



Review Article

Frequency, recognition, and management of postoperative hematomas following anterior cervical spine surgery: A review

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Received : 23 September 2020

Accepted : 23 September 2020

Published : 21 October 2020

DOI

10.25259/SNI_669_2020

Quick Response Code:



ABSTRACT

Background: We reviewed the frequency, recognition, and management of postoperative hematomas (HT) (i.e. retropharyngeal [RFH], wound [WH], and/or spinal epidural hematomas [SEH]) following anterior cervical discectomy/fusion (ACDF), anterior corpectomy fusion (ACF), and/or anterior cervical spine surgery (ACSS).

Methods: Postoperative cervical hematomas following ACDF, ACF, and ACSS ranged from 0.4% to 1.2% in a series of 11 studies involving a total of 44,030 patients. These included; 4 single case reports, 2 small case series (6 and 30 cases), 4 larger series (758–2375 for a total of 6729 patients), an a large NSQUIP (National Surgical Quality Improvement Program) Database involving 37,261 ACDF patients.

Results: Risk factors contributing to postoperative cervical hematomas included; DISH (diffuse idiopathic skeletal hyperostosis), ossification of the posterior longitudinal ligament (OPLL), therapeutic heparin levels, longer operative times, multilevel surgery, ASA Scores of ± 3 , (American Society of Anesthesiologists), prone surgery, operative times > 4 hours, smoking, higher/lower body mass index (BMI), anemia, age >65, > medical comorbidities, and male gender. Notably, the use of drains did not prevent HT, and did not increase the infection, or reoperation rates.

Conclusion: In our review of 11 studies focused on anterior cervical surgery, the incidence of postoperative hematomas ranged from 0.4 to 1.2%. Early recognition of these postoperative hemorrhages, and appropriate management (surgical/non-surgical) are critical to optimize recovery, and limit morbidity, and mortality.

Keywords: Anterior discectomy/fusion, Out-patient surgery, Postoperative wound hematoma, Retropharyngeal hematoma, Risk factors, Selection criteria, Symptomatic epidural hematoma

INTRODUCTION

Postoperative retropharyngeal (RFH), wound (WH), and/or spinal epidural hemorrhages (SEH) following anterior cervical discectomy/fusion (ACDF), anterior corpectomy fusion (ACF), and/or anterior cervical spine surgery (ACSS) occur in from 0.4%- 1.2% of cases.^[1-11] The incidence of postoperative hematomas (HT) was culled from 11 articles involving anterior cervical surgery; 4 single case reports, 2 small case series (6 and 30 cases), 4 larger series (758-2375 for a total of 6729 patients), and the largest series of 37,261 ACDF patients from the NSQUIP Database (National Surgical Quality Improvement Program).^[1-11] Our aim was to focus on the frequency, symptom duration/recognition, management, and outcomes of postoperative hematomas following cervical spine surgery.

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RISKS FACTORS FOR POSTOPERATIVE HEMATOMAS FOLLOWING ANTERIOR CERVICAL SURGERY

Risk factors contributing to postoperative cervical hematomas included; the presence of DISH (diffuse idiopathic skeletal hyperostosis), OPLL (ossification of the posterior longitudinal ligament), therapeutic heparin levels, longer operative times, multiple surgical levels, ASA Scores of \pm 3, (American Society of Anesthesiologists), prone surgery, operative times (e.g. >4 h), increased intraoperative blood loss, more medical comorbidities, age over 65, smoking, higher/lower body mass index (BMI), wider exposures, intraoperative hypotension, anemia, and male gender.^[2,3,5,8-10] Notably, the placement of drains did not prevent postoperative hematomas.^[2]

4 CASE REPORTS OF HEMATOMAS FOLLOWING ANTERIOR CERVICAL SURGERY

Four case reports focused on the incidence of postoperative hematomas following anterior cervical surgery [Table 1].^[4,6,7,11] In Hans *et al.* (2003) study, the patient developed a spinal epidural hematoma (SEH) characterized by acute respiratory distress, and a flaccid quadriplegia within 2.5 hours of having undergone a C6-C7 ACDF.^[6] The patient's immediate postoperative MR demonstrated an anterior SEH extending from C3-T3 that required an emergency laminectomy; 5 days later, the patient was discharged home, neurologically intact. In a second case report, Dedouit *et al.*'s (2014) 53-year-old developed a retropharyngeal hematoma (RPH) with mediastinal extension within 5 hours of undergoing an ACDF; the patient expired within minutes.^[4] In the third case study by Li *et al.* (2015), a 73-year-old male developed a postoperative HT, screw pull-out, and an esophageal perforation following a C5 ACF; timely surgery resulted in a good outcome.^[7] In the fourth patient, Ren *et al.* (2019) had a 55-year-old male who developed a postoperative RPH (e.g. acute swelling, respiratory compromise/dysphagia) following an ACSS.^[11] The MR-documented postoperative wound hematoma extending from T1 to the skull base, was immediately removed under local anesthesia, and the patient demonstrated no long-term sequelae.

2 SMALL CASE SERIES OF HEMATOMAS FOLLOWING ANTERIOR CERVICAL SURGERY

Hematomas following cervical spine surgery were evaluated in 2 case series respectively involving 6, and 30 patients [Table 1].^[5,8] In Gennari *et al.* (2018), 30 patients underwent ACDF (17 patients), or CDA (cervical disk arthroplasty: 13 patients) on an outpatient basis; operations were performed at the C5-C6 (19 patients), and C6-C7 levels (11 patients).^[5] All

patients were monitored postoperatively for at least 6 hours (average 7.5 hours). Of these, 10% (3 patients) developed postoperative hematomas that required; one immediate postoperative hospitalization (e.g. due to acute neurological deterioration), and 2 hospitalizations occurring on postoperative day one due to dysphagia/non-operative clots. Risk factors associated with these postoperative hemorrhages included; age >65 , 3+ level surgery, more medical comorbidities, and an ASA score of >2 . In a second series by Liao *et al.*, 6 patients developed postoperative neurological deterioration following ACSS due to SEH.^[8] The average interval between the end of the anterior surgical procedures and the onset of symptoms/signs of SEH averaged 9.9 hours (range 12–19 h), while it took another average 6.3 hours from the onset of neurological deficits to the time of surgery for the HT to be removed in 5 of 6 cases.

4 LARGER SERIES OF HEMATOMAS OCCURRING FOLLOWING ANTERIOR CERVICAL SURGERY

We looked at 4 larger series of patients (2011–2018) ranging in number from 785 to 2375. We identified 54 postoperative hematomas out of the total of 6729 patients undergoing anterior cervical surgery [Table 1].^[1,2,9,10] The percent of postoperative hematomas per series ranged from 0.6 to 1.2%. Of these, 41 HT were wound (WH) or epidural hematomas (SEH), while 13 were retropharyngeal bleeds (RPH). In Aono *et al.* (2011) series dealing with acute airway obstruction (AAO) following anterior corpectomy fusion (ACF), there were 785 patients; 9 (1.15%) developed postoperative hematomas.^[1] Of these, 6 bleeds occurred within 24 hours of surgery, while 3 were diagnosed an average of 72 hours postoperatively. Of interest, 2 developed acute postoperative stridor, swelling, and respiratory distress requiring emergent postoperative management, and one of the two warranted an acute cricothyroidotomy. When O'Neill *et al.* (2014) evaluated 2375 ACSS patients, 17 developed postoperative hematomas (0.7%).^[10] Of these 11 (65%) had bleeds requiring surgical removal within 24 hours, while 6 (35%) occurred an average of 6 days postoperatively; all 17 required secondary surgery, while 2 additionally warranted emergent cricothyroidotomies. In Boudissa *et al.* (2016), ACSS were performed in 2319 patient; 13 (0.6%) patients developed postoperative bleeds almost evenly split between RPH, and SEH.^[2] Notably, drains did not decrease or prevent postoperative HT. In 2018, Miao *et al.* observed 15 (1.2%) postoperative hemorrhages occurring out of a series of 1250 ACSS; 7 involved RPH, while 8 were SEH.^[9]

Table 1: Spinal hematomas following anterior cervical spine surgery.

Author/ reference/year	Study design	Operations	Complications	Frequency of hematomas	Outcome
Hans <i>et al.</i> ^[6] 2003	Acute SEH single case C6/7 2.5 h	Postop Respiratory distress Flaccid Quad 1988-2013 785 ACF	Immediate reop not successful	MR after 2 nd OR anterior SEH C3-T3 no cord compression 4/9 REOP HT	LAM Remove HT: Next day Extubated-home 5 days Intact 1 Crico -Arterial bleed All intact
Aono <i>et al.</i> ^[1] 2011	AAO (Acute Airway Obstruction) with ACF	9 (1.15%) AAO Emergency evacuation of HT Intubation Died	6 (67%) HT < /=24 Hours 3 (33%) HT Avg. 72 h Medicolegal autopsy; Massive RPH and mediastinal hematomas	2 acute stridor, swelling/distress venous bleeding Pathology: Acute cervical hemorrhage NO bleeding source	Cause of death Pharyngeal compression HT-mechanical asphyxia
Dedouit <i>et al.</i> ^[4] 2014	RPH cervical SS:1 fatal 53 yo F ACF 5 h Postop swelling dyspnea	Intubation Died			
O'Neill <i>et al.</i> ^[10] 2014	Risk Factors for RPH for ACSS HT vs. no-HT 2375 patients	Minutes 17 PO HT=0.7% 1995-2012 Time to Clot +Removal HT	Time HT removed 11/17 (65%)< 24 Hr 6/17 (35%) avg. 6 Days PO	All 17 Surgery for HT removal 2 Emergent cricothyrotomy PO HT no impact on Early/ Late NDI Multiple AE in One Patient	Risk factors for PO HT DISH OPLL, Therapeutic Heparin, Longer OR. >Levels
Li <i>et al.</i> ^[7] 2015	ACSS HT IE-instrument extrusion EI-esophageal injury	73 yo M CSM C5 ACF Mesh Bone Graft 2319 Cases; 7 yr F/O MATCHED: 2 Controls/1 Patient	AE cervical HT Screw pull-out Esophageal perforation		Early attention to postop hematoma Rule out other pathology
Boudissa <i>et al.</i> ^[2] 2016	ACSS; Risk factors for reintervention reop		13 (0.6%) REOP IN 72 hr 3F/10 M RPH 0.2% SEH 0.3% DT 0.04%	Risks early reop ASA Score > /= 3 Factors with SEH Pain, neuro deficit dysphagia/agitated dysphonia/dyspnea Deficit at onset	>Risk for SEH: Smoking NO risk factors for RPH drains not prevent HT
Miao <i>et al.</i> ^[9] 2018	Postop HT rare ACSS 15 (1.2%) out of 1250 total cases over 6 years	RPH 7 cases SEH 8 cases	PO HT total 1.2%: (1250 total patients) 0.5%RPA 0.6% SEH	B-1 case C-6 cases D-8 Cases Same postop JOA HT=No-HT	Risk For HT OPLL >OR time > Levels >BMI

(Contd...)

Table 1: (Continued).

Author/ reference/year	Study design	Operations	Complications	Frequency of hematomas	Outcome
Gennari <i>et al.</i> ^[5] 2018	Out patient ACDF 30 patients: Success 90% 3 Failures High risk factors >65 yo 3+ Levels, >Comorbidities ASA >2	2014-2018 16 M, 14 F Avg. 47.2 yrs 1 Level 19 C56 11 C67 Selection < 65 yo 1 Level ASA < 2 Standard morphology ACDF I7 CDA I3	Postop monitor at least 6 hours Dysphagia most common AE: 8-30% Avg. OR Time 38 min Postop monitor 7.5 h Average LOS 10 hours 10 min	No deaths Reports in first 30 days postop in literature Rare 0.2% ambulatory wound hematoma Most treated prior to discharge Conclusion: Outpatient ACDF safe carefully selected patients	3/30=10% failure rate 1 Neurological worsening- immediate transfer H 2 (7%) Day 1 readmit to HT dysphagia resolved ambulatory
Ren <i>et al.</i> ^[11] 2019	Retropharyngeal (RFH) Hematoma ACSS Dysphagia Early Symptom of RFH	55 yo M Myelo 33 h Postop Swelling Dysphagia Reop HT In 30 days 148 (0.4%) HT REOP Out of 37,261 patients	MR massive wound RH Base of Skull to T1 Increased Risk with HT: >LOS >AE >Mortality	Local Anes. removal of clot gloved hand removed RFH resolved 37% Postop HT after discharge Risks REOP HT.>Levels Low BMI ASA >/= 3 Preop anemia Male	Posterior pharyngeal compression leads to difficulty with intubation airway compromise HT Prior to discharge >LOS >Risk vent. >Deep infection Pneumonia Reintubation
Bovonratwet <i>et al.</i> ^[3] 2019	Risk factors For postop HT Requiring REOP 2012-2016 NSQUIP	All on NSDAIDS Preop None on Preop Anti- coagulation	Avg. Time to diagnosis SEH 9.9 h (2-19 h) postop to initial deficit Avg. 6.3 h (1.8-16.7 h) initial worse to OR for HT	5 Emergency surgery; 1 Non-surgical Rx Recovery; 4 ACDF, 1 Non-surgical; Avg. ASIA Grade 2.4 (Range 2-4)	6 th Patient: No recovery; arterial bleeding Cause 6 HT Wide exposure epidural space <BP during OR
Liao <i>et al.</i> ^[8] 2020	Risks cervical SEH- 6 ACSS: 5 M, 1 F Avg 56.7 yo (Range 42-76) 6 Neurological deterioration 3 ROS: Drinking Smoking				

RFH: Retropharyngeal hematoma, ACSS: Anterior spine surgery, HT: Hematoma group, no-HT: No hematoma group, PO: Postoperative, NDI: Neck disability index outcomes, OR: Operating room, DISH: Diffuse idiopathic skeletal hyperostosis, SEH: Symptomatic epidural hematoma, NSAIID: Non-steroidal anti-inflammatory, Rx: Treatment, ASIA: American spinal injury association grade, TL: Thoracolumbar, C: Cervical, AE: Adverse events, PCDF: Posterior cervical decompression/instrumented fusions, Reop: Reoperation, DM: Diabetes, EI: Esophageal injury, IE: Instrumentation extrusion, CSM: Cervical spondylotic myelopathy, ACF: Anterior cervical corpectomy/fusion, ID: Incidental durotomy, DT: Dural tears, Avg.: Average, PM: Pseudomeningocele, Reop: Reoperation, NSQUIP: National Surgical Quality Improvement Program Database, LOS: Length of stay, Vent.: Ventilator, ACF: Anterior cervical fusion, AAO: Acute airway obstruction, NIS: National inpatient sample, BMP: Bone morphogenetic protein, HO: Heterotopic ossification, CA: Cancer types, Quad: Quadruplegia, LAM Laminectomy, Crico: Cricothyroidotomy, SS: Spine surgery, Ant: Anterior, Post: Posterior, RP: Retroperitoneal, Teach: Teaching, No-Teach: Non-teaching, LOP: Laminoplasty, LAM-F: Laminoforaminotomy, H: Hospitals, WI: Wound infection, F/O: Follow-up, LOS: Length of stay, RE: Retrograde ejaculation, VO: Vertebral osteolysis, yo: Years old, hr: Hours, mos: Months, ASA: American Society of Anesthesiologists

RISK OF HEMATOMAS IN NSQUIP (NATIONAL SURGICAL QUALITY IMPROVEMENT PROGRAM) DATABASE INVOLVING 37,261 ACDF

In Bovonratwet *et al.* series (2019) involving 37,261 ACDF obtained from the NSQUIP database, 0.4% (148 cases) of patients required reoperations for postoperative hematomas [Table 1].^[3] Interestingly, 37% occurred following discharge from the hospital. Risk factors for developing postoperative hematomas included; multilevel ACDF, a low BMI, an ASA Score of 3 or greater, preoperative anemia, and male sex.^[3] Those who developed postoperative HT typically required; a longer length of stay (LOS), more ventilatory support and/or reintubation, a higher risk for deep infections and pneumonia, or other adverse events, including mortality.

TIMING OF SECONDARY SURGERY FOR HEMATOMAS FOLLOWING ANTERIOR CERVICAL SURGERY

In 6 studies, the interval between surgery, and the surgical removal of postoperative hematomas ranged from 2.5 hours to 6 days [Table 1].^[1,4,6,8,10,11] For 3 single case series (e.g. involving 2 ACDF, and 1 ACSS) the time from the end of surgery to the excision of a massive wound hematoma (1 case: C3-T3), and 2 large RPH (e.g. one of which was fatal) ranged from 2.5, to 5.0, to 33.0 postoperative hours.^[4,6,11] For one study including 6 patients undergoing ACSS, the average interval between surgery and the initial recognition of a postoperative SEH was 9.9 hours, while the average period between the first appearance of new neurological/other deficits and definitive surgery was an additional average 6.3 hours.^[8] There were two other larger series involving secondary surgery for the resection of HT following anterior cervical surgery; 9 (1.15%) of 785 patients undergoing ACF with SEH, and 17 (0.7%) of 2375 patients undergoing ACSS with postoperative RPH.^[1,10] Postoperative hemorrhages were diagnosed/treated within 24 hours for 6 of 9, and 11 of 17 patients respectively in these two series; 3 of 9, and 6 of 17 underwent reoperations for HT over an average of 3 and 6 postoperative days respectively.^[1,10]

3 PATIENTS FROM 2 STUDIES REQUIRING EMERGENT POSTOPERATIVE CRICOTHYROIDOTOMY FOR ACUTE HT FOLLOWING ANTERIOR CERVICAL SURGERY

Three 3 patients from two studies required emergent postoperative cricothyroidotomies [Table 1].^[1,10] In the first study that involved 9 HT out of 785 patients undergoing ACF, one patient warranted an acute cricothyroidotomy.^[1] In the second study, that included 17 HT out of a series of

2375 ACSS, 2 patients required acute cricothyroidotomy.^[10] Additionally, in the case report by Dedouit *et al.*, an emergent cricothyroidotomy may have avoided the patient's immediate postoperative death attributed to a massive RPH/mediastinal hematoma.^[4]

ONE MORTALITY DUE TO ACUTE POSTOPERATIVE HEMATOMA OUT OF 11 SERIES (44,030 PATIENTS) UNDERGOING ANTERIOR CERVICAL SURGERY

Out the 11 series involving a total of 44,030 patients undergoing anterior cervical surgery, there was just one reported death attributed to a combined RPH/WH/SEH [Table 1].^[1-11] In Dedouit *et al.* (2014), 5 hours following an ACDF, a 53-year-old female developed an autopsy-confirmed massive postoperative hemorrhage with mediastinal extension resulting in immediate mechanical asphyxia/pharyngeal compression, and death.^[4]

CONCLUSION

Postoperative hemorrhages, including retropharyngeal hematomas (RPH), wound hematomas (WH), and spinal epidural hematomas (SEH) occurred in from 0.4 to 1.2% of cases following anterior cervical spinal surgical procedures performed in 11 studies (e.g. ACDF, ACF, and ACSS).^[1-11] Early recognition and management of these bleeds are critical to limit morbidity, mortality, and maximize recovery.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Commentary

Postoperative hematomas following anterior cervical spine surgery are important clinical entities. They require urgent decompression for restoration and preservation of neurologic and systemic function, maintenance of cord perfusion, and correction of underlying metabolic disturbances. Medical comorbidities predisposing to bleeding diatheses (including thrombocytopenia, platelet dysfunction, anticoagulation use, liver disease and renal insufficiency) are taken into account pre-operatively. Intraoperatively, metabolic acidosis from hemodynamic instability is corrected, facilitating intraoperative hemostatic control. Traumatic extubation may increase Valsalva Maneuvers, thus acutely increasing systemic blood pressure, resulting in an immediate postoperative clot. Alternative early postoperative manifestations of hematomas may be subtle, and include restlessness from hypercarbia prior to development of dyspnea and associated with peri-extubation episodes of Valsalva maneuvers.

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How to cite this article: Epstein N. Frequency, recognition, and management of postoperative hematomas following anterior cervical spine surgery: A review. *Surg Neurol Int* 2020;11:356.