Australasian Journal of Dermatology

Australasian Journal of Dermatology (2017) 58, 80–85 doi: 10.1111/ajd.12427

REVIEW ARTICLE

Topical pine tar: History, properties and use as a treatment for common skin conditions

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ABSTRACT

Pine tar is the end product of pine wood carbonisation following distillation using extreme heat. An extensive literature search was conducted back to the 1950s for this review. Pine tar has been used in medicine for more than 2000 years to treat a range of skin conditions because of its soothing and antiseptic properties. Pine tar should not be confused with coal tar, which has been produced from coal for approximately a hundred years. Pine tar is thought to exert its effect by reducing DNA synthesis and mitotic activity, which promotes a return to normal keratinisation. In addition, pine tar has been shown to be antipruritic, anti-inflammatory, antibacterial and antifungal. These properties make pine tar suitable for the topical treatment of eczema, psoriasis, seborrhoeic dermatitis and other dry, itchy, flaky or inflamed skin conditions. Topical products available over-the-counter in Australia today contain up to 2.3% pine tar, and come in several different formulations that can be used on the entire body, including the face. Modern day pine tar is manufactured with increased purity to eliminate toxic phenol and carcinogenic components, which have been of concern in the past. Primary irritation is uncommon. In conclusion, the long experience with topical pine tar therapy and its worldwide usage, together with the evidence presented in this review, suggests that pine tar is an effective treatment with minimal safety risk.

Key words: coal tar, eczema, pine tar, psoriasis, seborrhoeic dermatitis.

HISTORY

Tar from pine wood has probably been produced in Scandinavia since the Iron Age.[1] It became one of Sweden's most important exports for hundreds of years as a preservative for wood exposed to harsh conditions, including ship decking and rigging.[2] Maritime use spread from Sweden throughout Europe, and eventually to the British Colonies in America, which had extensive pine forests.[2] It is still used today to treat wooden furniture exposed to the elements, as a flavouring for candies, food and alcohol, and on the handles of baseball bats to improve grip.[2]

Pine tar was also known in ancient Greece.[2] In fact, the use of pine tar in medicine was first described by Hippocrates more than 2000 years ago.[3,4] Pine tar made in villages in Turkey according to traditional methods is still used today for medicinal purposes.[5] Commercial topical pine tar products have been manufactured around the world for well over a hundred years, and have been used for a range of skin ailments including eczema and psoriasis. It may also be present in deodorants, shampoos, toothpowder and disinfectants.[6]

Topical pine tar has been available over-the-counter in Australia since 1953. Today, it is available in various formulations including a gel, lotion, oil, soap-free bar and solution containing up to 2.3% w/w pine tar (Table 1). Furthermore, pine tar is widely used in veterinary medicine. It is a traditional antiseptic and hoof care product for horses and cattle and is also used to prevent chickens pecking the low hen.[2,5]

PRODUCTION AND CHEMICAL PROPERTIES

Four sources of tar have been used for therapeutic treatments; wood (wood tar), bitumen (shale tar), petroleum (petroleum tar) and coal (coal tar).[3] There are two kinds of wood tars; made either from trees with a high content of resin (pine and juniper), or from hardwood trees (birch and beech).[3] Pine tar (also known as tar, alquitrán vegetal, pix liquida, stockholm tar (in commerce), wood

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Conflict of interest: Tanya Barnes and Kerryn Greive are employed by Ego Pharmaceuticals, who manufactures pine tar products.

Submitted 3 September 2015; accepted 25 October 2015.

Abbreviations:

CHO	Chinese hampster ovary
PAH	polycyclic aromatic hydrocarbon

Table 1 Products containing pine tar (without coal tar) available in Australia today, their indications and directions for use[18]

Pine tar product	Indications	Directions for use
0.1% w/w pine tar lotion (Key Pharmaceuticals Macquarie Park, NSW, Australia)	Pruritus (anal and genital), pruritus and inflammation associated with dermatitis, eczema, heat rash, hives, nappy rash, chickenpox, insect bites, and sunburn	May be used as often as required, especially after bathing showering, shaving (underarms and legs) and at night
1% w/w pine tar bar (Ego Pharmaceuticals Braeside, Victoria, Australia)	Pruritus (anal and genital), generalised pruritus and inflammation associated with psoriasis, dermatitis, eczema, urticaria, sunburn, insect bites, heat rash, nappy rash and chickenpox	Wet skin, lather bar and apply to affected area. Rinse thoroughly, pat skin dry. Do not rub
1.6% w/w pine tar gel (Ego Pharmaceuticals)	Pruritus (anal and genital), generalised pruritus and inflammation associated with psoriasis, dermatitis, eczema, urticaria, sunburn, insect bites, industrial contact dermatitis, shaving rash and intertriginous inflammation (particularly of the groin area)	Apply to wet skin and smooth gently over the affected area. Leave on for 2 to 3 min, rinse lightly, then pat dry. Do not rub. May be used on sensitive areas of the skin such as the face, mucous membranes, anal or vulval area and hands. Use as often as required at the hand basin or in the bath or shower whenever inflamed hands or other areas are washed, particularly at night for very itchy areas. For severe conditions, further therapeutic effect is obtained by soaking in a bath containing pine tar solution or oil
2.3% w/w pine tar oil (Ego Pharmaceuticals)	Eczema, dermatitis (allergic and contact), psoriasis, sunburn, and other dry, itchy and inflamed skin conditions	Bath: add 15–30 mL to a tepid bath (5 mL to a baby bath or hand basin) and bathe for 10 min once daily; shower: apply undiluted to wet skin for a few min, then rinse; sponge bath: add 10 mL to 3L warm water. Pat skin dry
2.3% w/w pine tar solution (Ego Pharmaceuticals)	Pruritus (anal and genital) and generalised pruritus and inflammation associated with psoriasis, dermatitis, eczema, urticaria, sunburn, insect bites, heat rash, nappy rash and chickenpox	Bath (maximum therapeutic effect): add 15–30 mL to a tepid bath (5 mL to a baby bath or hand basin) and bathe for 5–10 min once daily or more often in severe cases; shower: spray approximately 5 mL onto wet skin, leave for a few min, rinse briefly with tepid water; patients in bed: for elderly and surgical patients or those with measles or chicken pox add 10 mL in 2L of warm water and sponge freely; face or other small areas: 10 mL in 2 L cool or iced water. Saturate cotton wool and hold onto affected area for a few min. Repeat for 10 min and pat skin dry; foot, leg or arm bath: the affected area may be soaked separately if preferred. Add 10 mL to 2L tepid water and bathe for 10 min, pat skin dry

tar, brea de pino, brea vegetal, goudron végétal, nadelholzteer, pix abietinarum, pix pini and pyroleum pini),[2,7] is obtained by high temperature carbonisation of pine wood from various trees of the family *Pinaceae* in anoxic conditions (dry distillation or destructive distillation).[2] This process causes tar and pitch to drip away from the pine wood leaving behind charcoal.[2] Pine tar is a dark brown or nearly black viscous semi-liquid, which is denser than water and has a characteristic empyreumatic odour and a sharp taste.[2,7] Pine tar is slightly soluble in water and soluble in alcohol, chloroform, ether, acetone, glacial acetic acid, in fixed and volatile oils and in solutions of caustic alkali.[2,7] The aqueous liquid produced by shaking pine tar with water is acidic, distinguishing it from coal tar, which is alkaline.[7]

The components of pine tar vary according to the pyrolytic process (e.g. method, duration, temperature) and origin of the wood (e.g. the age of the pine trees, type of soil, moisture conditions during tree growth).[2] It is extremely complex, containing several thousand chemical components, primarily aromatic hydrocarbons, tar acids and tar bases.[8] The principal constituents of pine tar include turpentine, resin, guaiacol, creosol, methylcreosol, phenol, phlorol, toluene, xylene and other hydrocarbons.[2]

The pine tar used in topical products available in Australia today is produced by the traditional method of burning pine tree stumps in kilns. Kiln burned pine tar is dark golden in colour and is characterised by a high resin content (rosin acids and retene), low content of pitch and high purity, and it is free from soot and other impurities.[9]

MECHANISMS OF ACTION

Although pine tar has been used for the treatment of various skin diseases for thousands of years, its mechanism of action is poorly understood and has been extrapolated from studies performed using coal tar. Pine tar is not pharmacologically standardised because of its inherent chemical complexity, and the specific therapeutic activity of the components is not known.[10]

Antiproliferative effect

The antiproliferative effect of tars has been studied using coal tar. However, it is postulated that all tars, including pine tar, work in a similar manner. Studies by Lavker and colleagues in volunteers with healthy skin demonstrated a transient increase in epidermal proliferation during the first 2 weeks of tar treatment, followed by a progressive thinning of the epidermis.[11] Tars appear to act as keratolytic agents which inhibit excessive proliferation of epidermal cells by the suppression of DNA synthesis in hyperplastic skin, which subsequently reduces mitotic activity and protein synthesis in the basal layer of the epidermis.[10,12] This promotes a return to normal keratinisation, which is important in skin diseases such as psoriasis.[13]

Other effects

In addition to its keratolytic action, pine tar has been shown to be antipruritic,[7,8,12] anti-inflammatory,[8] antiseptic,[7,12] astringent,[12] keratoplastic,[8] cytostatic,[6] antibacterial[14] and antifungal.[15] Fractionation of pine tar has revealed that the components responsible for its bacteriostatic properties are the resin acids,[14] and that acetovanillone, 1,1′,3,3′-tetraoxo-2,2′-bicyclopentyl and its 4-methyl derivative, as well as another unknown compound, are responsible for the antifungal properties of pine tar.[15] This is in contrast to coal tar where it is generally considered that phenols are responsible for its biological activity.[14]

In terms of pharmacokinetics, it has been observed by infrared spectroscopy that pine tar is detectable in the skin 1 h following the topical application of 12% pine tar to the skin, but was undetectable in the skin after 8 h.[16] The mechanisms by which pine tar is absorbed, metabolised and excreted are unknown.

CLINICAL USE

Indications

Pine tar has been used in topical preparations to relieve itching and inflammation associated with a range of skin conditions such as eczema or dermatitis,[6,7,12,17] psoriasis,[6,7,12,17] chronic lichen simplex,[8] seborrhoeic dermatitis and scalp psoriasis,[7,12,17] sunburn, [18] nappy rash,[18] prickly heat,[18] hives,[18] chicken pox,[18] insect bites,[18] anal and genital itching including jock itch,[18] and other dry, itchy, flaky or inflamed skin conditions.[18]

Contraindications

Sensitivity to pine tar.[18] Pre-existing folliculitis or severe acne are also possible contraindications.[19]

Caution

Avoid contact with eyes. If lather enters eyes, flush with clean water.[18]

How to use

The use of pine tar products available in Australia today is described in Table 1. Pine tar products may be used on the entire body, including the face, as an adjunct cleanser for red, itchy and inflamed conditions together with other prescribed medications such as corticosteroids and fungal creams. Pine tar products are interchangeable, with the oil being particularly useful for widespread dry, red, itchy and inflamed conditions as it is moisturising and suitable for bath use. Similarly, the solution, which is also suitable for bath use, is useful for widespread conditions that are not specifically dry. The bar and gel can both be used in the shower or at the hand basin, with the gel being more elegant to use and the bar suitable for patients who like to be able to hold the product.

As well as pine tar lotion, which contains a very low concentration of 0.1% pine tar, the pine tar formulations described in Table 1 are designed as wash-off products that are quick and easy to use, are less messy than other tar products which need to be left on for many hours, do not stain and any odour is minimised.[4] These attributes may increase patients' compliance.

PHARMATOXICOLOGY

Toxicity

The acute toxic potential of topical tar products, particularly wood tars, which include pine tar, has been linked to their phenol content.[17] However, since the phenol content has been reduced in the topical pine tar products manufactured today, phenol poisoning is unlikely.[17] In addition, unlike coal tar, which has been shown to be phototoxic, wood tars including pine tar have not been reported to cause photosensitisation.[10]

Carcinogenicity

A more serious problem than toxicity is the potential carcinogenicity of tars, including pine tar, which has often raised safety issues over its use in therapeutic treatments.

Carcinogenicity studies in animals have shown that the carcinogenic potential of tars is linked to the polycyclic aromatic hydrocarbon (PAH) fractions.[17,20] Swallow and Curtis measured the levels of eight different PAH which have been shown to be carcinogenic to animals in six different coal tar solutions commercially available in New Zealand.[21] A commercial product containing only pine tar (Ego Pharmaceuticals Pty Ltd, Braeside, Victoria, Australia) was also included in the study for comparison. The pine tar product was found to contain no detectable levels of four of the eight PAHs studied, and minimum detectable levels of the remaining four PAHs (Table 2).[21] The PAHs present in in the pine tar product summed to 8 mg/kg, which was at least sixfold, and up to approximately 300-fold less than the levels of PAHs in the other commercial coal tar preparations. Variations in PAHs levels were not due solely to the difference in the amount of tar added to the preparation.[21]

Table 2 Polycyclic aromatic hydrocarbon (PAH) concentrations found in topical tar products. Reproduced from Swallow and Curtis[21]

	BA/C	BF	BeP	BaP	Pe	DjA	InP/DhA	BPe
HSF solution of coal tar B.P.	1180	380	80	300	35	35	90	60
Balnetar bath oil	660	590	180	360	90	60	240	180
Alphosyl lotion	90	60	15	30	5	4	15	15
Tarquinor skin cream	200	140	60	90	30	10	60	50
Egopsoryl TA skin cream†	30	15	5	10	–	–	3	3
Polytar scalp cleanser	20	10	3	6	1	1	3	4
Pinetarsol†	2	3	–	1	2	–	–	–

†Products available in Australia today. All products contain coal tar except Pinetarsol, which contains pine tar alone. Concentrations are expressed in mg/kg. –, concentrations that are not quantified, that is, below 0.5 mg/kg. BaP, benzo(a)pyrene; BA/C, benzo (a)anthracene and chrysene; BeP, benzo(e)pyrene; BF, benzo(b) fluoranthene, benzo(k)fluoranthene and benzo(j)fluroanthene; DjA, dibenz(a,j)anthracene; InP/DhA, indeno(1,2,3-cd)pyrene and dibenz(a,h)anthracene; BPe, benzo(ghi)perylene; Pe, perylene.

A study by Athanasiou and Lillis found an absence of mutagenic action of pine tar resin in the *Salmonella*/microsomal cell culture system as developed by Ames and colleagues, and an absence of clastogenic action in Chinese hampster ovary (CHO) cell culture.[22,23] Thus it can reasonably be assumed that pine tar lacks significant carcinogenic activity.[23] Further, pine tar used in the manufacture of topical pine tar products available in Australia today has been found not to be carcinogenic by the Ames test (unpublished data, Ego Pharmaceuticals), and is not classified as a carcinogen.[9]

Despite the extensive use of medicinal tars, particularly in psoriasis patients, there is no epidemiological evidence that topical tar products, including pine tar, cause cutaneous or internal cancer.[24] For example, in a 25-year follow-up study of 280 psoriatic patients treated with coal tar, the investigators concluded that the incidence of cancer had not appreciably increased above the expected incidence in the general population.[25] In another study of 719 psoriasis patients, tar therapy (type of tar not indicated) did not increase the incidence of cancer above that expected in the general population over a 10-year period.[26,27] Therefore, the apprehension that topical pine tar may be carcinogenic is unfounded, based on the lack of supporting evidence.

Contact allergy

Hypersensitivity reactions for tars are rare, but wood tars are more likely to cause sensitisation than coal tar.[7,19] Patch test studies using wood tars have been performed on around 30 000 patients predominately with contact dermatitis.[28–51] Wood tars at concentrations of between 3 and 12% generally produced positive reactions in approximately 2–10%[28–41] of patients. A small number of studies found positive reactions in 20–30%[42–44] of patients. It is important to note that the number of positive reactions for wood tars was not significantly greater than those for other common allergens. In addition, the concentration of pine tar in topical products available in Australia is up to 2.3%, which is up to four times less than that tested in these studies.

Caution must be used when interpreting these types of studies since what is referred to as wood tars in these studies is generally a mixture of pine, juniper, birch and beech tars, and therefore the exact tar eliciting the positive reaction is not known. A positive reaction to pine tar alone would be considerably less as is shown in the study by van Andel and colleagues.[52] Of the 650 patients tested, 59 (9%) patients had a positive reaction to wood tar. Of the patients positive for wood tar 33 were available for further testing. Of these, only 20 (60%) were positive to wood tar on renewed testing, and only five (25%, which equals approximately 1% of the original population) were positive to pine tar alone. Further, a marked overlap of positive tests to wood tar, coal tar, balsam of Peru, colophony and turpentine was observed, and it was concluded that patch tests with wood and coal tar are of little diagnostic value.[52]

There has only been one case of adverse reactions to topical products containing pine tar reported in the literature by Iorizzo and colleagues.[6] A 61-year-old woman with a 3-year history of vesicular foot eczema presented with an acute dermatitis following the use of pine tar. However, patch testing revealed that she also showed a positive reaction to coal tar, birch tar, beech tar and juniper tar, supporting the finding that these reactions are a consequence of cross-sensitisation and not prior exposure. Her skin lesions rapidly resolved after treatment with topical corticosteroids.[6] Furthermore, there have been only five cases of adverse events for pine tar reported to the Therapeutic Goods Administration of Australia since records began in 1971, which included pruritus, rash and dermatitis.

Other adverse effects

Primary irritation is very uncommon, except in unstable psoriasis and treatment on the face, genitalia and the flexures.[7,19] An *in vitro* skin irritancy study has shown that pine tar is a minimal irritant, the lowest on a scale of four categories; minimal, mild, moderate and severe (results unpublished, Ego Pharmaceuticals). Folliculitis is the most common side effect.[19] In any case, any adverse effects caused by pine tar are likely to be reduced with the topical products available today, which are generally in contact with the skin for only a relatively short period before being washed off.

CLINICAL STUDIES

Despite the fact that topical pine tar has been used for the treatment of various skin diseases for over 2000 years, few clinical studies on the use of topical pine tar could be found following an extensive literature search conducted

back to the 1950s. Studies using products containing a mixture of tars, including pine tar, are not included since the results from these studies cannot be attributed to pine tar alone.

In a study by Anderson, 21 patients with generalised chronic dermatoses including psoriasis, mycosis fungoides and eczematous eruptions were treated with a morning bath containing either 3 tablespoons of pine tar or 3 tablespoons of coal tar solutions for 10 min.[53] Each patient had 6 consecutive days of one treatment followed by 6 consecutive days of the other. One patient's skin was irritated by the coal tar bath, and three patients claimed they felt more uncomfortable than before following coal tar baths. None felt this after pine tar baths. Of the 21 patients 19 preferred the pine tar baths due to the attractive green colour and smell. The two who preferred coal tar baths thought the coal tar solution was stronger and did their skin complaint good.[53]

In a study by Gharavi and colleagues, 50 healthy subjects tested a shampoo containing pine tar.[54] A corneocyte count and fungal study showed that pine tar shampoo is effective against *pityrosporum ovale*. The Draize test and skin sensitisation testing on rabbits used to determine potential irritancy showed that pine tar shampoo is relatively innocuous. In addition, subjects found pine tar shampoo cosmetically acceptable.[54]

In a further study by Langeveld-Wildschut and colleagues, six patients with atopic eczema were treated with 10% pine tar in cetamacrogol ointment, 0.1% triamcinolonacetonide in cetamacrogol ointment or cetamacrogol ointment vehicle on three separate sites of the back every morning for 3 weeks.[55] Atopy patch tests were then performed and biopsy specimens taken for immunohistochemical analysis. Both pine tar and glucocorticosteroid treatments had an almost equally inhibiting effect on the various cellular constituents of allergic inflammation including the influx of T-cells, eosinophils, and $CD1^+$, $RFD1^+$, IFN-γ^+, and IL-4^+ cells, as well as on the percentage of vessels expressing vascular cell adhesion molecule 1 and E-selectin in response to epicutaneous aeroallergen challenge.[55]

CONCLUSIONS

Topical pine tar has been used in medicine since antiquity to treat a range of skin conditions, particularly eczema, psoriasis, seborrhoeic dermatitis and other dry, itchy, flaky or inflamed skin conditions, and is still used successfully today.[2,7,12,17,18] It is postulated to work by reducing DNA synthesis and mitotic activity, which promotes a return to normal keratinisation. In addition, pine tar is considered to be antipruritic, anti-inflammatory, antibacterial and antifungal.[7,8,12,14,15]

In comparison to coal tar, studies have confirmed that the level of PAHs (the constituents of coal tar postulated to cause cancer in humans) in pine tar are very much lower than that found in coal tar.[21,24–27] Furthermore, pine tar has been shown not to be mutagenic.[25] Unlike coal tar, pine tar does not cause photosensitisation and is generally in contact with the skin for only a relatively short period before being washed off.[10]

Only one adverse reaction to topical pine tar in the community was reported in the extensive literature search conducted back to the 1950s.[6] Considering the long experience with pine tar therapy and its worldwide usage, the evidence presented in this review suggests that the safety risk from topical pine tar products is very small, while it is useful for treating a wide range of skin conditions.

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