

# Commonly used topical oral wound dressing materials in dental and surgical practice – a literature review

## Abstract

A small number of medicaments are used in oral and maxillofacial surgery to dress wounds, relieve pain, prevent infection and promote healing. While these materials are routinely used, their constituents, uses and effects on oral tissues are rarely discussed. This literature review provides an overview of the constituents, uses and effects of the common materials – oxidised regenerated cellulose, Whitehead's varnish, Carnoy's solution, bismuth iodoforn paraffin paste (BIPP), zinc oxide eugenol (ZOE) and Alvogyl.

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## Introduction

Surgery in the oral cavity causes trauma to the surrounding tissues and creates a wound that requires time to heal. Bleeding is an expected consequence of surgery and the mouth is a vascular area. However, bleeding after an extraction or dentoalveolar surgery is usually self limiting. Some surgical materials have anticoagulant effects and are useful in achieving haemostasis, when bleeding is not otherwise controlled.<sup>1,2</sup>

Classically, primary closure of a wound is preferred over secondary healing. In the mouth, primary closure is not always possible. Some of the oral tissues, for example the mucosa of the hard palate and attached gingivae, are tightly bound to their underlying bone and cannot be easily mobilised to provide primary closure. In lower wisdom tooth surgery, primary closure of the mucoperiosteal flap has been associated with increased postoperative pain and swelling compared to flap repositioning and secondary healing.<sup>3</sup> Dressing materials have been advocated and applied to wounds in the mouth in order to reduce postoperative pain, promote healing and prevent infection.<sup>4,5</sup> They can also have detrimental effects on the oral tissues. Nerve damage, local tissue reactions and toxicity

have been reported.<sup>6-8</sup> It is therefore important to be aware of the constituents of these materials, their uses and the potential for adverse reactions. Some of the commonly used wound dressing materials and their effects on oral tissues are discussed below.

## Oxidised regenerated cellulose

Cellulose is a carbohydrate that is found in the plant cell wall. It was noted in the 19th Century that cellulose could be oxidised, but it was not until 1942, when Yackel and Kenyon described a method of oxidising cellulose using nitrogen dioxide, that the material became useful in surgery.<sup>2,9</sup> Regenerated cellulose is now made by first dissolving the cellulose and then extruding it as a single fibre. This technique allows a more uniform chemical composition than the original nitrogen dioxide method.<sup>10</sup> Proprietary brands of oxidised regenerated cellulose include Surgicel, ActCel, Curacel and Gellita-Cel (Figure 1).<sup>11-14</sup>

Oxidised regenerated cellulose is used as a haemostatic agent, working primarily by chemical interaction with blood.<sup>2</sup> It forms a gelatinous mass when mixed with blood that functions as an artificial blood clot (Figure 2).<sup>10</sup> Due to its low pH, it may also have some antimicrobial effects.<sup>15</sup>

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FIGURE 1: Oxidised regenerated cellulose (Surgicel).



FIGURE 2: Oxidised regenerated cellulose retained by gently applied sutures in extraction sockets.



FIGURE 3: Ribbon gauze with Whitehead's varnish following removal of a palatal pleomorphic adenoma.

Oxidised regenerated cellulose has been shown to be relatively biocompatible. Animal studies have shown it to be completely broken down subcutaneously within 45 days and it does not significantly interfere with wound healing.<sup>16</sup> In view of its biocompatibility, dissolved oxidised cellulose was originally considered as a plasma substitute.<sup>2</sup> Loescher and Robinson in 1998 raised concern over the potentially neurotoxic effects of oxidised regenerated cellulose. They directly applied Surgicel to the rat saphenous nerve and showed an immediate but short-lived reduction in nerve function. They did not demonstrate any long-term change in nerve function when the material was applied for one week.<sup>6</sup> Oxidised regenerated cellulose is used extensively in the field of neurosurgery, where neurological complications have not been reported.

#### Whitehead's varnish

Whitehead's varnish was first described in a case report by Walter Whitehead in 1891 on its use following tongue resection.<sup>1</sup> The original varnish used by Whitehead contained iodoform, ether and turpentine. The composition of the Whitehead's varnish that is currently used is shown in Table 1.<sup>17</sup> Iodoform (tri-iodomethane) is an antiseptic compound with the chemical formula  $\text{CHI}_3$ . Benzoic acid is a preservative and disinfectant. Together, they give the varnish its antiseptic properties. Storax is a resin that is obtained from the sweetgum tree. It is a mixture of compounds, and is used in the perfume industry as a fixator of aromatic substances.<sup>18</sup> It also contains styrene and was the original source of the first polystyrene, used in our daily lives.<sup>19</sup> Balsam of Tolu is a resin that is obtained from South American balsam trees, and is also used in the perfume industry.<sup>20</sup> These materials are kept in solution using ether as a solvent.<sup>17</sup>

In Whitehead's original report, the prevention of capillary oozing, postoperative pain relief and allowing the patient to be fed orally were the main benefits attributed to the varnish.<sup>1</sup> Among published uses for the varnish are as a dressing for skin graft donor sites, as a pack for cystic cavities of the jaw, to reduce pain following wisdom tooth removal, in orbital floor reconstruction, in cleft palate surgery, and with the surgical management of osteomyelitis.<sup>21-27</sup> In all of these cases the varnish acts as a dressing material to keep soft tissue or bony cavities free from infection postoperatively and to prevent bleeding (Figure 3).

Table 1: Constituents of Whitehead's varnish.<sup>17</sup>

Material	Quantity
Iodoform	10g
Benzoic acid	10g
Storax	7.5g
Balsam of Tolu	5g
Ether	100ml

Table 2: Constituents of Carnoy's solution.<sup>28</sup>

Material	Quantity
Chloroform	3ml
Glacial acetic acid	1ml
Ferric Chloride	1g
Alcohol	6ml

#### Carnoy's solution

Carnoy's solution is a tissue fixative used primarily in histological sample preparation. It is made up of chloroform, acetic acid and ferric sulphate, in an alcohol solvent (Figure 4).<sup>28</sup> Carnoy's solution is used in the mouth as a tanning agent in order to facilitate the removal of cyst linings. Most notably its use has been advocated prior to the enucleation of keratocystic odontogenic tumours (KOTs).<sup>29</sup> It allows the thin, friable lining of these cystic neoplasms by fixation



FIGURE 4: Carnoy's solution.

Table 3: Constituents of bismuth iodoform paraffin paste. <sup>32</sup>		Table 4: Some zinc oxide-based dressing materials.		Table 5: Constituents of Alvogyl.	
Material	Quantity	Eugenol-containing	Non-eugenol-containing	Material	Quantity
Iodoform	440g	Kalzinol <sup>47</sup>	Coe-Pak <sup>48</sup>	Butamben	25.7g
Bismuth subnitrate	220g	Nobetec <sup>49</sup>	Voco-Pak <sup>50</sup>	Iodoform	15.8g
Paraffin base	220g		Perio Care <sup>51</sup>	Eugenol	13.7g
				<i>Excipients: olive oil, spearmint oil, sodium lauryl sulphate, calcium carbonate, penghawar djambi, purified water</i>	



FIGURE 5: BIPP on ribbon gauze.

and contraction to be more completely removed, reducing the rate of recurrence.<sup>30</sup>

A common site for KOTs to occur is the angle of the mandible. They may therefore be in close proximity to, or involving, the inferior alveolar nerve. *In-vivo* research in the rat and rabbit has shown Carnoy's solution to have detrimental activity on nerve function.<sup>6,28</sup> Ferich *et al.* in 1994 investigated the effect of Carnoy's solution on rabbit inferior alveolar nerves under general anaesthesia. This study found that no effect on nerve function was observed when Carnoy's solution was placed in contact with the nerves for up to two minutes. However, after three minutes of application, some reduction in nerve function was noted, and after a five-minute application almost no nerve function remained.<sup>28</sup>

Loescher and Robinson in 1998 also looked at the effect of Carnoy's solution using an *in-vivo* model.<sup>6</sup> They found that the rat saphenous nerve was completely inhibited after two minutes when Carnoy's solution was placed directly on the nerve. When Carnoy's solution was left *in situ* for two weeks, two out of the four nerves showed no electrical activity. In the other two, the nerve function was significantly reduced.<sup>6</sup>

Clinically, anaesthesia and paraesthesia of the inferior alveolar nerve have been reported following the removal of KOTs treated with Carnoy's solution and enucleation. Gossau *et al.* in 2010 reported on the recurrence rates and postoperative nerve damage following enucleation of KOTs.<sup>30</sup> They found that postoperative nerve damage occurred in six out of 23 patients treated. Nerve damage was present in patients treated with and without Carnoy's solution. While it is apparent that damage can be caused as a result of enucleation alone, it is difficult to know from clinical reports how much damage is due to the application of Carnoy's solution. High success rates in the treatment of KOTs have also been shown by marsupialisation, which has made the use of Carnoy's solution less common.<sup>31</sup>

### Bismuth iodoform paraffin paste

Bismuth iodoform paraffin paste (BIPP) was first described by Rutherford Morison in 1917.<sup>32</sup> He noted that the combination of bismuth and iodoform mixed with paraffin, when applied to open wounds, allowed excellent healing and reduced rates of infection. This discovery was made of necessity during the First World War, when gunshot wounds and large open wounds were becoming common on a large scale for the first time.<sup>32</sup> Bismuth is a trivalent metallic element with the atomic number 83. Iodoform (tri-iodomethane) is an antiseptic compound with the chemical formula CHI<sub>3</sub>. The formulation of BIPP as described by Morison is shown in Table 3.

After the war, BIPP continued to be used as a dressing material for fractures and open wounds with good success.<sup>33</sup> Currently, BIPP is used as a wound packing and dressing material (Figure 5). Its use as a wound bandage has been advocated in those at risk of dry socket.<sup>34</sup> It is commonly used to prevent infection after the reduction of nasal fractures.<sup>35</sup> Its use has also been described in the treatment of epistaxis and as a dressing after ear surgery.<sup>36-38</sup> Bismuth toxicity, leading to neurological impairment, has been reported. It is recommended that BIPP be applied sparingly to open wounds as a result.<sup>7,32,39,40</sup>

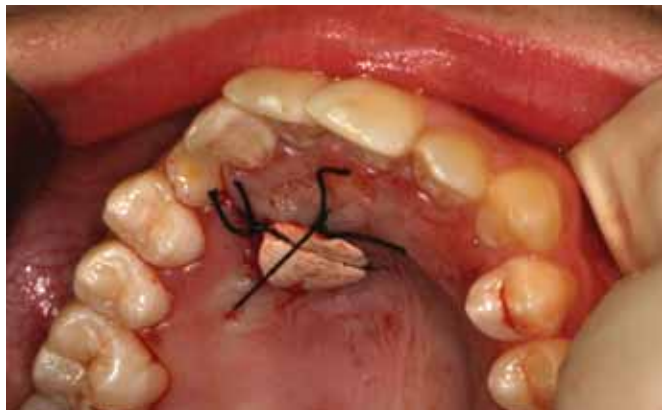


FIGURE 6: A non-eugenol (Coe-Pak) dressing covering an exposed canine, retained by silk sutures.

### Zinc oxide-based dressings

Zinc oxide can be combined with other materials to form a paste or cement, which is used to cover the gingival tissues or extraction sockets. These materials function to provide a physical barrier against the entry of food or other materials. They may be divided into eugenol-containing and non-eugenol-containing materials (Table 4).

Eugenol has been shown to have anaesthetic properties; its derivatives have been used for general anaesthesia.<sup>41</sup> These properties are often desirable in the presence of inflammation to reduce postoperative pain. However, it has also been associated with contact allergy at low doses and cytotoxicity at high doses.<sup>42</sup> Alemen Navas *et al.* in 2010 described a case where a zinc oxide and eugenol dressing was used to treat dry socket. It was not removed and was covered by soft tissue, becoming embedded in the alveolus and causing chronic pain.<sup>43</sup> These dressings must be removed.

Non-eugenol zinc oxide-based materials avoid the potential for eugenol-related cytotoxicity and allergy. However Saito *et al.* in 2008 showed that the non-eugenol materials also cause inflammatory reactions. They placed a number of periodontal dressing materials into rat incisor extraction sockets and histologically examined the effects of the materials over a 28-day period. They found an increase in inflammatory reaction at 28 days for all materials compared to controls.<sup>44</sup> Alpar *et al.* found that Coe-Pak reduced the growth of human primary gingival fibroblasts *in vitro*, but showed no reduction in the growth of human osteoblast-like cells.<sup>45</sup>

Jorkjend and Skoglund in 1990 compared the postoperative pain after periodontal surgery of materials containing eugenol and those without eugenol.<sup>4</sup> They found that the non-eugenol material resulted in greater reported pain in the first 12 hours postoperatively compared to the eugenol-containing materials. They suggested that this may be due to the local anaesthetic effects of eugenol on the soft tissue nerve fibres. While this study shows that the eugenol-containing materials can reduce postoperative pain, they are not a replacement for regular analgesics.

All of the zinc oxide materials act simply as a physical barrier to protect the wound and are not antibacterial.<sup>46</sup> Figure 6 shows a non-eugenol zinc oxide dressing material in place.



FIGURE 7: Alvogyl.

### Alvogyl

Alvogyl is a proprietary material that has butamben, iodoform and eugenol as its active ingredients.<sup>52</sup> It is primarily used for the treatment of alveolar osteitis. Butamben is an ester local anaesthetic with the chemical name butyl 4-aminobenzoate.<sup>53</sup> Iodoform is an iodine-based antimicrobial agent. Eugenol is an essential oil, which is derived from numerous plants, including cloves.<sup>54</sup> Numerous other materials are mixed with these active ingredients to form a paste-like consistency. Penghawar djambi is one of these materials, which is a product of fibres of the bracken fern *Cibotium barometz*.<sup>8</sup> The composition of Alvogyl, according to the manufacturer, is shown in Table 5.<sup>55</sup>

Alvogyl (Figure 7) is often used for the treatment of alveolar osteitis.<sup>52</sup> It is placed into an extraction socket with the aim of reducing pain and infection.<sup>56</sup> Syrjänen and Syrjänen in 1979 showed that Alvogyl delays healing in extraction sockets.<sup>8</sup> Their study was carried out on eight volunteers, each of whom required the removal of two molars. One extraction socket was packed with Alvogyl, while the other was left to heal normally. At one week and two weeks post extraction, a biopsy was taken from each site and the degree of healing compared. The authors found a significantly higher level of fibrous tissue, inflammatory reaction and giant cells in the sockets dressed with Alvogyl. Despite this they noted that all patients subjectively reported less pain in the sites that had been treated with Alvogyl. Interestingly, the effectiveness of Alvogyl in treating alveolar osteitis has only recently been demonstrated by Kaya *et al.*<sup>56,57</sup> They compared curettage alone to curettage with Alvogyl, an aloe vera extract and low-level laser therapy. A significant reduction in reported pain was shown for all treatments when compared to curettage alone.

### Conclusion

Dressing materials can be used in the mouth to aid healing, prevent infection and reduce postoperative discomfort. However, all materials have the potential to cause local and systemic adverse reactions. It is therefore important to be aware of the constituents and effects of these materials on the oral tissues.



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