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Beyond Hemostasis: Understanding the Risks of Bone Wax in Orthopedic Surgery - A Case Report

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Learning Point of the Article:

Bone wax may cause foreign body reactions, delayed migration, and extrusion of bone wax from the surgical site.

Abstract

Introduction: Osseous hemorrhage following a surgical incision or traumatic fracture can be a challenging issue to manage. During orthopedic surgeries, bone wax is frequently utilized as a surgical technique to enhance hemostasis and reduce bleeding from bone. The hemostatic effect of bone wax mostly stems from its physical characteristics. The advantages of using bone wax are that it is easy to handle, low cost, inert, malleable, and has good sealing capacity and bone adherence. A review of the literature also shows that the most notable side effects of using bone wax are allergic foreign body reactions, development of granulomas, infection, and disruption of bone healing.

Case Report: We present two cases of exostosis where the main surgical procedure for exostosis excision involved the use of bone wax to achieve hemostasis. A few months later, they presented with delayed migration and discharge of bone wax from the site of the surgery. To remove the bone wax off the primary application site, both of these individuals needed surgical intervention.

Conclusion: When needed, bone wax should only be applied for the duration required to bring about hemostasis. It acts as a foreign body; hence, using bone wax may result in foreign-body granulomas. Bone wax is a cost-effective, user-friendly, and promptly efficient hemostatic substance; nevertheless, its advantages should not be blindly used without prior assessment of the associated hazards. In conclusion, even though bone wax is frequently used in Orthopedic surgeries to help with hemostasis and control bleeding, medical personnel must be aware of any possible risks involved with using it. It is essential to closely follow individuals who have received bone wax treatment to address any issues or problems that may develop.

Keywords: Bone wax, hemostasis, foreign body, granuloma.

Introduction

The bones contain a variety of channels for the circulation of blood and bone marrow. Osseous hemorrhage following surgical incision or traumatic fracture can be a challenging issue to manage. To keep the bones from bleeding during orthopedic, neurological, and thoracic surgeries, medically sterile bone wax is an essential ingredient. The advantages of using bone wax are that it is easy to handle, low cost, inert, malleable, and has good sealing capacity and bone adherence [1]. Bone wax is a sterile blend consisting of white beeswax in major proportions (85-90%), isopropyl palmitate (10-15%), and other softening agents, which is derived from palm oil and is used as a thickening, antistatic, and emollient as well as a wax solvent [2] (Fig. 1).

To stop bleeding from damaged bone surfaces and cure wounds, bone wax functions as a mechanical barrier. In 1886, bone wax was first introduced [3]. It is commonly recognized that

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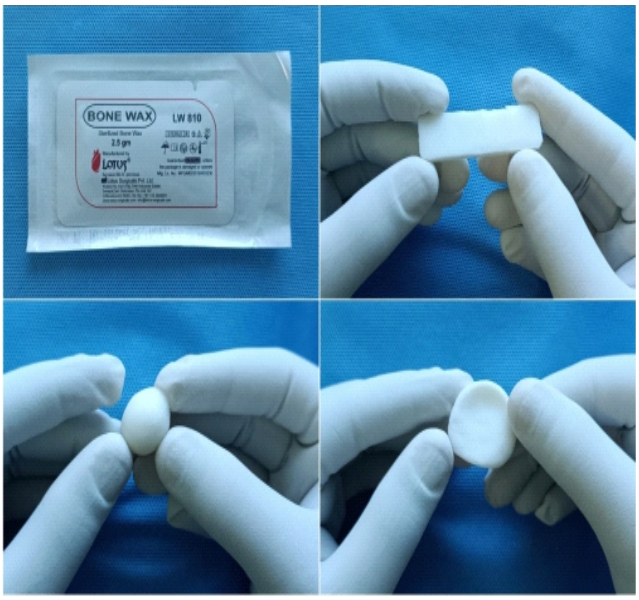

Figure 1: Bone wax- predominant hemostatic bone sealant due to widespread availability, user-friendly application, quick efficacy, and minimum negative consequences.

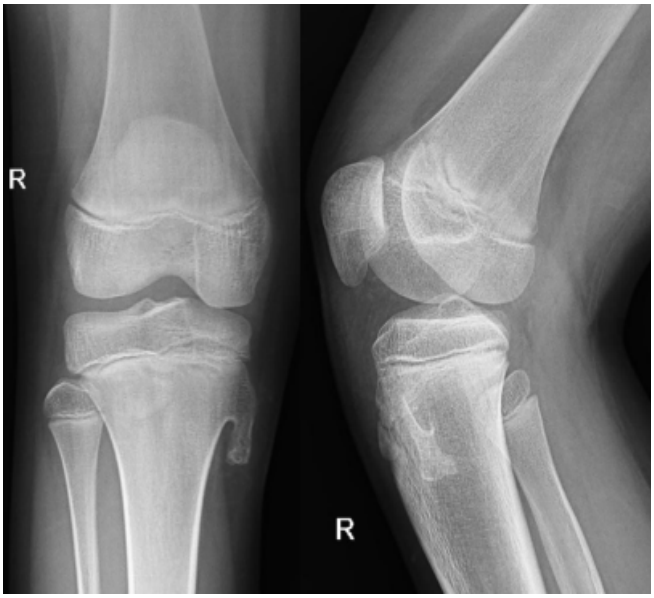

Figure 2: Presenting radiograph of the right knee of patient 1- anteroposterior and lateral views show an exostosis over the medial aspect of proximal tibia.

traditional bone wax formulations, which contain a significant amount of beeswax, may inhibit the healing of bones and trigger inflammatory responses [4]. The composition of bone wax formulations that are currently on the market has not altered much; they consist of isopropyl palmitate or paraffin-softened beeswax, which is insoluble in water. Bone wax does not get absorbed. The hemostatic effect of bone wax mostly stems from its physical characteristics and not its biochemical characteristics. By preventing blood flow from damaged blood vessels from entering the bone, it induces the formation of clots.

Figure 3: Post-operative radiograph of patient 1 after exostosis excision. The margins of the bone over the medial aspect of proximal tibia looks smooth, suggesting that the whole mass of exostosis was excised.

Though bone wax can be beneficial for hemostasis, it suppresses osteogenesis, is non-resorbable, and can result in a foreign body response [5]. A literature review has shown that osteoblasts are absent from areas where bone wax is present. Similarly, some research indicates that bone wax reduces the capacity for microbial elimination from the bone. At the site of the bone wax application, there was an inflammatory response as well as a reaction involving foreign body giant cells [6].

To sum it up, the most notable side effects of using bone wax are as follows:

1. Allergic foreign body reactions
2. Granuloma development
3. Infection risk
4. Cord compression (in spinal procedures)
5. Disruption of bone healing.

To highlight that bone wax can trigger a local inflammatory response and giant cell reaction, and interfere with the bone repair while still being bound to the bones as a foreign body, two cases involving delayed migration and the extrusion of bone wax from the site of surgery are discussed.

Figure 4: One year and 3 months following initial surgery. 4(a): Clinical image of the patient 1 year and 3 months following the initial surgery of exostosis excision. Bone wax extrusion is visible from the distal part of the surgical wound over the right proximal tibia. 4(b): The repeat radiograph of the Right knee (anteroposterior view) does not show any bony outgrowth at the previous pathological site, suggesting no recurrence of the exostosis.

Case Report

Case 1

After 2 years of swelling and pain in his right leg, a 15-year-old teenage boy visited the Orthopedic Outpatient Department (OPD). Free knee range of motion (ROM) was present (0-140°) and no local temperature increase was observed. No fever or other symptoms were seen. Right proximal tibia exostosis was identified (Fig. 2) and excision was performed. Blood oozing from the bone was sealed intra-operatively using bone wax. Recovery was smooth and the incision healed properly (Fig. 3). The patient returned to the OPD 1 year and 3 months after surgery with discharge from the distal part of the surgical scar (Fig. 4).

On wound examination, 0.5 × 0.5 cm gaping over the incision scar and thick, white discharge were seen. No redness or warmth was noted- normal erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels. After being diagnosed with persistent inflammatory reaction to bone wax with discharging sinus, the patient underwent right proximal leg wound exploration and debridement. Bone wax granuloma was detected in proximal tibia fissures where bone wax was administered previously. They were all removed and the wound debrided. Culture-sensitivity and biopsy were performed on surrounding soft tissues. A thorough cleansing of the wound was done. Serial wound examination showed healthy wounds. The tissue biopsy revealed acute to chronic inflammatory granulation tissue with numerous foreign body giant cells and no cancer. This patient's knee ROM was 0-140° and no further complications were seen after 2 years.

Case 2

A 25-year-old lady complained of discomfort and swelling in the outer aspect of the left thigh and knee for 4 years. The discomfort started slowly and increased at night, feeling intense. Walking and regular activities worsened pain; rest helped. The patient's younger sister had right elbow surgery for similar issues. Multiple osteochondroma with distal femur Erlenmeyer flask deformity was seen on the left knee radiograph. The patient had multiple hereditary exostosis (Fig. 5).

Lateral femoral and medial tibial condyles had 2 × 1 cm and 6 × 2 cm bony hard swellings, respectively. Overlying swellings were painful. The knee had no significant deformity or warmth. The patient then had left distal femur and proximal tibia exostosis excision and biopsy. During surgery, bone wax was used to stop the bone from bleeding. Post-operative recovery was uneventful. No malignant transformation of osteochondromas was found in histopathology (Fig. 6).

After 3 months, the patient returned to the OPD, complaining of discharge from the surgical wound on the left thigh for 1 week. A serous, non-foul-smelling discharge with slight swelling and no local warmth was present. ESR and CRP were normal. The patient underwent left distal thigh wound exploration and debridement for the surgery site infection. A greyish-white material, likely bone wax, was isolated intraoperatively (Fig. 7).

A thorough wound wash was given and tissue samples were sent for culture, sensitivity, and biopsy. Histopathological examination revealed giant cells with focal areas of necrotic debris. No malignancy was found in the sections studied. The patient got appropriate intravenous antibiotics after the culture and sensitivity tests confirmed Staphylococcus aureus growth. Adequate wound healing was present. One year of follow-up revealed no similar or further issues. Left knee ROM was 0-120°.

Discussion

As there is no hard and fast rule or quantification as to how much bone wax is to be used, the usual method for applying bone wax is to mold it over the area of bleeding bone. By obstructing the perforated blood vessels in the bone, it is able to prevent more blood loss. Although bone wax serves its function well, there may be adverse consequences, such as migration of the bone wax, allergic responses, infections, inflammation, and interference with the healing of bones.

Bone wax is cheap, simple to apply, and instantly effective in

Figure 5: Presenting radiograph of patient 2, diagnosed with hereditary multiple exostosis. The lateral femoral condyle and the medial tibial condyle (in the anteroposterior view) show the growth of osteochondroma. In the distal femur, numerous other exostoses are visible on the anterior and posterior aspects as well (in lateral view). In the anteroposterior view, the Erlenmeyer flask deformity is well appreciated.

Figure 6: Immediate post-operative radiograph (anteroposterior and lateral views) following distal femur and proximal tibia exostosis removal. The margins of the bone over the lateral aspect of distal femur and the medial aspect of proximal tibia look smooth, suggesting that the whole mass of exostoses were excised.

stopping bleeding, but it should only be used sparingly after assessing its benefits and potential risks. The likelihood of getting foreign-body granulomas is always increased while using bone wax since it is a foreign body. In case it is left in situ, caution must be taken to prevent the collection of bone wax in the craters of the bone created by the surgery. Applying bone wax with fingers to create a smooth coating might cause it to develop lumps in the craters in the bone, so one should be extra cautious about it [7].

In one of the research, bone wax significantly inhibited rabbit cancellous bone's ability to remove the usual S. aureus inoculum after needle inoculation into the iliac crest [8]. The tissue sample sensitivity and culture report indicated S. aureus growth in our second case. This shows that bone wax decreases microbial bone clearance.

Figure 7: Intraoperative images showing bone wax pieces and soft tissues debrided during surgery.

Both the cases mentioned above show that there is extrusion of the bone wax from the surgical wound site which is not very acute. Both patients presented late with similar complaints after complete healing of the surgical wound after primary surgery of exostosis excision. This extrusion of the bone wax may be due to allergic foreign body reactions and delayed migration to the bone wax from the surgical site.

Research shows that bone wax acts like a foreign body and stays in bony regions for a long time after implantation [9]. This facilitates the bone wax to serve as a breeding ground or nidus for infection [10]. Hence, this is evidence of the fact that a standard bone wax is not biodegradable, i.e., it stays in the body until it is surgically removed. Furthermore, the presence of a foreign body might impair bone growth and repair.

Optimal hemostatic material for bone tissue should possess the following characteristics: immediate hemostatic efficacy, resorbability, non-interference with bone healing, and induction of a transient foreign body response. Alternatives to conventional bone wax have been developed because of potential adverse effects. These consist of substances like absorbable waxes that the body can potentially break down. The literature has documented many alternative materials, including polyethylene glycol/collagen [5], fibrin-collagen [11], polyorthoester [12], chitin-based substances [13], and

gelfoam [14]. Nevertheless, none of these substitute materials have achieved general acceptance, indicating that a substance that has the excellent hemostatic properties of Bone wax, together with favorable osseous integration and cost, has not yet been produced. Furthermore, a few newer hemostatic agents have been employed that, in addition to stopping bleeding, may also encourage bone regeneration, for example, BoneSeal [15], an innovative combination of hydroxyapatite and biodegradable polylactic acid, a material that exhibits wax-like characteristics for easy handling.

Due to the fact that just two cases have been identified where there were complications with the utilization of bone wax, we would like to bring forward the limitations of the study. These issues could also be the result of various factors that are associated with the patient. It is possible that the precise etiology of the issue may be much better known if there were a greater number of cases that had complications after the application of bone wax.

Conclusion

When needed, bone wax should only be applied for the duration required to bring about hemostasis. Although it has several drawbacks, bone wax is an important surgical material. Surgeons must weigh the advantages of using it against any possible hazards. Careful observation is required after surgery to manage any possible complications. It acts as a foreign body; hence, using bone wax may result in foreign-body granulomas. Bone wax is a cost-effective, user-friendly, and promptly efficient hemostatic substance; nevertheless, its advantages should not be blindly used without prior assessment of the associated hazards. In conclusion, even though bone wax is very frequently used in Orthopedic surgeries to help with hemostasis and control bony bleeding, medical personnel must be aware of any possible risks involved with it. It is essential to closely follow individuals who have received bone wax treatment to address any issues or problems. To guarantee the best possible outcomes for their patients, surgical teams must remain up to date on the newest advancements and available options in hemostatic agents.

Clinical Message

The judicious use of bone wax should be employed during surgery while treating patients because bone wax has been shown to have numerous complications. Surgeons must weigh the risks and benefits before providing this mode of management to control intraoperative bone hemorrhage.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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