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REVIEW ARTICLE

Bismuth iodoform paraffin paste: a review

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Abstract

Introduction: This article reviews the literature pertaining to bismuth iodoform paraffin paste.

Overview: Bismuth iodoform paraffin paste is used in most otolaryngology departments on a daily basis. Questions about its properties are common in postgraduate otolaryngology examinations. This article reviews bismuth iodoform paraffin paste's current and historical usage, constituents, properties, side effects, and radiographic properties, and its alternatives in otological and rhinological practice.

Key words: Bismuth; Iodoform; Paraffin; Epistaxis; Anti-infective Agents, Local; Post-operative Care

Introduction

Bismuth iodoform paraffin paste (BIPP) is used in many otolaryngology departments on a daily basis. A literature search using the PubMed database identified no general review article on BIPP.[1]

This paper offers a review of the history, properties and side effects of BIPP. Alternatives to its usage in clinical practice are also suggested.

History

Bismuth iodoform paraffin paste was invented by James Rutherford Morrison, Professor of Surgery at the University of Durham. It was used widely in the First World War to dress soldiers' suppurating battlefield wounds.[2] Wounds were thoroughly debrided, any foreign material was removed, and they were then smeared with BIPP. This was left in situ for days or weeks, without disturbance. Prior to this, wounds were regularly inspected and redressed after the application of various 'antiseptic' solutions. The perceived improved antiseptic effect of the BIPP regime may have been due in part to the reduced opportunities for wound colonisation by pathogenic bacteria.[3]

Some British army surgeons deviated from Rutherford Morrison's initial regime. They applied large amounts of BIPP to wounds, rather than a smear. Cases of both bismuth and iodoform toxicity followed, with some fatalities.[4,5]

In smaller quantities, BIPP had relatively few adverse effects. It thus remained in use by otolaryngologists and maxillofacial and neurosurgical practitioners. Otolaryngologists began to find it particularly useful to aid healing and resolution of sepsis after mastoid surgery.[6]

Constituents, properties and side effects

Bismuth iodoform paraffin paste gauze is sterile ribbon gauze impregnated with a paste consisting of one part bismuth subnitrate, two parts iodoform and one part sterilised liquid paraffin by weight.

Bismuth subnitrate

Bismuth compounds have been used to treat a variety of ailments for hundreds of years. They have been used topically as astringents and antiseptics, orally to treat gastrointestinal complaints, and parenterally to treat syphilis.[7] Bismuth subnitrate is included in BIPP for its astringent properties. It is soluble in weak acid but highly insoluble in water and alcohol. It may contribute to the antiseptic properties of BIPP by releasing dilute nitric acid on hydrolysis.[8]

Bismuth toxicity. Bismuth and its compounds are less toxic than antimony and polonium (its metalloid periodic table neighbours), and other heavy metals such as lead. Bismuth has a half-life for whole-body retention of 5 days, but it can remain in the kidney for years.[9]

Neurotoxicity due to the absorption of bismuth from BIPP is rare, but may be fatal if it is not recognised. Bismuth is thought to interfere with oxidative metabolism in the brain by binding the thiol groups of essential enzymes and by reducing cerebral blood flow.[10] Symptoms of toxicity include headache, nausea and stomatitis. Blue-black deposits in the gingiva may be seen, the so-called 'bismuth line'.[11]

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In the 1970s, there was an outbreak of bismuth poisoning in France which affected hundreds of people. Bismuth was used widely at the time to treat a variety of gastro-intestinal complaints. The outbreak was postulated to be due to an increase in the prevalence of an otherwise benign group of gastro-intestinal microbes that promoted the methylation of bismuth, producing a more easily absorbed form.[12]

Toxic blood levels of bismuth have been reported after nasal packing with BIPP-impregnated gauze for epistaxis.[13] Bismuth is absorbed through mucous membranes, but is absorbed more readily by physically injured tissues. This is worth bearing in mind if a patient has required repeated nasal packs for epistaxis, and thus has potentially traumatised nasal mucosa.

Bismuth subnitrate can also cause nitrite poisoning. This is indicated by vasomotor paralysis, tachycardia and asphyxia due to the formation of methaemoglobin.[14] Bismuth subnitrate is reduced to nitrite by resident bacteria in the bowel. Absorption of the nitrite causes the iron in haem to exist in the ferric (Fe^{3+}) rather than ferrous (Fe^{2+}) state, producing methaemoglobin, which cannot carry oxygen. Pulse oximetry in this situation may be misleading, showing an erroneous 85 per cent saturation reading.[15]

Fatalities have occurred due to nitrite poisoning after the use of preparations containing bismuth subnitrate to treat diarrhoea.[16] A 60 cm length of BIPP gauze, generally sufficient for an average nasal pack, contains approximately 5.6 g of bismuth subnitrate. Although some of the paste will undoubtedly be ingested following nasal packing, this quantity is unlikely to cause nitrite poisoning. There is only one report in the literature of raised methaemoglobin levels after using BIPP packing for epistaxis, and this was following resection of a nasal angiofibroma.[17]

Iodoform

Iodoform is the constituent that gives BIPP its distinctive colour and smell. It is virtually insoluble in water, slightly soluble in alcohol, and freely soluble in chloroform and ether. Its chemical name is tri-iodomethane (CHI_3).

Iodoform decomposes to liberate elemental iodine, which acts as an antiseptic. This process is hastened by high temperatures and by the presence of weak acid.

Early work speculated that nitric acid, liberated from bismuth subnitrate, potentiated the release of iodine from iodoform in BIPP, increasing its antiseptic efficacy.[8]

More recently, Nigam and Allwood found no appreciable iodine release *in vitro* on agar plates.[18] However, iodine has been found in the urine of soldiers treated with larger amounts of BIPP, and O'Connor and colleagues' case report, mentioned above, identified raised plasma iodine levels after BIPP use in a maxillectomy cavity.[5,19] These reports seem to offer quite compelling evidence that iodine is released *in vivo*.

In vitro studies provide poor evidence of an antimicrobial effect, as first noted by Fleming.[3] Nigam and Allwood identified slight inhibition of growth of *Staphylococcus aureus* exposed to BIPP paste.[18] *Pseudomonas aeruginosa* and *Escherichia coli* showed little or no inhibition of growth due to BIPP or its components. These authors speculated that, in a clinical context, the perceived antiseptic efficiency of BIPP may be due to the accompanying meticulous debridement of the wound.

Iodoform toxicity. Iodoform toxicity was relatively common when BIPP was applied to larger wounds.[5] However, it has also been reported in modern practice. O'Connor *et al.* reported a case of severe iodoform toxicity in a patient receiving BIPP gauze packing following total maxillectomy.[19] The presence of a raised plasma iodine concentration was confirmed by spectrophotometry. The packing was removed, and the patient made a full recovery. These authors concluded that BIPP should be used with caution when packing cavities as large as those resulting from maxillectomy.

Bismuth iodoform paraffin paste allergy

If BIPP gauze is used to pack the ear canal after otological surgery, there is a well documented risk of atopic reaction. Two retrospective series have found an overall risk of BIPP allergy of 0.4 and 6 per cent, variously.[20,21]

A prospective patch testing study suggested that the true incidence of BIPP allergy is 12 per cent with previous exposure and 1 per cent without. The component part found to be responsible was iodoform, not iodine. Patch testing of patients previously exposed to BIPP was recommended, prior to any further surgery. Testing of patients not previously exposed to BIPP was not recommended, as the incidence of allergy was low and there was a risk of sensitisation.[22]

When the allergic reaction to BIPP has settled, there may be longer term consequences, such as increased risk of residual perforation after myringoplasty.[21]

There is one reported case of delayed post-operative facial nerve palsy in association with BIPP allergy.[23] This was thought to be a consequence of local inflammation. Bismuth iodoform paraffin paste is not known to be neurotoxic. Application of BIPP directly to the saphenous nerve of rats was not shown to affect nerve function. This study used Whitehead's varnish and Surgicel® (Ethicon, Somerville, New Jersey, USA) (oxidised regenerated cellulose) as comparators; these agents did cause reversible impairment of nerve function.[24]

Bismuth iodoform paraffin paste aspiration

Aspiration of BIPP has been reported. The patient made a good clinical recovery, and repeated chest X-rays showed relatively brisk dispersion of the paste.[25]

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Alternatives to bismuth iodoform paraffin paste

In otological practice

In meatoplasty, alternative suturing techniques have been described that do not require BIPP packing to hold the meatal skin in position, with good long term outcomes.[26]

Xeroform® (Covidien, Mansfield, Massachusetts, USA) is petrolatum gauze with 3 per cent bismuth tribromophenate. It has been used as an iodide-free alternative to BIPP. However, there is a higher incidence of infective complications if it is not used in combination with ciprofloxacin and metronidazole antibiotic prophylaxis.[27]

In rhinological practice

Alternatives to BIPP for anterior nasal packing are now widely available.

Merocel® packs (Medtronic Xomed, Jacksonville, Florida, USA) are one example. They consist of compressed polyvinyl alcohol foam polymer sponges that expand on hydration.

Rapid Rhino® packs (Applied Therapeutics, Tampa, Florida, USA) consist of carboxymethylcellulose, a hydrocolloid material, wrapped around an inflatable polyvinyl chloride balloon. Both types of pack are easy to insert, and allow efficient nasal packing by non-specialist staff.

Two studies have compared anterior nasal packing with BIPP gauze and Merocel® packs. They found little difference in efficacy, although the sample sizes were small.[28,29]

The level of discomfort on removal varies between different types of nasal pack. Netcell 5000® packs (Network Medical Products, Ripon, UK) have a gel coating and cause less discomfort on removal than Rapid Rhino® packs.[30] In turn, Rapid Rhino® packs cause less discomfort on removal than standard Merocel® packs.[31,32]

Routine packing may not be justified after nasal septal surgery, as the incidence of epistaxis may be as low as 3 per cent.[33] If nasal packs are to be used, Rapid Rhino® packs have been found, in a small study, to be more easily removed than Merocel® packs, and to cause less reactionary bleeding.[34]

After larger intra- or paranasal resections, packing with gauze impregnated with Whitehead's varnish (iodoform 10 g, benzoin 10 g, storax 7.5 g and balsam of Tolu 5 g, mixed to 100 mls in ether) may be a safer alternative to BIPP packing, due to a lower risk of iodoform toxicity.[35]

Kaltostat® (ConvaTec, Skillman, New Jersey, USA) is a sodium and calcium alginate fibre dressing that has been used as an equally efficacious alternative to traditional gauze packing for epistaxis. It has been shown to cause less bleeding on removal after turbinate surgery than petroleum jelly trouser or gloved finger packs.[36]

Soluble nasal packing materials have been used to treat epistaxis for over 30 years.[37] An increasing variety of such products exist. The most effective is FloSeal® (Baxter, Deerfield, Illinois, USA). It consists of collagen-derived particles and topical bovine-derived thrombin. Unfortunately, when used after sinus surgery it may result in increased adhesion formation.[38] FloSeal® is used in some units to treat acute epistaxis, with better results than traditional packing.[39,40]

NasoPore® (Stryker Canada, Hamilton, Ontario, Canada) is a biodegradable synthetic polyurethane foam that can be used after sinus surgery, with no increased risk of adhesion formation.[41,42]

Surgicel® biodegradable packing can be locally applied, under endoscopic guidance, to treat posterior epistaxis. In a small study of eight patients, in the first three months following treatment, bleeding re-occurred in one individual.[43]

Tips for more efficient packing with bismuth iodoform paraffin paste gauze

Nasal cavity

Traditionally, Tilley's nasal dressing forceps are used to insert a loop of BIPP gauze along the floor of the nose, with further layers added superiorly. After inserting a few loops, the internal nasal valve makes packing of the superior nasal cavity difficult. It has been suggested that the superior nasal cavity should be packed first, and the BIPP gauze compressed superiorly with the dorsum of the Tilley's forceps as packing proceeds. This may minimise the risk of damage to the cribriform plate and result in more effective packing, especially in bleeding originating from the ethmoidal artery.[44]

Proficiency in nasal packing can be improved by practice on a mannequin, or by using a 'closed fist' model.[45–47]

External auditory canal

Post-operative packing of the ear canal with BIPP gauze may be aided by the adjunctive use of an intravenous cannula casing.[48] The casing is trimmed by 5 mm at its distal end, and lubricated with Betadine® (Purdue Pharma, Stamford, Connecticut, USA) or water. The BIPP gauze is then introduced through the casing with crocodile forceps. The main advantage of this technique is improved visibility of the meatal skin flaps during placement of the gauze.

Bismuth iodoform paraffin paste and radiological imaging

Radiopaque marker strip

While BIPP itself is radiopaque, predominantly due to its bismuth content, BIPP gauze also contains a radiopaque marker strip. This consists of blue, multifilament polypropylene yarn filled with barium

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sulphate and wrapped in a white polyester yarn that is dyed blue. The strip aids the radiographic detection of the gauze, should the BIPP paste become displaced (C Akinola, personal communication).

Computed tomography

The high attenuation of BIPP (>3000 Hounsfield units) results in severe image degradation and streak artefacts on computed tomography scanning. This is due mainly to BIPP's bismuth content. Betadine® gauze also has a high attenuation (258 Hounsfield units), but causes few streak artefacts. Calcium sodium alginate dressings have a similar attenuation to muscle.[49]

Magnetic resonance imaging

On magnetic resonance imaging, BIPP and calcium sodium alginate have imaging characteristics similar to muscle, whilst aqueous Betadine® gauze resembles bone marrow.[49]

Angiography

The radiopacity of BIPP is such that removal of nasal packing will usually be required prior to radiographically guided embolisation for persistent epistaxis.[50]

Usage of BIPP in pregnancy and hyperthyroid patients

Iodine release from iodoform poses a theoretical risk when BIPP is used during pregnancy and in patients with metabolic thyroid disease.

If a patient has pre-existing hyperthyroidism, any iodine-containing compound may in theory exacerbate the condition, or even cause a thyrotoxic crisis.[51] In practice, however, there have been no reports of this in relation to BIPP usage.

Iodine exists in equilibrium with its ionised form, iodide, which readily crosses the placenta.[52] Fetal hypothyroidism has been reported to occur as a result of repeated exposure to topical iodine.[53] However, short term exposure to iodine appears safe; iodine preparation given prior to maternal thyroid surgery rarely cause fetal problems.[54]

Maternal exposure to excessive iodine may induce fetal hyperthyroidism or hypothyroidism.[55] In a number of reported cases, 'congenital iodide goitre' has resulted in tracheal compression and death.[56,57]

However, there are no reported instances of fetal harm from BIPP usage.

Conclusion

This paper presents an overview of the constituents and side effects of BIPP-impregnated ribbon gauze, and alternatives to its use. Toxicity from BIPP usage is possible, even from the relatively modest quantities used in modern surgical practice. Allergy is not uncommon, and BIPP can also cause marked degradation of radiological imaging. Little information exists on its use in pregnancy and in thyroid disorders, where it poses a theoretical risk.

An increasing number of alternatives are becoming available for use in otological and rhinological practice.

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