

REVIEW

Contact dermatitis in athletes

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Athletes face numerous hazards in their daily activities. An athlete's skin, in particular, endures repeated exposure to trauma, heat, moisture, and numerous allergens and chemicals. These factors combine with other unique and less well-defined genetically predisposing factors in the athlete's skin to cause both allergic contact dermatitis (ACD) and irritant contact dermatitis (ICD). As with other cases of contact dermatitis, these eruptions in athletes present as a spectrum of acute to subacute to chronic dermatitis. Recognizing the unique environmental irritants and allergens encountered by athletes is paramount to facilitate appropriate therapy and prevention. This review comprehensively examines the literature on contact dermatitis in athletes. The different types of contact dermatitis have been classified under sport-specific subheadings. Furthermore, within each subheading, both ACD and ICD types are discussed. (J Am Acad Dermatol 10.1016/j.jaad.2006.12.025.)

SWIMMING, DIVING, AND SNORKELING

Swimming

Owing in part to the excellent health benefits, swimming has gained in popularity. The need for equipment, such as goggles, nose plugs, and swim caps, however, has made contact dermatitis a problem for swimmers. Several cases of allergic contact dermatitis (ACD) from swimming goggles have been reported in the literature.¹⁻⁵ Most eruptions present with well-demarcated, bilateral edema and erythema of the periorbital skin along with varying degrees of pruritus, exudate, and scaling. Conjunctival injection was noted in at least one case; a history of atopy was also reported in one case.³ In a related, although rather unique, clinical presentation, one goggle donning swimmer suffered from asymptomatic, well-demarcated periorbital hypopigmentation.⁶ Several different etiologies were proposed for this type of unusual reaction.

The diagnosis of typical contact dermatitis to goggles is usually readily apparent based on the characteristic distribution pattern and the patient's history of repeated flares almost immediately or shortly following goggle use. Patch testing best

confirms a diagnosis of ACD and should always include a piece of the padding material taken from the offending goggles. In all reported cases, the goggles were lined with a rubber or neoprene cushion and the swimmer was allergic to chemicals used in cushion manufacturing. The list of offending agents included: benzoyl peroxide, phenol-formaldehyde resin, various substituted thioureas, and antioxidants frequently used in rubber production (Table I). In some instances, communication with the manufacturer proved useful not only to help identify chemicals used in goggle processing, but also to offer non-rubber based alternatives.⁵ By completely avoiding the goggles or switching over to ones without a rubber padding, swimmers experience dramatic improvement in just a few days.⁷

Other items causing ACD in swimmers include: rubber or elastic swimwear, certain dyes,⁸ nose clips, ear plugs, and swim fins.⁹ Mercaptobenzothiazole found in some rubber bathing or swim caps caused dermatitis in several swimmers.¹⁰ Much like goggles, these items would be expected to cause eczematous eruptions that are easily discernable based on location and a brief clinical history pertinent to the athlete's activities.

Aside from equipment, contact dermatitis may relate to the unique environment of the sport. Both ACD and irritant contact dermatitis (ICD) may result from chemicals used to disinfect swimming pools.¹¹⁻¹⁵ The athletes presented with a diffuse, markedly pruritic erythematous eruption. Notably, the swimsuit offered some protection in an individual with chlorine allergy, as evidenced by the sparing of skin involvement under the suit (Table II).¹⁵ Athletes' description of the correlation between the rash and their regular swims can be a key element in making the diagnosis. Patch testing confirms the diagnosis,

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Table 1. Allergic contact dermatitis in water sports

Sport	Exposure	Specific agent	How identified	Reference
Diving/snorkeling	Wet suit	PTBP-FR	Patch testing	25
		Ethylbutylthiourea	Patch testing	26
		Nickel	Patch testing	28
		N, N-diethylthiourea	Patch testing	21,22
		Diethylthiourea and dibutylthiourea	Patch testing	23
		Diphenylthiourea	Patch testing	24
		Tego 103G disinfectant used on wet suit	Patch testing	29
	Diving footgear swim fins	Dibutylthiourea, and diethylthiourea	Patch testing	30
	Diving mask	Unknown agent (IPPD suspected)	Patch test to rubber chemicals (mask not included)	34
		IPPD	Patch testing	33
Fishing	Fishing rod	IPPD (suspected)	Patch testing	36
	Unknown	Nickel and mercaptobenzothiazole	Patch testing	35
	Fishing bait	Flesh fly maggot larvae (<i>C vomitoria</i>)	Weekly handling and prick testing	40,42
		Midge larvae (<i>Chironomus thummi thummi</i>)	Prick test and RAST	41
		Azo compounds in maggot dye	Patch testing	43
Sailing	Unknown	Thiourams, nickel, and latex	Patch testing	35
Surfing/wind surfing	Wishbone (handle on sail)	CPPD and IPPD; CPPD and DPPD	Patch testing	47
	Wet suit	Diethylthiourea	Patch testing	46
Swimming	Swimming goggles	Benzoyl peroxide and phenol-formaldehyde resin	Patch testing	1
		Black foam rubber padding	Patch testing	2
		Diethylthiourea, ethylbutylthiourea, and possibly dibutylthiourea	Patch testing	3
		Ethylbutylthiourea	Communication with company	5
		IPPD, CPPD and DPPD	Patch testing	4
		Mercaptobenzothiazole	Patch testing	10
		Di-halo, chlorinated compounds	Patch testing	15
	Swimming cap	Halobrome (specific chemical unknown)	Patch testing	11
	Swimming pool water			
	Spa pool water			

CPPD, N-cyclohexyl-N'-phenyl-1,4-phenylenediamine; DPPD, N,N'-diphenyl-p-phenylenediamine; IPPD, N-isopropyl-N-phenylparaphenylenediamine; PTBP-FR, para-tertiarybutylphenol-formaldehyde resin.

and it is important to note that both chlorine and bromide may cause contact dermatitis.^{11,15,16}

Swimmers have also developed contact dermatitis in seawater. A specific type of seaweed caused a mini-epidemic of contact dermatitis in individuals swimming around one of the Hawaiian Islands.¹⁷ The primary area of involvement in this form of ICD was the area covered by the swimsuit and the differential diagnosis included seabather's eruption and swimmer's itch. After brief contact with a yellow coral in the Red Sea, a group of swimmers, snorkelers, surfers, and divers developed an intensely

pruritic form of ICD. This eruption persisted in its acute stage for several days and took up to 15 weeks to completely resolve in some individuals.¹⁸ Sponges, sea cucumbers, sea mosses, and even plants washing in on the "red tides" can cause ICD in swimmers.¹⁹

One final form of contact dermatitis, "swimmers shoulder," is irritant in nature. An unshaven beard that repeatedly rubs the shoulder during the swim stroke creates an erythematous plaque.²⁰ It can easily be prevented by more frequent shaving; however, this case illustrates the need for careful attention to

Table II. Irritant contact dermatitis

Sport	Contactant	Clinical term	Specific agent	Reference
Baseball	Clothing	Baseball pitcher's friction dermatitis	Friction and sweat	75
Basketball	Ball	Basketball pebble fingers	Surface of basketball	70
Canyoning	Multiple factors	Canyoning hand	Cold water, repeated wetting and drying, and rocks	44
Hockey	Hockey sticks	No specific term	Fiberglass	83-84
Running/walking/jogging	Hard-fibered shirt	Jogger's nipples	Friction from shirt	50
Soccer	Field markings/boundary lines	Cement burns	Alkaline lime component (calcium oxide and hydroxide)	62-64
Surfing/Wind surfing	Raft, board, and water/sand	Surf rider's dermatitis	Surface of board, salt water, wind, and sand	45
Swimming	Brominated pool water	Pool water dermatitis	Di-Halo (brominated compound)	12-14
	Seaweed	Seaweed dermatitis	Toxins from <i>Lyngbya majuscula</i>	17
	Red Sea coral	No specific term	Coral	18
	Hair	Swimmer's shoulder	Friction unshaven beard	20
Tennis	Tennis player's thighs	No specific term	Friction and sweat	78
Trapshooting	Shotgun stock	Trapshooter's stigma	Friction and wood stock	89
Weight lifting	Chalk	No specific term	Chalk	87

all aspects of the athletic patients' daily workouts when attempting to determine the etiology of their dermatitis.

Snorkeling and diving

Snorkeling and scuba diving require certain equipment. One of the most frequent causes of contact dermatitis in divers and many other individuals participating in water sports is the wet suit. In most cases the diver reacts to some chemical used in the production of the rubber or neoprene material of the suit. Sensitizing agents have included *n,n*-diethylthiourea,²¹⁻²³ dibutylthiourea,²³ diphenylthiourea,²⁴ para-tertiary-butylphenol-formaldehyde resin,²⁵ or ethyl butylthiourea.^{26,27} These agents have been used as rubber accelerators or occasionally as glues to attach nylon linings. All affected divers present with a generalized pruritic and sometimes vesicular eczematous eruption that occurs each time a sensitized diver comes into contact with the suit.

The eruption's distribution is particularly helpful in making the diagnosis of contact dermatitis, but variations are common. Leached nickel from the fabric of a wetsuit resulted in a localized contact dermatitis over the wrists in one case.²⁸ Chemicals used for cleaning and disinfecting diving gear can also cause a contact dermatitis. One author described a pruritic eruption on a diver who only reacted positively to material taken from his suit following emersion in the disinfectant solution Tego 103G.²⁹ Patch testing should therefore be performed with a high index of suspicion for not only the rubber components but also adhesives, dyes, and cleansers.

Less commonly, other items worn by divers (eg, footwear, gloves, snorkels, and mouthpieces) cause contact dermatitis in divers.^{9,30} Lastly, masks cause a facial dermatitis sometimes called "mask burn."^{31,32} Affected swimmers present with pruritus and erythema of the skin in areas where the mask directly contacts the face, and mini-epidemics of this facial dermatitis have been reported in the literature.³³ The dermatitis may occur almost immediately or up to 48 hours after wearing the mask; *N*-isopropyl-*N*-phenylpara-phenylenediamine or IPPD, used as a rubber antioxidant, represent the most common sensitizing agents in mask burn.³³⁻³⁵

FISHING

Sports fishermen risk acquiring ACD most commonly on the hands from either the fishing rod or bait. One study of young fishermen presenting with ACD revealed an increased sensitivity to both nickel and mercaptobenzothiazole.³⁵ One case report noted that a graphite fishing rod caused unilateral palmar dermatitis in a fisherman after several hours of contact with the rod.³⁶ The fisherman's patch test was positive for IPPD. Although IPPD could not be specifically linked to the fishing rod, covering the handle with an insulating tape prevented further flares.

Piercing bait onto the hook may also result in ACD in fishermen. Various species of maggots cause an acute, generalized reaction of rhinorrhea, sneezing, pruritus, asthma, and even angioedema.³⁷⁻³⁹ A few reports have described a localized ACD of the hands characterized by hyperkeratosis and erythematous

vesicles on the palms, mainly involving the thumb and first fingers.⁴⁰⁻⁴² Although patch testing was negative in all three case reports, prick testing and/or repeat handling tests confirmed that the bait was the allergen in all cases. Lesions healed after the anglers discontinued handling the particular species of maggot. It is also important to note that in addition to the maggots themselves, azo compounds used to dye maggots can also cause an ACD.⁴³

CANYONING

Canyoning involves racing through ice-cold rapids, scaling across rocks, and portage. Repeated irritation of the palms by the cold water, constant wetting and drying cycles, and abrasion from the rocks result in an ICD appropriately termed “canyoning hand.” Painful and erythematous erosions on areas of the palms and fingertips typify “canyoning hand.” Prevention and treatment includes the use of a sturdy pair of gloves.⁴⁴

SURFING AND SAILING

Whether riding the surf chest down on a boogie board or drawing on the power of the wind to skip across the waves, water enthusiasts place themselves at risk for both ICD and ACD. Surfers may develop a skin eruption termed “surf rider’s dermatitis.” Extremely painful erythema and edema of the nipples along with small abrasions and fissures occurred in several reported cases.⁴⁵ Multiple etiologies (eg, sand, salt water, wind, and the board itself) contribute to the production of this ICD. Protective clothing can prevent surf rider’s dermatitis.

In one study, patch testing revealed an overall increased sensitivity to thiourams, nickel, and latex in a group of sailors.³⁵ Like swimmers and divers, surfers can develop allergic contact sensitization to wetsuits. In one case, a windsurfer developed a recurring dermatitis of the trunk and proximal extremities that appeared to occur under purple but not pink segments of her suit.⁴⁶ The allergen was later found to be diethylthiourea, which was identified in the black foam rubber lining of only the purple material.

Lastly, to channel the wind’s energy into forward momentum, a windsurfer must use a handle called a wishbone to manipulate the sail. This wishbone, often made of black rubber, can cause very pruritic, erythematous plaques on the palms. This dermatitis is fairly resistant to treatment with topical steroids; the athlete should substitute aluminum in place of the black rubber.⁴⁷

RUNNING/JOGGING/WALKING

Runners and joggers endure myriad skin and nail problems which include contact dermatitis from the

shoes and shirts they wear and the various topical medications they use (Table III).^{48,49} The dermatitis displays a characteristic distribution relating to the location of contact. Jogger’s nipples represent irritant dermatitis of the nipples caused by friction from the running shirt.⁵ The application of petroleum jelly or adhesive patches to the nipples before running or wearing a synthetic moisture wicking shirt can prevent these painful, erythematous, and crusted erosions.^{50,51}

Runners may react to the components of rubber, leather, various glues, or even dyes used in the manufacture of running shoes.^{27,52,53} The moisture-rich environment of the shoe helps leach out the specific chemicals responsible for causing ACD. In several shoe dermatitis epidemics, ethyl butyl thiourea in the neoprene insoles of Nike shoes resulted in an erythematous vesiculo-pustular eruption on the soles. This eruption developed after 2 weeks to several months of wearing new running shoes.^{27,52} Rubber insoles from tennis shoes containing mercaptobenzothiazole and dibenzothiazyl disulfide also caused recurrent eczematous eruptions of the feet.⁵⁴ The key to prevention involves switching to new insoles. Polyurethane shoes made by Puma or Nike exist as alternatives to rubber.

An interesting study examined pieces of the shoes’ insoles after placing them into synthetic solvents designed to mimic human sweat. The purpose of this study was to determine whether the quantity of the chemicals leaching out of the shoe material into sweat was sufficient to elicit ACD. Diethylthiourea, ethyl butyl thiourea, and dibutyl thiourea all leached out of the shoe material at thresholds high enough to elicit thiourea sensitization in certain individuals.⁵⁵

Analgesic sprays, topical salicylates, and anti-inflammatory creams and gels have caused ACD in athletes.⁵⁶⁻⁵⁹ Some of the specific allergens cited in these cases included eucalyptus oil, picolinamine salicylate, and indomethacin and diclofenac gels. In one case, a walker developed dermatitis of the hands, feet, and face resulting from a blister preventing jogging cream. Further inquiry revealed that this jogging cream contained at least 32 different constituents, of which the jogger proved sensitive to 4.⁶⁰ In a large case series study on the incidence of ACD in a group of student athletes, benzocaine and lanolin (found commonly in topical anesthetics and massage creams) were the most prevalent allergens responsible for contact dermatitis in runners.³⁵

SOCCER

In soccer, or football as it is called by our European colleagues, contact dermatitis is usually caused by equipment or chemicals used on the soccer field. There have been several reported cases

Table III. Allergic contact dermatitis in land sports

Sport	Exposure	Specific agent	How identified	Reference
Basketball	Ball	Thiuram, mercaptobenzothiazole	Patch testing	71
	Adhesives for athletic tape	PTBP-FR	Patch testing	74
	Knee pad	Rubber accelerator	Unknown	72
	Knee guard	PTBP-FR and PFR	Patch testing	73
Billiards	Billiard cue	Epoxy resin in varnish	Patch testing	90
Cycling	Not specified	Paraphenylenediamine, potassium dichromate benzocaine, and yellow dispersion	Patch testing	35
Handball	Anesthetic freezing spray	Ethyl chloride	Patch testing	82
Hockey	Gloves	Unknown	Unknown	85
	Face mask	Epoxy resin adhesive	Unknown	27
Judo	Judo carpet	Sudan IV red dye	Patch testing	91
Jogging/running/ walking	Athletic (running) shoe	Ethylbutyl thiourea	Patch testing	27,54
	Tennis shoe	Mercaptobenzothiazole and dibenzothiazole disulfide	Patch testing	54
	Jogger's cream	Benzocaine and lanolin	Patch testing	35
Lawn bowling	Bowls grip	Colophony (resin)	Patch testing	77
	Bowling green	TMTD	Patch testing	76
Skiing	Unknown	Epoxy resins, cobalt, and formaldehyde	Patch testing	86
Soccer	Unknown (possibly related to field)	Lichenoid dermatitis	Unidentified photoactive substance suspected	65
	Shin-pads	Urea formaldehyde resin	Patch testing and clinical suspicion	66
	Adhesives for athletic tape	Tincture of benzoin	Patch testing	67-69
Squash	Squash ball	IPPD	Patch testing	81
Tennis	Plastic tennis racquet	Isophorone diamine and epoxy resin	Patch testing	79
	Neoprene elbow splint	Diphenylthiourea	Patch testing	80
Weightlifting	Metal weights/bar	Nickel and palladium	Patch testing	88
Various sports	Anti-inflammatory cream	Eucalyptus	Patch testing	57
	Jogging cream	Arnica, palmitoyl hydrolysed milk, palmitoyl collagen amino acids and lipacide-cas	Patch testing	60
	Adhesive for athletic tape	PTBP-FR	Patch testing	74

IPPD, N-isopropyl-N-phenylparaphenylenediamine; PTBP-FR, para-tertiarybutylphenol-formaldehyde resin; TMTD, tetramethylthiuram disulfide.

of ICD from the lime component often used in field markings.⁶¹⁻⁶³ This dermatitis, also known as “cement burns,” presented with erythematous, edematous plaques, bullae, and erosions characteristically located on the upper inner thighs. In all cases, a mild to severe burning or stinging was noted either during

or within a few hours after completing the match. Symptoms worsened after taking a hot shower. In each case, characteristic physical findings and a history of exposure to wet field lines cinched the diagnosis. Patch testing performed on a few of the athletes yielded negative results. Treatment for

cement burns should involve removing contaminated clothing, cleaning the areas with water, and applying topical antibiotics or petroleum jelly.^{61,64}

The playing field may also play a role in ACD. One case series noted that players developed pruritic and erythematous papules and plaques on the upper thighs over sites of previous trauma. Histologic specimens revealed a lichenoid pattern, suggesting the possibility of a photolichenoid dermatitis related to contact with some unidentified plant on the playing field.⁶⁵ Shin pads can also cause contact dermatitis in soccer players. One young soccer player developed bilateral ACD of the shins as a result of urea-formaldehyde resin in his shin pads.⁶⁶

Much like runners, soccer players may develop ACD from topical anesthetic creams (containing benzocaine or dibucane), as well as certain athletic shoes which may contain epoxy resins or nickel.^{35,67} Lastly, soccer players, along with athletes from several other sports, have demonstrated ACD to adhesives, such as tincture of benzoin used in conjunction with athletic tape.⁶⁷⁻⁶⁹

BASKETBALL, BASEBALL AND LAWN BOWLING

In sports played with a ball, it's easy to conceptualize how both ICD and ACD can occur. One form of ICD related to basketball is termed "basketball pebble fingers," which results from mechanical irritation from the ball's pebbled surface along with any small surface defects. The fingertips and pads demonstrate small petechiae and abrasions on a shiny denuded surface.⁷⁰ Affected basketball players may prevent the lesions by using a topical emollient before play or avoiding balls with abrasive surfaces (typical outdoor basketballs).

Rubber basketballs contain a potential sensitizer for many young athletes and may cause eczematous lesions on both palms, particularly the skin over the palmar fingertips and base of the thumbs.⁷¹ Following a switch to a leather ball, the eruption clears.

It is important for both basketball and baseball players to consider aspects other than the balls as a cause for contact dermatitis. There have been several reports of a pruritic, erythematous, and vesicular eruption on the knees of basketball players wearing protective knee padding. In one case, the pad contained a rubber accelerator,⁷² while, in another, dermatitis was attributed to two formaldehyde resins in the knee guard.⁷³ In addition, several basketball players have developed ACD to formaldehyde resins used as adhesives for athletic tape.⁷⁴ One professional baseball pitcher with a history of atopy developed a rather unique form of ICD: multiple, pruritic papules on the inner right ankle and knee

resulted from friction that occurred during his pitching motion.⁷⁵

Lawn bowlers may acquire hand dermatitis after frequent contact with balls or certain fungicides used on the bowling greens.⁷⁶ The common sensitizing agent reported, however, is not the ball itself, but rather a proprietary "bowls grip" that is sometimes used to create a better grip on the ball. Affected lawn bowlers developed erythema and scaling of the palms; several bowlers patch tested positive to a colophony resin used in this product.⁷⁷ Lesions resolved with avoidance of the "bowls grip."

TENNIS/RACQUETBALL/SQUASH/HANDBALL

The traumatic skin problems inherent in tennis are well known⁷⁸; less commonly, contact dermatitis occurs in tennis players. The particularly well-developed legs that result from extensive training can sometimes produce an uncomfortable, irritated, brightly erythematous eruption over the medial thighs as the legs continuously rub one another.⁷⁸ Isophorone diamine and an epoxy resin used in the manufacture of tennis rackets cause ACD.⁷⁹

Finally, tennis elbow (lateral epicondylitis) has indirectly lead to several cases of elbow dermatitis caused by neoprene splints.⁸⁰

Although racquetball, handball, and squash might all be expected to cause hand dermatitis as a result of direct hand-to-rubber contact, only squash has been reported in this manner. The squash player presented with erythema, pruritus, and fissuring of the left palm and upon patch testing reacted to IPPD as well as the rubber from the squash ball.⁸¹ Anesthetic sprays also cause ACD in these racquet sport athletes, just as they might in other athletes. A handball player developed a vesicular dermatitis in areas where she sprayed a local anesthetic spray.⁸² Patch testing later confirmed that ethyl chloride was the responsible substance.

HOCKEY/SKIING

Winter athletes also develop contact dermatitis. Professional hockey players have developed ICD from the fiberglass in their hockey sticks.^{83,84} Another hockey player developed a bilateral ACD on the face after exposure to epoxy resin adhesives in a face mask.²⁶ Hockey players may also react to dyes used in the manufacture of hockey gloves.⁸⁵ Twelve ski factory employees suffered from contact dermatitis directly related to their work in the factory.⁸⁶ Patch testing of these workers revealed positive reactions to epoxy resins, cobalt, and formaldehyde used to manufacture the skis.

VARIOUS OTHER OLYMPIC SPORTS

Weightlifting involves frequent contact of the metal bars with the weightlifter's skin, particularly on the hands, shins, neck, and shoulders. Friction from this repeated contact may cause erythema, abrasions, and lichenification; a few weightlifters have exhibited a contact dermatitis from the chalk used to achieve a better grip.⁸⁷ Another report suggested that weightlifters may develop an ACD to nickel and palladium contained in the weights or bars.⁸⁸

There are a few other reports of contact dermatitis in athletes in the literature that should be included for comprehensiveness. Trapshooter stigma presents as a lichenified plaque or atrophic scar and results from repeated friction of the wood stock of a gun against the shooter's face.⁸⁹ An exotic wooden billiard cue coated with an epoxy resin varnish caused an ACD on the hands of a pool player.⁹⁰ Finally, a red dye in the carpet of a judo club caused a generalized ACD in a martial artist.⁹¹

CONCLUSION

Athletes constantly encounter both synthetic and natural chemicals in their equipment and their environment. The consequent skin eruptions can be very confusing to the clinician and alarming to their athletic patients. Recognizing the unique presentation of ACD and ICD in athletes and performing careful sports-directed histories and allergen-directed patch testing enhances the clinician's ability to care precisely for the athletic patient.

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