Conservative management of laryngeal perforation in a rural setting: case report and review of the literature on penetrating neck injuries

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ABSTRACT

Penetrating neck injuries (PNIs) are infrequent but can result in significant morbidity and mortality. Although surgical management of unstable patients with penetrating neck trauma is the standard of care, management of stable patients remains controversial owing to the possibility of occult injuries. Recent studies suggest that physical examination and ancillary imaging may be sufficiently accurate to diagnose or rule out surgically significant injuries in PNI. We report a patient with a laryngeal perforation who was managed conservatively in a rural hospital without complications and review the literature pertinent to cases of this nature.

RÉSUMÉ

Les traumatismes pénétrants de la région du cou sont rares, mais peuvent entraîner une morbidité et une mortalité importantes. Bien que la prise en charge chirurgicale de patients instables présentant un traumatisme pénétrant de la région du cou soit la norme, la prise en charge des patients stables demeure controversée en raison de la possibilité de blessures latentes. De récentes études suggèrent que l'examen physique et l'imagerie auxiliaire peuvent être suffisamment précis pour poser un diagnostic ou exclure des blessures importantes sur le plan chirurgical dans les cas de traumatismes pénétrants du cou. Nous présentons le cas d'un patient au larynx perforé qui a fait l'objet d'un traitement conservateur dans un hôpital rural sans complications. Nous passons aussi en revue la littérature pertinente de cas semblables.

Keywords: conservative management, neck injuries, penetrating neck trauma, penetrating trauma, rural emergency medicine, zone II

Penetrating neck injuries (PNIs) account for 1% of all traumatic injuries in adults in the United States and have a mortality rate of 3 to 6%, mainly from major vascular injury.[1,2] The anatomy of the neck is complex, and many vital structures reside in close proximity, sometimes within millimetres, to one another (Figure 1).

PNIs are classified according to the mechanism of injury, the location of the entry wound, patient stability, and the anatomic structures injured (vascular, laryngotracheal, or esophageal).[3,4] The neck is divided into three horizontal anatomic zones (zones 1, 2, and 3) (Figure 2). Zone II, which extends from the cricoid cartilage to the mandible, is the largest and the most commonly injured zone in PNIs[2–5] and is the focus of this article. Zone I and III injuries are difficult to evaluate and surgically manage[4] and therefore should likely be managed in a trauma centre.

Most of the published literature on PNIs originates from US trauma centres,[6] where the most common etiologies of PNI are stabbings and gunshot wounds.[2,3] In Canada, gunshot wounds are less frequent, and stab wounds are the most common cause of PNI.[5,7]

Transfer to a trauma centre for surgical intervention is indicated for unstable patients with PNI and patients with signs of major vascular or airway injury (Table 1).[2,4,6] By contrast, the management of stable patients with PNIs is controversial, particularly in rural areas with limited or no surgical backup. Areas of debate include the accuracy of the physical

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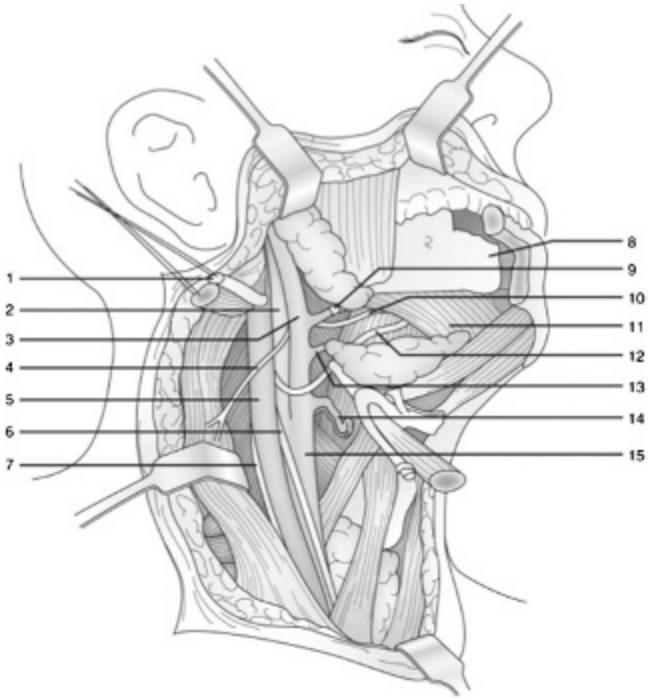

Figure 1. Anatomic structures in zone II of the neck. Reproduced with permission from Bagheri SC et al[3] with permission from Elsevier Inc. 1 = facial nerve; 2 = internal carotid artery; 3 = external carotid artery; 4 = spinal accessory nerve; 5 = internal jugular vein; 6 = vagus nerve; 7 = cervical plexus; 8 = mandible; 9 = facial artery; 10 = lingual nerve; 11 = mylohyoid muscle; 12 = hypoglossal nerve; 13 = lingual artery; 14 = superior thyroid artery; 15 = common carotid artery.

examination in detecting major injuries, which imaging modalities can be used to identify occult injuries in stable patients, and whether all patients with PNIs should be transferred to a trauma centre for diagnostic imaging or surgical assessment and exploration.

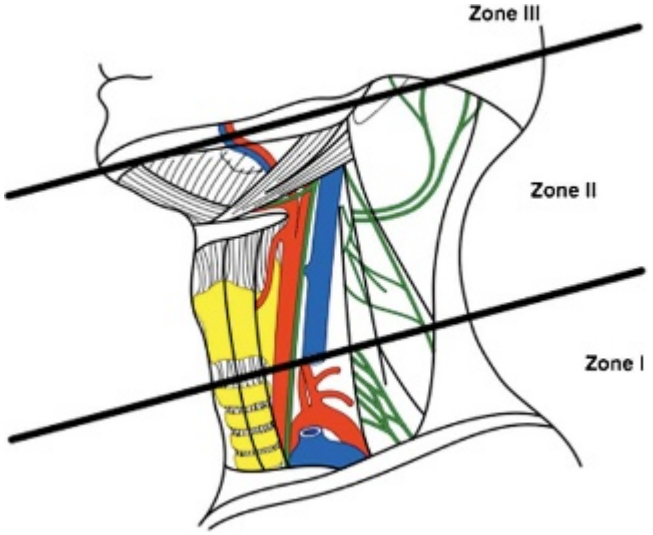

Figure 2. Anatomic zones of the neck. Reproduced with permission from Bagheri SC et al[3] with permission from Elsevier Inc.

Table 1. Signs and symptoms associated with penetrating neck injury

Vascular	Shock*
	Exsanguinating hemorrhage*
	Expanding hematoma*
	Bruit
	Pulse deficit
Respiratory	Airway obstruction/compromise*
	Massive subcutaneous emphysema*
	Dyspnea
	Hoarseness
	Hemoptysis
Neurologic	Focal deficit
Digestive	Dypshagia
	Odynophagia
	Hematemesis

Adapted from Bell RB et al.[2]
*Indications for immediate surgical intervention.

We describe a case of a young man with penetrating trauma to zone II of the neck and a laryngeal perforation. The patient was managed conservatively in rural Alberta by a family physician after telephone consultation with an otolaryngologist and made a full recovery without complications. To our knowledge, this is the first report of occupational PNI from rural Canada.

CASE REPORT

A 24-year-old man presented to our rural emergency department (ED) after sustaining an occupational PNI.

He was hammering steel on steel when a fragment approximately 3 to 4 mm^2 in size splintered off and entered his neck. He subsequently coughed and spat the metallic fragment out of his mouth. He complained of a mild choking sensation and had a sensation of swelling in his neck, along with mild hemoptysis, hoarseness, and bleeding from his entrance wound. All of his symptoms had improved by the time he presented, in an ambulatory fashion, to the ED approximately 60 minutes after the injury occurred.

On initial examination, the patient was stable with a respiratory rate of 16 breaths/min, pulse of 87 beats/min, blood pressure of 133/87 mm Hg, and arterial oxygen saturation of 99% on room air. A 4 mm right anterior neck wound in zone II was identified, cleaned,

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and gently explored with a small probe. There was no obvious air flowing from the entry wound, and subcutaneous emphysema was not identified.

He was treated initially with oxygen by nasal cannulae and intravenous normal saline. Neck radiographs were obtained and did not demonstrate a foreign body. A complete blood count was normal.

After telephone consultation with an otolaryngologist, noncontrast computed tomography (CT) of the neck was performed and revealed disruption of the wall of the infraglottic larynx and mild subcutaneous emphysema (Figure 3). No additional airway injuries or major vascular injury was identified on the CT scan.

After CT, the decision was made to conservatively manage the patient in our rural hospital. He remained stable and was discharged home about 36 hours after his presentation with only mild hoarseness and minimal anterior neck pain. At the 6-week follow-up, the patient had no sequelae from his injury.

DISCUSSION

Our case of an occupational PNI is unique in that the patient was managed conservatively in a rural hospital after CT of the neck was performed rather than transferred to a tertiary care centre for surgical assessment or intervention. We performed a literature review on three key questions regarding the management of stable PNIs:

Figure 3. Computed tomographic image of a penetrating neck injury. The *arrow* indicates disruption of the infraglottic larynx.

1. *Is physical examination sufficiently accurate to identify major injuries in stable patients with PNI?*

   Traditionally, the physical examination was deemed to be unreliable for ruling out major injury in stable PNI; therefore, mandatory exploratory surgery was standard practice.[8] However, recent literature supports the use of physical examination as a reliable tool for ruling in and out serious injuries from PNI.[1–4,6,9] Serial physical examination with auscultation of the carotid arteries is reported to be 95% sensitive[6] for ruling out major injuries and may be as high as 100% specific.[10,11] The largest and most relevant studies on the role of physical examinaton in stable PNI are outlined in Table 2.

   Two caveats, however, merit mention with respect to the accuracy of physical examination in PNI. First, these studies were performed in US trauma centres, where physicians undoubtedly have more experience in examining and treating PNIs than most rural emergency physicians. Second, when PNI is from a gunshot, the physical examination may be less reliable.[12]

   In our case, the patient was stable despite having symptoms suggestive of an aerodigestive injury. Although we did not clinically detect the small amount of subcutaneous emphysema found on the CT scan, this discrepancy between physical examination findings and diagnostic imaging did not change the management of our patient.

2. *Which imaging modality is sufficiently sensitive and specific to assess for occult injury in PNIs?*

   The choice of imaging modalities for the evaluation of stable patients with PNIs remains a source of debate.[1,4,13–18] Stable zone II injuries may be evaluated with plain radiography, conventional angiography, CT (conventional, spiral, multidetector helical computed tomographic angiography [CTA]), duplex ultrasonography, endoscopy, or laryngoscopy/bronchoscopy depending on the nature of suspected injuries.[2,17] In reviewing the literature on this topic, we focused on imaging modalities used to rule out significant life-threatening injury attributable to occult vascular injury.

   Plain chest or neck radiographs are often obtained first and may be the only modality available in many

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rural sites. Although useful for detecting metallic foreign bodies and extraluminal air, plain films are not overly helpful in detecting injuries to deeper structures.[10,13,18]

Historically, angiography has been considered the gold standard for diagnosis of vascular injuries in PNIs.[15] Owing to potential complications with angiography, the time required to complete the study, the large proportion of negative studies, and the inability of angiography to image nonvascular structures, multidetector helical CTA has now replaced angiography as the preferred imaging technique for evaluating stable PNIs.[2,6,15,17] Angiography still has a role in stable PNIs when CTA findings are inconclusive for vascular injury or when an injury amenable to angiographic intervention is identified.[17]

CTA may have technical limitations when metallic foreign bodies are present[17] and, more importantly, is not available in many rural Canadian centres.

Although some of the literature suggests that CTA is only marginally better than physical examination for determining the need for surgery,[10,13] other studies suggest that CTA is as accurate as angiography in identifying vascular injuries in PNIs[15] and that the use of CTA in stable PNI patients limits unnecessary surgical intervention.[19]

Doppler ultrasonography has also been found to be accurate in detecting clinically significant vascular lesions in PNIs, with reports of 95 to 100% sensitivity and 99 to 100% specificity.[10,17,20,21] Despite this, CT is used preferentially over ultrasonography for a number of reasons.[17] First, CT is useful for imaging soft tissue and bony injuries as opposed to only vascular structures. Second, CT is more readily accessible when skilled sonographers or radiologists may not be available on site. Finally, in settings where patients are immobilized in a cervical spine collar or are bandaged, vascular structures may not be accessible by ultrasonography.

In rural centres where the only imaging available is plain radiography, referral of stable patients with PNIs that extend beyond the platysma for advanced imaging is a pragmatic option. In our case, a single-channel spiral CT scan identified the underlying airway injury and ruled out any significant vascular or esophageal injury, which aided in our decision not to transfer the patient to a trauma centre. In hindsight, ultrasonography, which is available at our hospital, also would have been a reasonable option for imaging our patient. Nonetheless, our case supports recent clinical guidelines suggesting that CT is sufficient to rule out vascular injury when the trajectory of the foreign body is evident.[6]

3. *Do all patients with PNIs deep to the platysma require mandatory surgical exploration?*

Previously held beliefs about the inaccuracy of the physical examination, coupled with the lack of sophisticated imaging modalities and the relative ease of accessing zone II injuries, resulted in mandatory surgical exploration of all zone II PNIs that violated the platysma to rule out occult injuries.[8,22] However, mandatory surgical exploration has been found to fail to identify clinically significant injuries in approximately 53 to 60% of cases[6] and perhaps up to 75% of cases.[9] An 18-year retrospective Canadian study reported a 41% overall negative surgery rate, which increased to 67% when asymptomatic patients were explored.[5] Mandatory surgical exploration adds financial costs[3] and potentially increases hospital length of stay, as well as patient costs, owing to the expense of recovering from surgery [3,5–7,23]

Selective surgical management of PNIs is therefore the recommendation in the most recent reviews and guidelines.[2,4,6] The data supporting this again originate from the United States, with the majority of cases undergoing observation as opposed to surgical management.[20,24,25] In two Canadian studies, by contrast, even though selective surgical management was employed, the majority of cases were explored.[5,7] Most importantly, in all of the studies that directly evaluated selective nonoperative management of PNIs, none of the patients who were observed required delayed surgery for an initially occult injury.[5,7,19,23–25]

Finally, although rare, esophageal perforations from PNIs can be difficult to diagnose, and delayed diagnosis and treatment result in increased morbidity and mortality.[6] Because of this, stable patients with symptoms suggestive of a digestive injury (dysphagia, odynophagia, or hematemesis) should have esophagography, whereas unstable patients, intubated patients, or others requiring surgical treatment of their PNI should undergo rigid esophagoscopy.[6]

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Table 2. Diagnostic characteristics of physical examination for major injury in stable penetrating neck injury

Study design	Authors	Study population		Outcome
		n	Type of injury	
Retrospective	Demetriades et al[20]	223	Stable PNIs	100% sensitivity for major vascular injury requiring surgical treatment; none of the patients with normal PE were found to have major injury requiring surgery
	Sekharan et al[24]	145	Zone II PNIs	99% sensitivity: PE missed only one serious vascular injury
Prospective	Demetriades et al[10]	82	Stable PNIs	100% specificity, 91% sensitivity for major injury of combined PE, Doppler ultrasonography, and angiography
	Azuaje et al[11]	152	Stable PNIs	100% specificity, 98% sensitivity: 89 patients had a negative PE; of these 89, only 3 had a positive angiogram and none required surgical intervention

PE = physical examination; PNI = penetrating neck injury.

The management of our case was consistent with current clinical guidelines.[6] Stable zone II injuries with violation of the larynx are rare as the majority of laryngeal injuries have serious airway compromise, which requires surgical intervention.[26] Our patient exhibited only mild symptoms of airway injury: hemoptysis, hoarseness, and sensation of swelling in the neck. Despite CT evidence of a walled-off laryngeal perforation, he remained clinically stable and made a complete recovery with local conservative management. Our management was also consistent with the recent recommendation that nonsurgical management of laryngeal injuries should be limited to those with minor injuries without airway compromise.[26]

CONCLUSION

We have endeavoured to provide a basic approach to the initial management of stable PNI, with an emphasis on special considerations in rural centres such as ours. Physical examination and ancillary imaging with duplex Doppler ultrasonography or contrast-enhanced CT are likely sufficiently sensitive and specific to diagnose or exclude significant injuries in patients with PNIs. Selective operative management of PNIs, with the majority of patients being observed and undergoing repeated systematic clinical examinations, limits unnecessary surgery while minimizing the risk of missing a clinically significant injury.

Future studies are needed to determine whether emergency physicians have physical examination acumen similar to that of trauma surgeons with respect to PNI and whether rural PNI patients have outcomes comparable to those of their urban counterparts.

Canadian studies are needed to evaluate the accuracy of imaging modalities across urban and rural centres, with the purpose of determining which PNIs can be safely managed nonoperatively and without transfer to a trauma centre.

Competing interests: None declared.

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