NURSING CARE OF PATIENTS UNDERGOING NECK SURGERY: PREVENTING, RECOGNIZING, AND TREATING NECK COMPARTMENT SYNDROME

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Abstract
The aim of this article was to describe the phenomenon of neck compartment syndrome and its nursing management.

Compartment syndrome is currently known as a potentially serious problem occurring mainly in patients with limb trauma or in patients who underwent abdominal surgery. On the other hand, the scientific literature has devoted little attention to compartment syndrome of the neck.

The scientific literature describing the physiology of wound healing was reviewed, with a focus on two factors closely related to wound healing in the neck and potentially affecting the development of neck compartment syndrome: neck bandaging techniques and wound drainage. Current knowledge about neck compartment syndrome was summarized.

At present, only limited yet important information is available that may assist nurses and other members of the health care team to implement measures to minimize the risk of neck compartment syndrome.

The information that is available about neck compartment syndrome could serve as an impetus for nurses to implement care that aims to prevent neck compartment syndrome. Of equal importance is a coordinated effort by the entire health care team to prevent this complication, or, if it develops, to manage it.

This study highlights the importance of realizing that compartment syndrome is a potentially serious complication occurring not only in the commonly known anatomical locations (such as the limbs and the abdomen) but also in the neck. Additional studies shedding more light on this complication – using a nursing as well as a multidisciplinary approach – are needed.

Key words: *neck compartment syndrome; wound care; wound healing; neck surgery*

ORIGINAL ARTICLE

INTRODUCTION

Wound healing

Surgical wound healing has been discussed extensively in the nursing literature. For example, Vuolo provided a clear overview of surgical wound classification, wound closure techniques, and principles of wound healing (Vuolo 2006). Moreover, Vuolo (2006) provided a systematic approach to wound assessment and management and discussed various wound healing complications, such as wound dehiscence and wound infection.

According to Vuolo (2006), many factors are involved in the development of wound healing complications. While it is well known that certain peri- and postoperative factors (for example, breaking sterility when caring for the wound) may contribute to the development of wound healing complications, other factors contributing to such complications arise from the patient's initial physical status. Of these, Vuolo (2006) mentioned low albumin and hemoglobin levels, certain chronic conditions, and chronic stress on the wound.

The process towards uncomplicated wound healing, then, begins preoperatively. For example, the patient's nutritional status and preoperative skin preparation need to be optimized (Pellant et al. 2006a, b). In the operating room, a number of other actions and decisions are necessary to promote uncomplicated wound healing, such as: a) correct surgical technique consisting of careful arrest of bleeding; b) uncontaminated surgical field; c) physiological reconstruction of the tissues; d) appropriate drainage of the wound; and e) selection of appropriate suture materials (Leaper 2006, Pellant et al. 2006a, b). In the postoperative period, dressing changes using a sterile technique are important (Pellant et al. 2006a, b). Because nurses are involved in many of these activities, they must minimize the risk of wound complications by ensuring that correct and evidence-based procedures are followed at all times (Pellant et al. 2006a).

Another factor that is important in ensuring uncomplicated wound healing is the level of physiological blood supply to the wound area and its surroundings. As Gorgos (2004) explained, adequate wound and periwound tissue perfusion – and therefore, sufficient oxygen supply – are important to ensure that the wound heals well. In fact, adequate wound and periwound tissue perfusion is one of the most important prerequisites to successful wound healing especially after complex surgical procedures (Harvey 2006). The goal of sufficient blood volume maintenance may be attained, for example, by a judicious provision of supplemental oxygen and fluids in the perioperative period. Additionally, problems may develop if the bandage covering the wound is applied too tightly or too loosely, or if the site is not drained using an appropriate method (Pellant et al. 2006a). This issue gains importance especially in anatomical areas of the human body that change its volume only with great difficulty (in so called 'compartments').

To understand the above issue of wound blood supply and drainage, some authors focused on studying the body's response at the vascular system level, especially at the level of the capillaries. This is because capillary bed pressure is an important factor that has an impact on fluid shifts in the area supplied by the capillaries. If such areas are subjected to an increase in capillary bed pressure exceeding 32 mm Hg at the capillary's arterial end and 12 mm Hg at its venous end (which are the values representing physiological capillary end pressures), blood and interstitial fluid may penetrate interfascial space. This situation may occur if a tight bandage is applied over the wound (Harvey 2006). As a result, tissue ischemia and – in serious cases – tissue necrosis may occur (Pellant et al. 2006b). In addition, interstitial fluid or blood may accumulate, which sometimes leads to pus formation (Pellant et al. 2006b). Alternatively, interstitial fluid freely accumulates in drainage 'pockets' or in tissue spaces with a similar result: seroma, hematoma, or abscess formation (Pellant et al. 2006b). This situation may lead to the development of a compartment syndrome – a potentially serious complication that is known especially in abdominal surgery and in limb trauma (Edwards 2004, Harvey 2006, Gerhart 2007). However, this complication may occur even in the neck area (Mohamed et al. 2002, Pellant et al. 2006b). Compartment syndrome in the neck may lead to symptoms that are different from compartment syndrome symptoms in other parts of the body, especially to dyspnœa and stridor (Mohamed et al. 2002). However, the results of a careful review of the nursing literature suggest that neck compartment syndrome has not yet received any attention (Fig. 1).

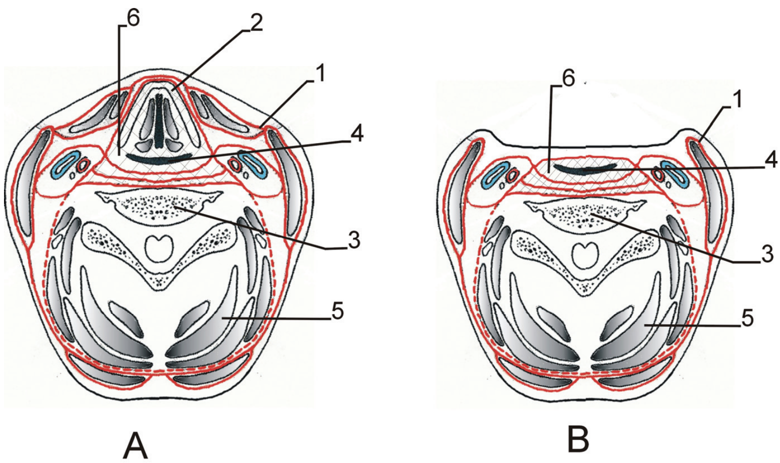

Fig. 1. Cross section of the neck prior (A) and after (B) the total laryngectomy.
1. Superficial layer of deep neck fascia; **2.** Larynx; **3.** Cervical vertebra; **4.** Hypopharynx; **5.** Paravertebral muscles; **6.** Anterior neck compartment represents the place where tisuular hypoperfussion due high interfascial pressure can develop.

Wound healing in neck surgery

Drainage methods

Small and superficial wounds do not require the use of drains. In small surgeries involving the neck area, a small latex or rubber strip (also called the glove drain) may be used (Čapov et al. 2001). In more complex surgical procedures, a closed vacuum suction drainage system, first described by Jost and Redon (1954), may be used (Čapov et al. 2001). The function of the modern Redon drain (used in some European countries) is very similar to the Hemovac and the Jackson Pratt drains familiar to nurses in North America and elsewhere. According to the extent of the surgical procedure, one, two, or rarely, three such drains are used (Čapov et al. 2001). Correct drain placement and maintenance ensure the achievement of standard suction in the drainage area and enable accurate assessments of the amount and character of the drainage (Pellant et al. 2006a). However, restoring the system's drainage function if the drain clogs or if its perforated part gets partially dislodged above the level of the skin suture may be difficult. Moreover, the patient may experience a slight discomfort (Pellant et al. 2006b).

In the neck area, a size 10 French (Charrière) drain is used the most frequently, and its length can be adjusted according to the size of the wound area (Pellant et al. 2006). The drain is usually removed after the drainage amount decreases to less than 10–20 ml in 24 hours, which typically occurs on the first or second postoperative day (Pellant et al. 2006a). During the drain removal, it is important to cover the drain insertion site with a small sterile gauze pad in order to prevent introducing possible infection from the surface of the skin to soft tissues (Pellant et al. 2006a). Premature or delayed drain removal can cause a very serious inflammatory complication and can delay wound healing (Pellant et al. 2006a).

In diffuse deep neck infections (parapharyngeal phlegmon, necrotizing fasciitis), the wound is left open (a so called therapeutic drainage is used) (Pellant et al. 2006b). In some cases – for example, if there is a need to perform drainage of the upper mediastinum—wider tube drains may be used, with the possibility of lavage and a connection to a sub-atmospheric drainage system (Pellant et al. 2006a). As Pellant et al. (2006a) explained, the decision to remove such drains is individual. Apart from the overall health status of the patient and the laboratory results, the most important criteria include especially the amount and characteristic of the drainage, the depth of the drained area, and possibly other factors (Pellant et al. 2006a).

Negative pressure wound therapy – also known as vacuum assisted closure (VAC) therapy or vacuum therapy – developed in the 1990s, has been used for chronic, acute, subacute, and traumatic wounds, for flaps and grafts, and most recently, for partial thickness burns (Stannard 2004). The latest VAC technology includes a pressure sensor that is capable of measuring the pressure exerted at the wound site to better control the wound healing environment (Stannard 2004). While the use of VAC therapy is not common in head and neck surgery, Shreenivas et al. (2006) described its use in a compromised wound in a patient with cervical rotation flap dehiscence after a radical neck dissection. However, it is not clear whether Shreenivas et al. (2006) used, on their patient, the latest pressure sensor technology mentioned by Stannard (2004).

In orthopedic patients, VAC therapy is sometimes used not to prevent compartment syndrome but to promote healing of tissues affected by compartment syndrome. For example, the VAC pump was used to promote healing post-fasciotomy over the tibia in a study of 34 patients (as is well-known, this treatment method of releasing pressure from the compartment is used if simpler strategies fail). The results of this study demonstrated that wound closure time was significantly lower in patients treated with a VAC pump compared to patients in the control group (Stannard 2004). Next, Marsh et al. (2007) reported that in their trauma unit at a hospital in the United Kingdom, VAC therapy was regularly used to manage fasciotomy wounds after compartment release.

Wound pressure and its impact on healing

The VAC technology enables pressure measurement at the wound site. A different method of wound pressure monitoring – so far not described elsewhere – was used by Pellant et al. (Mejzlík 2006a). Mejzlík (2012) studied wound pressure in 30 patients undergoing a relatively extensive neck surgery (in most cases, total laryngectomy with a block dissection of the neck). During a reconstruction of their neck tissues, the patients had a silicone microchip (Codman ICP MicroSensor) implanted into a suitable location under the muscle layer (Mejzlík 2012). The microchip is normally used to monitor intracranial pressure in serious brain injuries or surgeries (Fig. 2). In addition to the microchip, Pellant et al.'s (Mejzlík 2012) patients had a vacuum drain inserted into the periwound area. Following surgery, continuous monitoring of pressure in selected tissue boundaries was performed and recorded for a period of 48 hours (Mejzlík 2012). If the pressure exceeded the set level of 20 mmHg, the vacuum drainage system was inspected for patency (Mejzlík 2012). At the same time, the wound bandage was loosened in order to maintain the pressure below the predetermined limit (Mejzlík 2012). Pellant et al. (Mejzlík 2012) explained that during vacuum drainage, excessive tightening of the bandage for a prolonged period of time may cause insufficient drainage of the wound area and may lead to ischemic tissue changes (including necrosis). Furthermore, extreme tightening of the bandage may cause decreased blood circulation through the main neck arteries (Mejzlík 2012). On the other hand, insufficient compression – caused by loosening of the dressing – may lead to extravasation of blood and interstitial fluid into the interfascial space, which may contribute to abscess formation or to other inflammatory complications (Pellant et al. 2006b). The authors concluded that the discussed tissue findings were congruent with the current knowledge of tissue response in closed compartments. On the one hand, the number of patients studied by Pellant et al. (Mejzlík 2012) was quite small, and high costs may prevent method from becoming 'widespread' (Mejzlík 2012). On the other hand, Mejzlík et al's study (2012) suggests that the authors' method may contribute to a decreased number of postoperative complications in patients undergoing neck surgery.

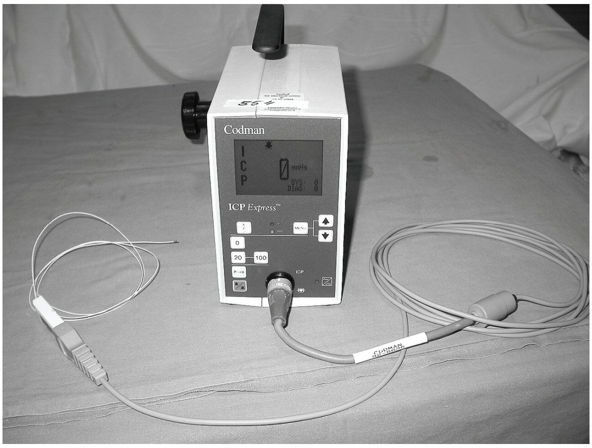

Fig. 2. Codman ICP MicroSensor used to monitor intracranial pressure

While the above results were tentative (Mejzlík 2012), demonstrates that the interaction between wound drainage and neck bandaging technique (and ultimately, the wound pressure level) may have an impact on the patient's wound healing. The same findings were reported elsewhere (Mejzlík 2006a, Mejzlík et al. 2006b). Mejzlík (2006a) examined variations in neck bandage compression achieved by applying an elastic bandage at different tightness levels. Mejzlík (2006a) asked 30 baccalaureate nursing students (who did not have practical experience in the neck bandaging technique) to apply an elastic bandage on one another's neck. The Codman ICP MicroSensor (a microchip) was imbedded in the bandage (Mejzlík 2006a). The students were instructed to apply the bandage 'tightly', 'moderately tightly', or 'loosely'. Repeated measurements of pressure levels in the microchip demonstrated that depending on the tightness level of the bandage, the difference in the obtained mean pressures was as high as 100% (Mejzlík 2006a). This study suggests that the wound bandaging technique may have a profound effect on the level of achieved compression, and ultimately, on the response at the tissue level. Therefore, as Pellant et al. (2006a) stressed, the first dressing change requires that the staff caring for the patient adjusts the tightness level of the bandage according to the condition of the wound and the type of used drainage. Moreover, Pellant et al. (2006a) said that the surgical site area could be padded by using a foam dressing, which should be placed between the sterile dressing covering the wound and the bandage. This strategy aims to distribute pressure over a greater area (Pellant et al. 2006a).

Compartment syndrome of the neck

Symptoms

The five P's of compartment syndrome that nurses commonly encounter in orthopedics – progressive pain on passive stretch, paresthesia, pallor, paralysis, pulselessness (Harvey 2006) – are, to a certain extent, relevant in neck compartment syndrome as well (Pellant et al. 2006b). According to Pellant et al. (2006b), early signs include skin color changes in the area above the dressing (purple color). In addition, using fingers to press down on the skin of the neck leads to blanching of the skin (Pellant et al. 2006b). The skin rebounds and does not remain indented when the pressure is released (Pellant et al. 2006b). Late signs include bluish skin color, edema, pitting edema lasting for several seconds, and temporary skin color changes (to pink) in areas where the examiner's fingers pressed down on the skin of the neck (until the venous blood reached the area again) (Pellant et al. 2006b). Moreover, the same authors mentioned what they saw as reliable signs of neck compartment syndrome: painless soft edema of the wound with a discharge of serosanguinous secretions from the operative wound and a purple skin color that does not disappear upon palpation. Pellant et al. (2006b) stressed that the above information was the result of observations made during their extensive experience in a department of head and neck surgery.

Methods of pressure measurement

Experts in the field stressed that identifying compartment syndrome as early and quickly as possible is important; measuring pressure in the involved tissue is a strategy assisting to detect changes at an early stage (Mejzlík 2012). Edwards (2004) and Gerhart (2007) described various methods of compartment pressure monitoring, their advantages, and disadvantages. For abdominal compartment syndrome, several methods of intra-abdominal pressure measurement were described, ranging from direct, intraperitoneal pressure measurements, to more indirect methods using a nasogastric tube, a urinary catheter, or the rectal route (Gallagher 2006). Gerhart mentioned that Stryker is the most common compartment monitor as it is portable and easy to use. With the exception of Mejzlík (2012), the above mentioned author considered the use of compartment pressure monitoring devices only in locations other than the neck.

Another problem was mentioned by Mejzlík (2012) and by Jerosch et al. (Jerosch et al. 1997): there are no standard criteria determining which pressure levels are still normal and which ones represent a pathological state. Mejzlík et al. (2006b) reported that in pressures exceeding 15 mmHg, there was a higher incidence of wound-related complications (Table 1).

Table 1. The interfascial pressure inside the soft tissues of the neck announces possible healing complications. Physiological values of the mean pressure enable capillary perfusion, risk levels cause the hypoperfusion and the schemia can develop if the pressure outreaches 12 mm Hg.

Overwiev of interfascial pressure values after neck surgery	
	Interfacsial space pressure mm Hg
Mean	7,5–10
Risk level	10–15
Ischemia	>15

Prevention and management

Pellant et al. (2006b) stressed that health care workers could take steps to prevent neck compartment syndrome as early as in the preoperative period. These steps include preparing patients for surgery by ensuring that they have physiological serum levels of albumin and a satisfactory complete blood count. At the same time, Pellant et al. (2006b) mentioned that delaying surgery is not always possible due to other risks (for example, risks associated with delaying oncological surgery).

In the postoperative period, neck compartment syndrome prevention methods include patient positioning (elevating the upper part of the body) and a careful observation of the wound area in the first 48 hours when the neck tissue pressure is the most likely to rise (Pellant et al. 2006b); the observation should include repeated neck circumference measurements (Pellant et al. 2006b).

Numerous other authors have discussed the importance of neck circumference measurements in the surgical patient. Neck circumference is frequently mentioned in association with obesity and related phenomena, especially obstructive sleep apneas. For example, Paje and Kremer (2006) mentioned that patients with a body mass index (BMI) over 30 kg/m^2 or with a neck circumference exceeding 40 cm (i.e., obese patients) have an altered pharyngeal patency. Paje and Kremer (2006) argued that this change (together with other changes characteristic of the obese patients) can increase the probability of sleep obstructive apneas. In fact, Benumof (2004) stated that up to 90% of patients with sleep obstructive apneas where obese. Ezri et al. (2003), who studied the issue of intubation in patients with a BMI >40 kg/m^2 (i.e., in the morbidly obese), found that in these patients, a neck circumference exceeding 50 cm was a risk factors for difficult intubations. Similarly, Jain and Dhand (2004) found a correlation between a neck circumference >46.5 cm and difficult intubations. El-Kadi et al. (2007) saw postoperative neck circumference measurements as a strategy to recognize delayed neck hematoma in anterior cervical discectomy and fusion surgery. The importance of the above issues is undisputable; however, it appears that neck circumference measurements have been identified as an important strategy in detecting neck compartment syndrome only by Pellant et al. (2006b).

If symptoms of neck compartment syndrome develop, Pellant et al. (2006b) recommend decompression by cutting the bandage and applying a new bandage while ensuring that it is not too tight or too loose.

CONCLUSION

The information that is available about neck compartment syndrome could serve as an impetus for nurses and other members of the health care team to implement care that aiming to prevent neck compartment syndrome. This article demonstrates that measures can be taken to decrease the incidence of this potentially important complication in the preoperative, perioperative, and the postoperative period. However, the available knowledge is limited and tentative. Research studies with sufficiently large samples or detailed case studies would allow shedding more light on the issue. Moreover, because the VAC technology may be useful in neck surgery (in addition to some of the other surgical subspecialties), it would be beneficial to consider studying its effect on neck compartment syndrome development as well as its role in patient monitoring and in neck compartment syndrome detection. Finally, other methods of neck compartment pressure monitoring could be studied while focusing on patient outcomes and on other relevant factors, such as financial implications and staff-related issues (ranging from ease of use to staff educational needs).

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