All participants in the study signed informed consents. The study has been conducted on 48 patients presented with ruptured or unruptured intracranial aneurysms in Al-Azhar University hospitals and Damanhur Medical national institute. In the study, there were 27 males and 22 females. The youngest case was 14 years old while the oldest one was 72 years old. Twenty-six patients have been treated with endovascular coiling to study the durability of coiling of the cerebral aneurysms. Another group of twenty-two patients were treated with surgical clipping.

Inclusion criteria: Both sexes, any age, intracranial aneurysms either in the anterior or posterior circulations and patients with GCS > 6.

Exclusion criteria: Vitally unstable patient, rebleeding of previously treated intracranial aneurysms and cases with GCS \leq 6.

Patients presented with subarachnoid hemorrhage have been subjected to complete history and clinical examination. Radiological investigations were done using either computed tomography (CT), magnetic resonance CT Angiography or digital subtracting angiography.

Endovascular intervention: A diagnostic angiography was done at the beginning of the procedure for all cases using a diagnostic catheter. A preshaped guiding catheter was used to cannulate the corresponding internal carotid artery according to the location of aneurysm. It was connected to a Y-connector to facilitate continuous pressurized flush with heparinized saline. Under roadmap guidance, a micro catheter was carefully guided over a micro guide-wire into the aneurysm. The rule was never to introduce a wire into the aneurysm. The catheter was preshaped that was directed toward the aneurysm. The tip of the catheter was not introduced further than the neck of the aneurysm. Sometimes the catheter was introduced into the aneurysm over the first coil loop (if needed). In some cases, balloon assistance was used to prevent prolapse of the coil loop. Stent assisted

coiling was performed in other cases with wide neck aneurysms.

Surgical clipping: There were six steps to the procedure, i.e., prepared the patient, performed a craniotomy, exposed the aneurysm, inserted the clip, checked the clip and closed the craniotomy. The time of the operation was about 3-5 hours. For both modalities, patients were followed after intervention clinically and radiologically: (1) Clinical follow-up was done in most of the patients directly after the intervention and for a mean of period 6 months using Glasgow outcome scale (GOS). (2) Radiological follow-up also was done using either, CT Angiography (CTA), MR Angiography (MRA) or Digital Subtraction Angiography (DSA) according to availability, compliance and patient's medical condition.

Statistical analysis:

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level.

The used tests were Chi-square test, Fisher's Exact or Monte Carlo correction, Student t-test and Mann Whitney test.

RESULTS

In the present study, 26 patients underwent endovascular intervention of their intracranial aneurysms (54.2% of all cases) and 22 patients had surgical clipping (45.8% of all cases).

In this study, 44 of all cases (91.7%) were discharged after receiving their treatment while four patients (8.3%) died, two patients of them had endovascular coiling and two patients had clipping. 87.5% of aneurysms in the study were saccular and 12.5% were not saccular. Half of those not saccular aneurysms had

endovascular intervention and the other half was treated by surgical clipping. 87.5% of cases had aneurysmal rupture at presentation and a clinical picture of severe headache, loss of consciousness fits, photophobia, neck rigidity or even hydrocephalus. Only 6 cases (12.5%) presented by persistent headache and a diagnosis of non-ruptured intracranial aneurysms was made. 4 cases were treated by endovascular coiling and 2 cases by surgical clipping.

Table (1): Comparison between the two studied treatments according to rupture

Rupture \ Groups	Total cases (n = 48)		Treatment			
			Coiling (n = 26)		Clipping (n = 22)	
	No.	%	No.	%	No.	%
Not rupture	6	12.5	4	15.4	2	9.1
Rupture	42	87.5	22	84.6	20	90.9

The admission period ranged from 2 days to 12 days (mean = 5.31 days), regarding endovascular coiling the admission period ranged from 2 days to 12 days (mean = 4.5 days) while admission period for patients who underwent clipping was longer ranging from 4 days to 12 days (mean = 6.27 days).

The most common intra-operative complication was vasospasm which occurred in 13 (27.1%) of all patients (6 patients had endovascular coiling and 7 patients had clipping), so 23.1% of endovascular group of patients had intra-

operative vasospasm while 31.8% of the clipping group had vasospasm. Aneurysm rupture occurred in 7 patients (14.6%) four of them had clipping and three had coiling. (15.4% of patient who had endovascular coiling and 13.6% of patients who had surgical clipping). Other reported intraoperative complications during endovascular intervention were iliac arteries dissection, coil migration adhesion to microcatheter and failed technique. Reported complications during surgical clipping were cortical injury, High ICP and bleeding from trauma to anterior communication artery (**Figure 1**).

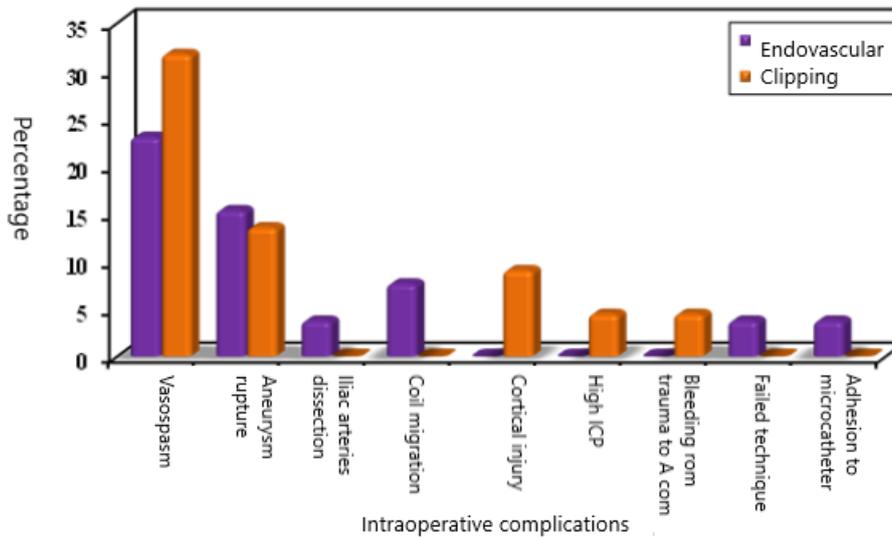


Figure (1): Comparison between the two studied treatments according to intraoperative complications.

Regarding post-operative complications: fits was the most common post-operative complication as 7 patients had post-operative fits 3 of them had endovascular coiling and 4 had clipping. Weakness was the 2nd most common complication (12.5% of all cases), 5 of patients who had endovascular coiling developed post-operative weakness compared to only one patient had clipping.

Other reported complications were headache (6.3% of cases), dysphasia (2.1%) and asymptomatic sinus bradycardia (2.1%). Flap bogginess due to CSF leak was reported in 2 cases (4.2%) underwent clipping. Hydrocephalus occurred post-operatively to 2 patients (4.2%), one of them had clipping and the other one had coiling. 3 patients (6.3%) were unconscious post-operatively 2 of them had clipping (**Figure 2**).

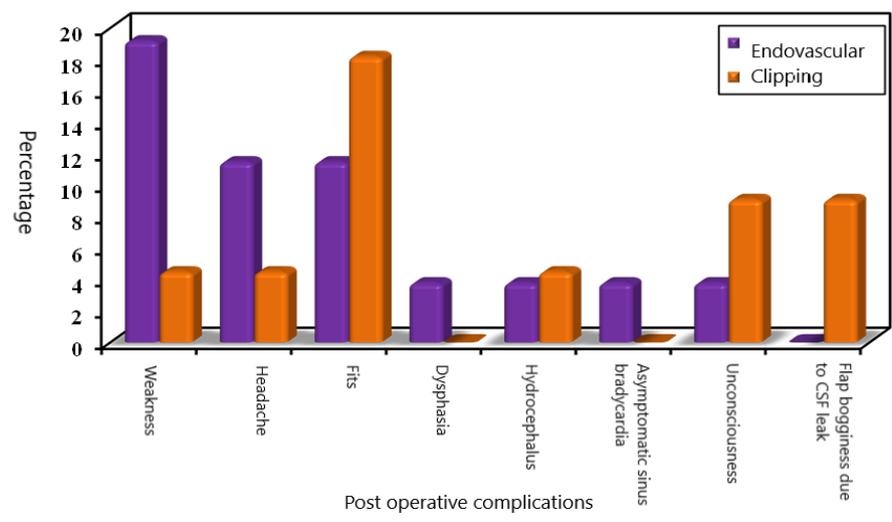


Figure (2): Comparison between the two studied treatments according to post-operative complications.

46.2% of endovascular coiling cases had intraoperative complications while 50% of cases who underwent surgical clipping had intraoperative complications which means that intraoperative complications was near equal in the two groups.

The rate of post-operative complications for endovascular technique was similar to clipping as well (42.3% for endovascular coiling compared to 45.5% for clipping).

The majority of cases in the study (60.4%) had no symptoms during follow up duration either underwent coiling or

clipping. Headache during follow up duration was the most common complain, there are 6 cases had sustained headache (12.5%) half of them underwent coiling and the other half underwent clipping. Four patients (8.3%) had epilepsy during follow up duration, three of them were in the endovascular group and one patient was in the clipping group. Two patients had headache and blurred vision during follow up duration and those two patients underwent endovascular intervention, three patients had temporal pain during follow up duration and all of them had surgical clipping (**Figure 3**).

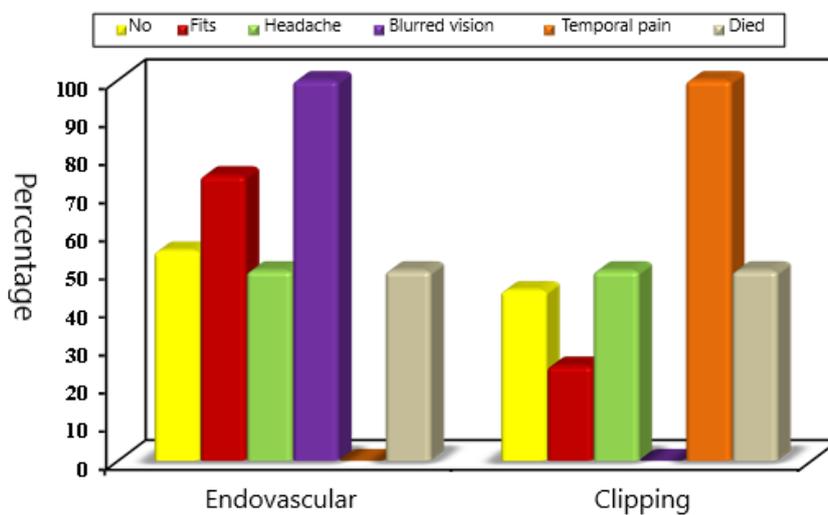


Figure (3): Relation between symptoms during follow up duration and treatment

Direct and total costs were higher for endovascular coiling cases than coiling cases while the indirect cost was higher for endovascular coiling cases. We mean by the direct cost, the cost of the operation itself but the cost of hospital admission either in ICU or ward according to length of stay was named as the indirect cost.

Complete occlusion was done to 39 cases (81.3%) compared to only 9 cases (18.9%) who had near complete

occlusion. 76.9% of endovascular cases had complete occlusion of the aneurysm and 23.1% had near complete occlusion, while 86.4% of clipping cases had complete occlusion and 13.6% had near complete occlusion. 73.1% of endovascular cases didn't have regrowth of aneurysm during follow up duration, while 90.9% of clipping cases didn't have regrowth which means that clipping has lower aneurysm regrowth rate.

Table (2): Relation between degree of occlusion and modality of treatment

Occlusion Treatment	Degree of occlusion				χ^2	FE p
	Near complete n = 9 (18.9%)		Complete n = 39 (81.3%)			
	No.	%	No.	%		
Endovascular	6	23.1	20	76.9	0.697	0.478
Clipping	3	13.6	19	86.4		

The rate of re-bleeding was 7.7% for patients who underwent endovascular coiling and 4.5% for patients who had clipping but it was statistically insignificant. 89.6% of cases in the study had favorable clinical outcome by Glasgow outcome scale (GOS 4 and 5). The results were nearly equal for endovascular group and clipping group (88.5% and 90.9% respectively) regarding favorable clinical outcome by GOS.

Table (3): Relation between Rebleeding and modality of treatment

Rebleeding Treatment	Re-bleeding				χ^2	FE p
	No n = 45 (93.75%)		Yes n = 3 (6.25%)			
	No.	%	No.	%		
Endovascular	24	92.3	2	7.7	2.557	0.175
Clipping	21	95.5	1	4.5		

DISCUSSION

In a specialized neurovascular center, endovascular coiling significantly decreases time of the procedure, the stay in the ICU, and the length of hospital stay which gives advantage to that modality of treatment over surgical clipping (*Zhang et al., 2018*).

In the present study, the mean hospital stay for endovascular coiling was shorter than clipping (The mean period of hospital stay for endovascular coiling was 4.5 days, while for surgical clipping was 6.27 days).

Neurosurgical clipping for intracranial aneurysms has a worse perioperative clinical outcome than endovascular coiling which has a poorer outcome by the long term (*Ayling et al., 2015*).

Elective coiling of un-ruptured intracranial aneurysms is associated with fewer deaths and perioperative complications compared with elective clipping (*Alsheklee et al., 2010*).

In the present study, the rate of intraoperative complications was similar in surgical clipping and endovascular coiling. The rate of post-operative complications for endovascular technique was near equal to surgical clipping as well.

The incidence of asymptomatic vasospasm was 25% of patients for coiling and 46% of patients for clipping. Symptomatic vasospasm occurred in 6% of patients for coiling, and 15% of patients for clipping, and was significantly less in the coiling group (*Kentaro et al., 2019*).

In the present study, the most common intra-operative complication was vasospasm which occurred in 13 (27.1%) of all patients, six patients (23.1%) of the coiling group had asymptomatic vasospasm and seven patients of the clipping group (31.8%) had asymptomatic vasospasm.

A study evaluating clinical outcome after coiling or clipping for intracranial aneurysms indicates a higher independent outcome and lower mortality after coiling (*Falk Delgado et al., 2017*).

In the previous studies, the clinical outcome was similar in comparison between the two groups. The present study also has similar results, as 88.5% of coiling cases had favorable clinical outcome compared to 90.9% of clipping cases.

There were neck remnants in 26% and refilling happened in 8% of cases who had coiling in comparison to 12% and 6% respectively for patients who underwent surgical clipping, according to the international subarachnoid aneurysm trial (*Chen et al., 2015*).

Although the better initial outcome with the endovascular interventions, it is associated with more frequent incomplete occlusions and regrowth of the aneurysms (*Salle et al., 2018*).

In the present study, surgical clipping had lower aneurysm regrowth rate than coiling. The majority of cases had no regrowth during follow up duration (81.3%). 26.9% of endovascular cases had regrowth of aneurysm while for patients who had surgical clipping 9.1% had regrowth.

In a meta-analysis which included four randomized controlled trials and 23 observational studies, the risk of rebleeding after coil embolization was greater after coiling clipping (*Li et al., 2013*).

In the present study, the majority of cases (93.75%) didn't have re-bleeding post-operatively. The rate of re-bleeding was higher after endovascular coiling compared to clipping but it was statistically insignificant.

Patients with ruptured aneurysm who had endovascular coiling had higher charges than patients who were treated by clipping. They also had shorter hospital stay, but higher direct cost of the procedure and cost of consumables (*Lad et al., 2013*).

This meet the results of our study as direct and total costs are higher for endovascular coiling cases than clipping cases while the indirect cost was higher for clipping cases.

CONCLUSION

Surgical clipping has a higher rate of occlusion than endovascular coiling. It also has a lower rate of recurrence and re-bleeding. It has the advantage of lower direct and total cost of the intervention. On the other hand, endovascular coiling has a shorter period of hospital stay and fewer symptoms during follow up period. Both techniques were similar regarding the rate of intra-operative and post-operative complications, they have similar results regarding clinical outcome as well.

REFERENCES

1. **Alshehlee A, Mehta S, Edgell RC, Vora N, Feen E, Mohammadi A, Kale SP and Cruz-Flores S (2010):** Hospital mortality and

- complications of electively clipped or coiled unruptured intracranial aneurysm. *Stroke*, 41(7):1471-6.
2. **Ayling OG, Ibrahim GM, Drake B, Torner JC and Macdonald RL (2015):** Operative complications and differences in outcome after clipping and coiling of ruptured intracranial aneurysms. *J Neurosurg.*, 123(3):621-8.
 3. **Chalouhi N, Dumont As and Randazzo C (2013):** Management of incidentally discovered intracranial vascular abnormalities. *Neurosurg Focus*, 5(2):344-354.
 4. **Chen KS, Wilson TJ and Stetler WR (2015):** Management of recurrent aneurysms following endovascular therapy. *J Clin Neurosci.*, 1901-6.
 5. **Falk Delgado and Andersson T (2017):** Clinical outcome after surgical clipping or endovascular coiling for cerebral aneurysms: a pragmatic meta-analysis of randomized and non-randomized trials with short- and long-term follow-up. *J Neurointerv Surg.*, 9(3):264-277.
 6. **Güresir E, Schuss P, Setzer M, Platz J, Seifert V and Vatter H (2011):** Posterior communicating artery aneurysm-related oculomotor nerve palsy: influence of surgical and endovascular treatment on recovery: single-center series and systematic review. *Neurosurgery*, 68(6):1527-33.
 7. **Kentaro Shimoda, Kouki Kamiya, Toshikazu Kano, Makoto Furuichi and Atsuo Yoshino (2019):** Cerebral Vasospasm and Patient Outcome after Coiling or Clipping for Intracranial Aneurysmal Subarachnoid Hemorrhage. *Journal of Neuroendovascular Therapy*, 13: 443–448
 8. **Lad SP, Babu R, Rhee Ms and Franklin RL (2013):** Long-term economic impact of coiling vs clipping for unruptured intracranial aneurysms. *Neurosurgery*, 72(6):1000-11.
 9. **Li H, Pan R, Wang H, Rong X, Yin Z, Milgrom DP, Shi X, Tang Y and Peng Y (2013):** Clipping versus coiling for ruptured intracranial aneurysms: a systematic review and meta-analysis. *Stroke*, 44(1):29-37.
 10. **Loewenstein JE, Gayle SC, Duffis EJ, Prestigiacomo CJ and Gandhi CD (2012):** The natural history and treatment options for unruptured intracranial aneurysms. *Int J Vasc Med.*, 898052.
 11. **McNeill L, English SW, Borg N, Matta BF and Menon DK (2013):** Effects of institutional case-load of subarachnoid hemorrhage on mortality: a secondary analysis of administrative data. *Stroke*, 44(3):647–52.
 12. **Ryu CW, Kwon OK, Koh JS and Kim EJ (2011):** Analysis of aneurysm rupture in relation to the geometric indices: aspect ratio, volume, and volume-to-neck ratio. *Neuroradiology*, 53:883–9.
 13. **Salle F., Jaume A., Castelluccio G. and Spagnuolo E. (2018):** Surgical Clipping vs Endovascular Coiling for Newly Diagnosed and Recurrent Cerebral Aneurysms: an Update on the Current Literature. *Single-Center Case Series. International Neuroscience Journal*, 2(1): 16-21.
 14. **Zanaty M, Chalouhi N, Tjoumakaris SI, Rosenwasser RH and Jabbour PM (2014):** Endovascular Management of Cerebral Aneurysm. *Translational Stroke Research*, 5(2), 199-206.
 15. **Zhang X, Tang H, Huang Q, Hong B, Xu Y and Liu J (2018):** Total Hospital Costs and Length of Stay of Endovascular Coiling Versus Neurosurgical Clipping for Unruptured Intracranial Aneurysms: Systematic Review and Meta-Analysis. *World Neurosurg.*, 115:393-399.

88.5% من حالات القسطرة المخية نتائج سريرية إيجابية مقارنة بـ 90.9% من حالات الجراحة.

الاستنتاج: جراحة تدببب التممد الشرياني كان لها معدل غلق أعلي للتمدد الشرياني، ومعدل أقل لعودة نمو التممد الشرياني أو معاودة النزف، كما كان لها ميزة انخفاض التكلفة المباشرة للجراحة والتكلفة الإجمالية. علي الجانب الاخر، فقد تميزت القسطرة المخية بمدة إقامة أقصر بالمستشفى وأعراض أقل أثناء فترة المتابعة للمريض بعد الجراحة. كلا الطريقتين كانتا متشابهتان فيما يتعلق بمعدل حدوث المضاعفات أثناء الجراحة أو بعد الجراحة مباشرة، كما كانتا متشابهتان من حيث النتائج السريرية.

التمدد الشرياني، تدبببب التممد الشرياني، القسطرة المخية، النزيف تحت الأم العنكبوتية.

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