

Wound hematoma after anterior cervical spine surgery: A retrospective study of risk factors analysis

Kai Zhou

Chongqing Medical University First Affiliated Hospital

Zhongyuan He

Chongqing Medical University First Affiliated Hospital

Ke Tang

Chongqing Medical University First Affiliated Hospital

Zhengxue Quan (✉ walleyezhu@163.com)

Research article

Keywords: wound hematoma, logistic models, risk factors, hypertension, heparin use, hemostasis

Posted Date: January 7th, 2020

DOI: <https://doi.org/10.21203/rs.2.20210/v1>

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Abstract

Background: The postoperative wound hematoma after anterior cervical spinal surgery is a very critical complication. We aim to explore the risk factors independently associated with postoperative wound hematoma in patients who have undergone anterior cervical spine surgery. **Methods:** Clinical data of patients with cervical spondylosis or cervical disc herniation who underwent anterior cervical spine surgery by the senior author from January 2011 to December 2017 were evaluated. A multivariate logistic regression was conducted to compare the hematoma group and the non-hematoma group in order to find out which factors that were independently associated with hematoma formation. Mann-Whitney U test was conducted to compare the Neck disability Index score in two groups. **Results:** A total of 678 patients met the criteria who underwent anterior cervical spine surgery. 13 patients were identified as wound hematoma who have undergone hematoma evacuation, in which hemorrhage sites were found. Multivariate logistic regression identified that history of hypertension ($p=0.039$ OR=4.42 95%CI 1.08-18.07) and therapeutic heparin use ($p=0.020$ OR=4.58 95%CI 1.27-16.59) were independent risk factors of hematoma formation. The t-test shows no significant differences between the hematoma group and no hematoma group in APTT and PT levels ($p>0.05$). Mann-Whitney U test indicates that there was no difference in NDI scores between the two groups ($p>0.05$). **Conclusion:** History of hypertension and therapeutic heparin use are risk factors for hematoma formation. Meticulous hemostasis, moderate muscle subtraction, and perioperative airway management are critical in avoiding hematoma development. Hematoma evacuation as quickly as possible is necessary. **Key word:** wound hematoma, logistic models, risk factors, hypertension, heparin use, hemostasis.

Background

The past decades have seen increasingly rapid advances in the field of anterior cervical spine surgery (ACSS) technic. In 1958, Smith and Robinson first proposed anterior cervical discectomy and fusion (ACDF). After that, anterior cervical corpectomy and fusion (ACCF), anterior cervical discectomy and arthroplasty (ACDA) were successively presented. Most clinical studies have confirmed the effectiveness of these procedures. Although the anterior cervical surgery is less invasive, and the postoperative effect is good. Because of the anatomical complexity of the anterior cervical approach, with many vital structures, the complications occasionally happen, among which wound hematoma, dysphagia, and recurrent laryngeal nerve injury are the most common.

The development of postoperative wound hematoma is a very critical complication in the clinic, which needs to be discovered and treated in time. If not handled properly, it can cause serious consequences, such as airway compromise, neurological deficit, and even life-threatening. To date, few studies have investigated the risk factors of wound hematoma formation. Therefore, the present research explores the effects of risk factors and bleeding site of wound hematoma formation, and to minimize the occurrence of this dangerous complication.

Methods And Materials

Inclusion criteria: ☒Age>18;☒Patients with cervical spondylosis or cervical disc herniation;☒First neck surgery;☒Elective surgery.

Exclusion criteria: ☒Tumor, trauma, infection, deformity diffuse idiopathic skeletal hyperostosis(DISH), and ossification of the posterior longitudinal ligament(OPLL);☒Anterior and posterior combined surgery.

A total of 678 consecutive patients (355 males and 323 females), meeting the inclusion and exclusion criteria, were included in our study. Patient data recorded in a database included: gender, age, preoperative symptoms, operation method, surgical levels, low-level segment (C6/7 segment), operative time, blood loss, Body Mass Index (BMI) preoperative comorbidity (hypertension, diabetes), smoking history, therapeutic heparin usage, activated partial thromboplastin time (APTT) and prothrombin time (PT) examination before and after surgery. All patients underwent careful preoperative neurological examination, routine blood examination, coagulation examination, anterior and lateral cervical X-ray, CT scan with 3-dimensional reconstruction, and cervical MRI examination. Patients who had taken antiplatelet or anticoagulant agents daily received heparin replacement therapy until five days prior to surgery. Heparin was disused 12 hours before surgery was performed, and antiplatelet or anticoagulant agents were continued two days after surgery.

All surgeries were operated on by the senior author, through the right side of the neck, under general anesthesia and endotracheal intubation. All operations were carried out by the senior surgeon, and hemostasis was performed carefully during the operation. Plate fixation(SKYLINE, SLIMLOC and VENTURE anterior cervical plate system), cage(n-HA/PA66 cage), and autograft were used in all surgeries except ACDA. Artificial disc(Prodisc-C, Prestige LP) was used in ACDA. Hemostatic methods include electrocautery, bipolar electrocautery, bone wax, which was used when corpectomy was performed, hemostatic agent (Surgiflo Ethicon), which was applied in intervertebral space and longus colli. At the end of the operation, a subfascial drainage tube was placed through a separate stab incision and removed the next day after surgery. All patients with postoperative wound hematoma were included in the case group, while the remaining patients were included in the control group. All patients with wound hematoma received hematoma evacuation immediately, which proved the wound hematoma a truth.

We followed up all patients and used Neck disability index (NDI) scores to evaluate postoperative neck function. We divided the NDI scores of all patients according to the corresponding time into three groups: preoperative group, early postoperative group (> 3mon < 12mon), and late postoperative group (> 12mon).

Statistics

SPSS software version 24.0 was used for statistical analysis. The measurement data in line with the normal distribution were expressed as mean \pm standard deviation, the rest was expressed as median (InterQuartile Range), and the counting data were expressed as a percentage. Univariate Logistic regression was conducted to analyze the risk factors of wound hematoma. Factors of $p < 0.05$ were added to multivariate logistic regression. Odds ratio (OR) and 95% confidence intervals (CI) were

determined when statistically significant differences ($P < 0.05$) were found in multivariate logistic regression. T-test and mann-Whitney U test are employed for other measurement data.

Results

A total of 678 patients meeting the inclusion and exclusion criteria were included in the study, and demographic characteristics of patients are collected in Table 1. Of these, 354 were male(52.2%) and 324 female(47.8%). The patients' age ranged between 25 and 84 years, with their mean age being (53.7 ± 11.2) years. BMI ranged between 15.1 and 37.3, with an average of (23.7 ± 2.9) . There were 307 cases of radiculopathy (45%), 223 cases of myelopathy (33%), and 148 cases of myeloradiculopathy (22%). There were 305 cases underwent ACDF (45%), 236 ACCF (35%), 79 ACDA (12%) and 58 underwent ACDF+ACCF (8%).

13 cases(1.9%) of hematoma occurred in all patients (Table 2). The earliest hematoma occurred in 1 hour after surgery, and the latest appeared 44 hours after surgery, with the mean time being 11 $(2.5-37.5)$ hours. All patients presented wound swelling, among which 10 cases (77%) had significant wound bleeding, and 3 cases (23%) had dyspnea. In 2 cases (15%), the trachea was deviated to the left side. All patients received hematoma evacuation surgery in time, which proved the hematoma a truth. Bleeding sites were found in 3 patients with longus colli, 1 patient with longus colli and omohyoid, 2 patients with platysma, 2 patients with drainage stab incision, 1 patient with esophageal wall, and 4 patients with no distinct bleeding sites.

Risk factor analysis

Univariate logistic regression showed that heparin usage ($p < 0.001$), history of hypertension ($p = 0.001$) meet the criteria of multivariate logistic regression ($p < 0.05$). The result shows that history of hypertension ($p = 0.039$ OR=4.42 95%CI 1.08-18.07) and therapeutic heparin use ($p = 0.020$ OR=4.58 95%CI 1.27-16.59) were statistically significant, which were independent risk factors of hematoma development (Figure 1). Gender ($p = 0.089$) was a possible risk factor but not statistically significant.

All patients underwent activated partial thromboplastin time (APTT) and prothrombin time (PT) examination before operation and after operation immediately. A t-test was conducted respectively, and the results showed no significant differences between hematoma group and non-hematoma group (Figure 2-3).

Clinical outcome

Neck disability index (NDI) scores were recorded to compare the two postoperative time between the hematoma group and the non-hematoma group. The early follow-up time was 3-12 months; the late follow-up time was >12 months. A Mann-Whitney U test was conducted, and there was no significant difference ($p > 0.05$ Figure 4).

Discussion

ACSS is commonly used and widely recognized by spine surgeons. The hematoma formation, however, is the most problematic and devastating complication, which cannot be overemphasized. An initial objective of the study was to identify risk factors that will lead to hematoma formation to assist surgeons to minimize the occurrence of postoperative hematoma.

Our findings indicate that history of hypertension and therapeutic heparin usage are the independent risk factors of hematoma formation. There is no statistical significance in age, BMI, symptom, surgical procedure, operative time, surgical level, low-level segment (C6/7 segment), diabetes, or smoking history.

The incidence of hematoma is 1.9% in our study, which is accordance with previous reports (0.2-2.4%). History of hypertension is a risk factor of hematoma formation, and this finding is consistent with that of Palumbo, who mentioned that surgical stress reaction and anesthesia could cause increased arterial blood pressure, especially in hypertension patients. Patient 10 in our study appears hematoma in 1 hour at the postanesthesia care unit (PACU) during extubation. Coughing during extubation could cause increased venous blood pressure, leading to the occurrence of hematoma. Poor perioperative blood pressure control will significantly increase the incidence of hematoma. Patient 8 had chronic pharyngitis history, and severe cough after surgery may result in hematoma formation. Therefore, perioperative airway management is also essential.

O'Neill's study concluded that therapeutic heparin usage is a risk factor for hematoma formation, which in line with our study. All patients who received heparin replacement therapy were discontinued heparin until 12 hours before surgery and continued 2 days after surgery. All hematomas occurred within 48 hours, a possible explanation for this might be that the leading cause of hematoma formation is the preoperative use of heparin. Perhaps the time of withdrawal of heparin should be advanced and preoperative monitoring of heparin dosage is also important. Our senior author considered that low-level cervical spine surgery might cause poor drainage, resulting in hematoma formation. We included C6/7 segment patients into logistic regression. However, the results are not statistically significant ($P=0.725$), which may require more studies in the future to explore the relation.

Heparin is an antithrombin, which does not affect APTT and PT levels, but anticoagulant does. Therefore the preoperative and postoperative APTT and PT outcomes were collected from all the patients and determined whether they were different or not. And the results showed no statistical significance.

Many studies suggest ossification of the posterior longitudinal ligament (OPLL) and diffuse idiopathic skeletal hyperostosis (DISH) are risk factors of hematoma formation. It is known that meticulous hemostasis is the crucial procedure to prevent hematoma formation. Compared with general cervical spondylopathy surgery, however, OPLL and DISH surgery were relatively involved, which requires higher surgical skills. Hence, we did not include that in our study.

All hematoma patients did not receive conservative treatment and cricothyrotomy in our study. Instead, they all received wound exploration and hematoma evacuation as quickly as possible when hematoma occurred. 9 cases were found with specific hemorrhage sites during the evacuation procedure, including 4 cases in the longus colli, 2 cases in the platysma, 2 cases in the drainage stab incision, and 1 case in the lateral wall of the esophagus (Table 2). Literatures have reported on the site of hemorrhage, but most of them do not see distinct bleeding points in the wound exploration. Nambu et al. concluded that hemorrhage site in postoperative neck surgery mostly occurred on the muscle surface, and excessive muscle subtraction and too much blunt dissection may be the causes of bleeding. The feeding vessels of vertebral body often found in ventral side of the longus colli. Thus, the stretcher or retractor should be placed on the superficial surface of the longus colli. Kunkel et al. found 1 case of hematoma bleeding site in platysma. Therefore, more attention should be paid to the hemostasis of longus colli, platysma, drainage stab incision. Bipolar electrocautery is indispensable, which can attain enough hemostasis.

2 patients developed hematoma after the drainage removal, and the bleeding site was found to be at the drainage stab point. At present, more and more reports tend to indicate that the use of drainage cannot prevent the occurrence of hematoma. On the contrary, it may cause the risk of hematoma formation during removal. Those views are consistent with our results, and it is still questionable whether the use of drainage is necessary.

Our study also found that 7 cases (54%) occurred within 24 hours and 6 cases(46%) occurred within 24-48 hours. Monika indicates that hematomas usually occur within 6-12 hours after surgery . Song mentioned that 67% of hematoma occurs within 24 hours, and the remaining within 72 hours. All the patients with hematoma recovered and were discharged from hospital. We followed them up and used the NDI score to evaluate the recovery of cervical spine function. The hematoma group shows no difference with the control group.

Our findings may be somewhat limited by the nature of retrospective analysis and small samples. The application of heparin dose and the preoperative blood pressure should be further quantified. The inclusion and exclusion criteria were strictly controlled to exclude confounding factors, but the occurrence of hematomas was still affected by some subjective factors. Therefore, we tried to obtain objective, independent risk factors through this study, and a large sample and multi-center study was still needed in the later stage.

Conclusion

ACSS is prevalent for treating cervical spine diseases, and the postoperative wound hematoma is a severe complication, with a low incidence but fatal consequences. Our study demonstrated that the history of hypertension and therapeutic heparin use are risk factors for hematoma formation. Meticulous hemostasis, moderate muscle subtraction, and perioperative airway management are also very crucial in avoiding hematoma development. Hematoma often occurs within 48 hours, especially within 24 hours, so more attention should be paid during this time. Wound exploration and evacuation of hematoma as

quickly as possible are recommended after the occurrence of hematoma, which can prevent airway obstruction as much as possible.

Abbreviations

ACSS: anterior cervical spine surgery

ACDF: anterior cervical discectomy and fusion

ACCF: anterior cervical corpectomy and fusion

ACDA: anterior cervical discectomy and arthroplasty

ACAF: anterior controllable antedisplacement fusion

NDI: Neck disability index

APTT: activated partial thromboplastin time

PT: prothrombin time

OPLL: Ossification of the posterior longitudinal ligament

DISH: diffuse idiopathic skeletal hyperostosis

Declarations

Acknowledgements

Not applicable.

Authors' contributions

Quan and Tang contributed to the study design. Quan, Tang, He and Zhou performed the surgery. Zhou and He collected the data. Zhou and Tang analyzed the data. Zhou wrote the manuscript. All authors read and approved the final manuscript.

Funding

Not applicable.

Availability of data and materials:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethical approval

This study is a retrospective clinical study and has approved by The First Hospital of Chongqing Medical University Ethics Committee. All patients had signed the consent form.

Consent for publication

Not applicable.

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Tables

Table 1. Patients' demographic characteristics

Variable	Hematoma group		No-hematoma group		p value
	Mean	SD	Mean	SD	
Age	55.6	9.35	53.6	11.2	0.512
BMI	24.2	2.9	23.7	2.9	0.556
	Median	IQR	Median	IQR	
Operative time(hr)	2.17	1.96-2.67	2.0	1.59-2.5	0.180
Blood loss(ml)	100.0	50.0-150.0	50.0	50.0-100.0	0.414
	N	[%]	N	[%]	
Gender					
Male	10	76.9	344	51.7	-
Female	3	23.1	321	48.3	0.089
Symptom					
Radiculopathy	3	23.1	304	45.7	-
Myelopathy	4	30.8	218	32.9	0.420
Myeloradiculopathy	6	46.1	143	21.5	0.143
Procedure					
ACDF	5	38.5	300	45.2	-
ACCF	5	38.5	231	34.6	0.202
ACDA	2	15.4	77	11.6	0.997
ACDF+ACCF	1	7.6	57	8.6	0.245
Level					
1	4	30.8	222	33.5	-
2	8	61.5	345	51.8	0.683
3	1	7.7	95	14.3	0.629
3+	0	0	3	0.5	-
Comorbidity					
History of hypertension	8	61.5	122	18.3	0.001
Diabetes	2	15.4	62	9.3	0.451
Smoking history	6	46.2	211	31.7	0.104
C6/7 segment	4	30.8	236	35.5	0.725
Heparin use	4	30.8	25	3.76	0.000

Table 2. Hematoma patients

Patient	Gender	Age	Symptom	Procedure	Time to onset(hr)	Hemorrhage site
1	M	52	Myeloradiculopathy	ACCF C5-C7	5	Longus colli
2	M	42	Myelopathy	ACCF C4-C6	33	Unseen
3	F	75	Radiculopathy	ACCF C5-C7	26	Longus colli
4	F	46	Myeloradiculopathy	ACDA C5-C6	42	Drainage stab incision
5	M	60	Myeloradiculopathy	ACCF C3-C5	30	Drainage stab incision
6	M	53	Radiculopathy	ACDF C3-C4	44	Esophageal wall
7	F	58	Myeloradiculopathy	ACDA C5-C6	11	Unseen
8	M	67	Myeloradiculopathy	ACCF C3-C5	5	Platysma
9	M	65	Myelopathy	ACCF C4-C6 ACDF C6-C7	3	Longus colli
10	M	53	Radiculopathy	ACDF C5-C6	1	Unseen
11	M	55	Myelopathy	ACDF C4-C6	2	Platysma
12	M	45	Myelopathy	ACDF C5-C6	2	Unseen
13	M	52	Myeloradiculopathy	ACDF C5-C7	44	Longus colli and omohyoid

Figures

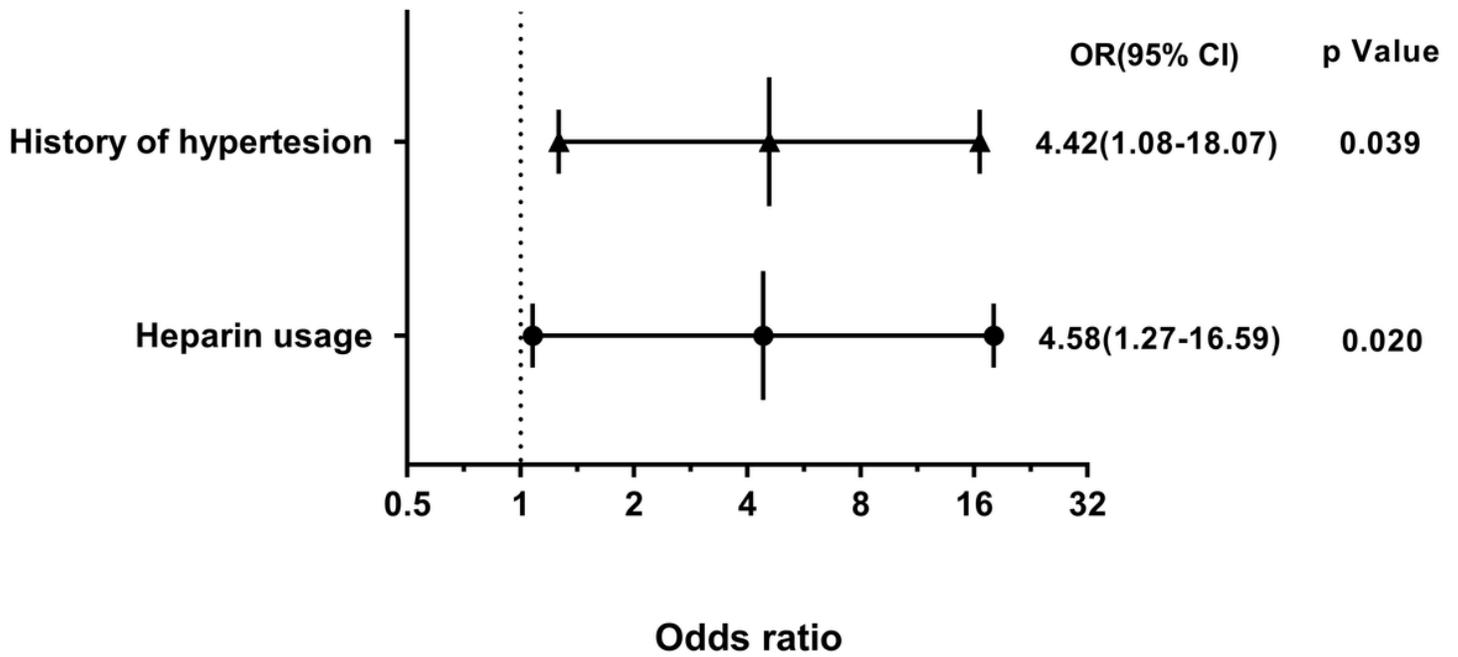


Figure 1

The multivariate logistic regression result shows that history of hypertension and therapeutic heparin use are statistically significant($p < 0.05$).

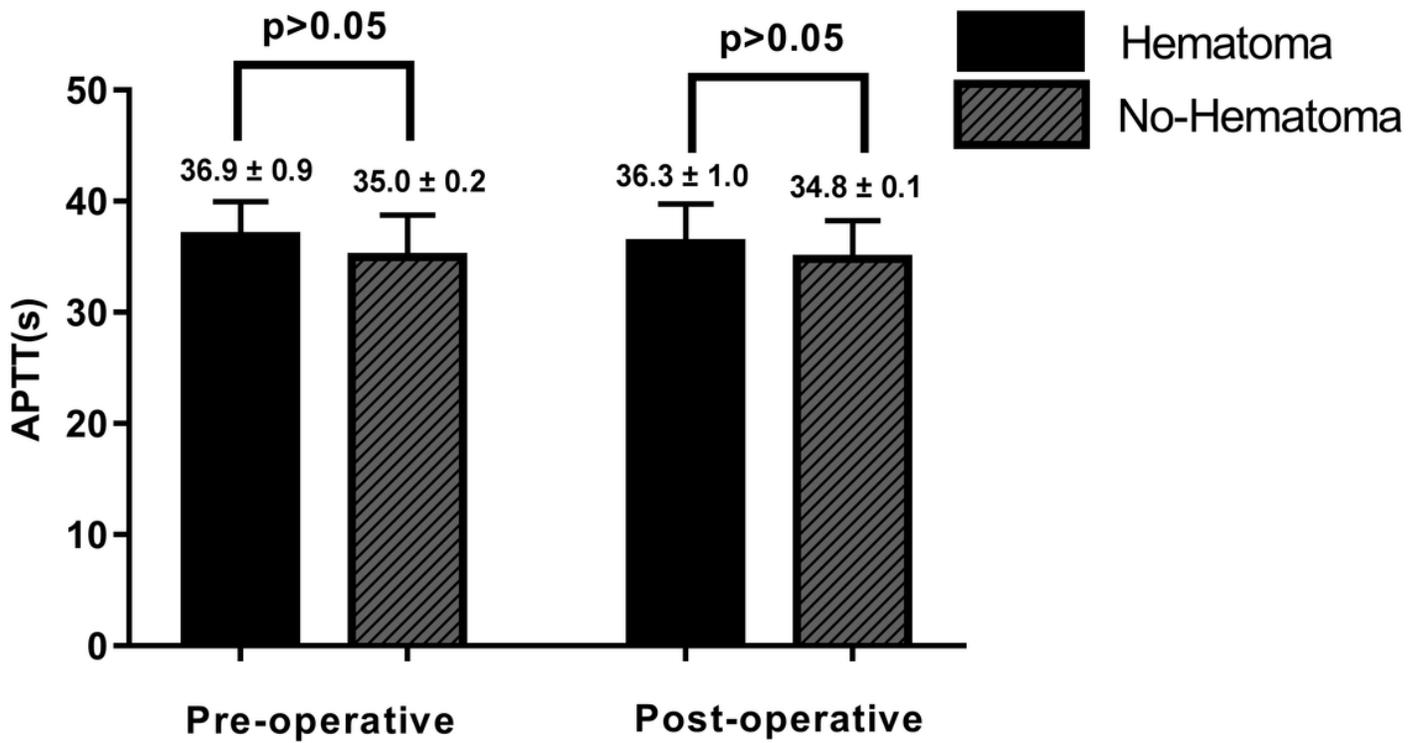


Figure 2

No statistically significant differences were found in APTT and PT levels between two groups at either time point ($p > 0.05$).

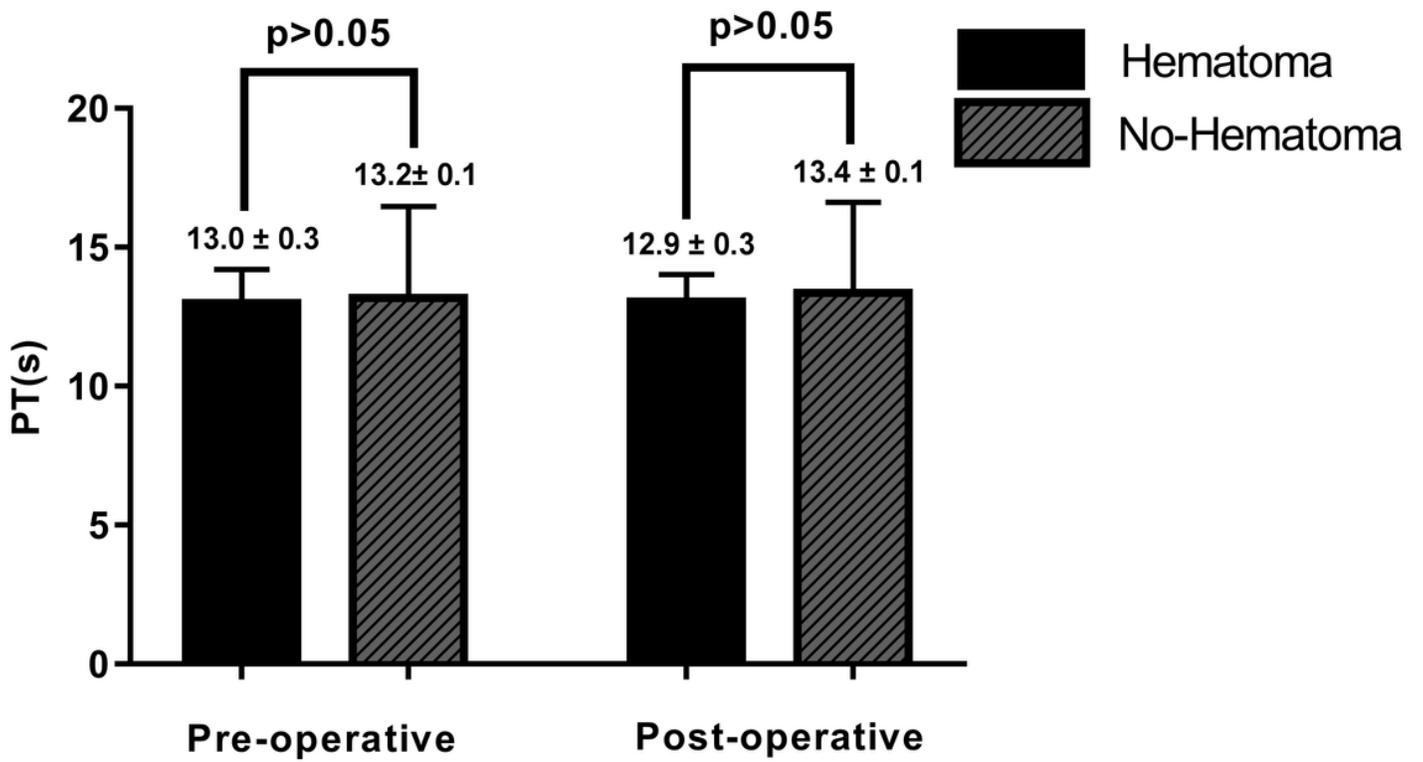


Figure 3

No statistically significant differences were found in APTT and PT levels between two groups at either time point($p>0.05$).

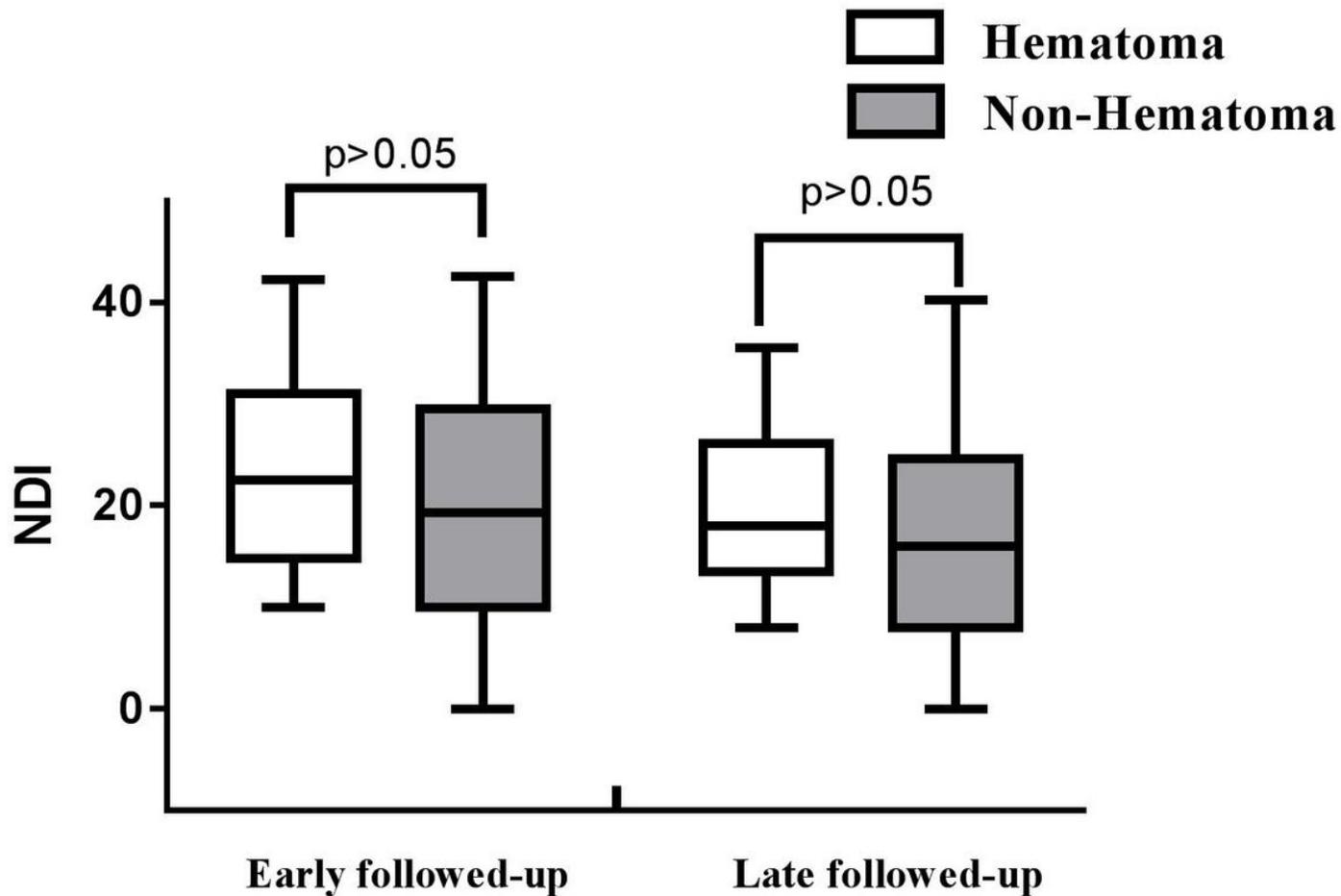


Figure 4

Nonparametric test found that the difference has no statistically significant in NDI scores between two group at either time point($p > 0.05$).