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Skin reactions associated with glucose monitoring devices

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Abstract

Introduction

Novel diabetic devices have become increasingly popular in recent years, circumnavigating the need for regular finger pricking to order to obtain blood glucose levels. These technological advances have led to improved quality of life and reduced frequency of complications. Devices such as subcutaneous insulin pumps and interstitial glucose monitors are convenient, long-lasting, and discrete options for patients. However, as they require prolonged contact time with skin as well as the use of strong adhesives, they can be associated with a variety of localised unwanted cutaneous reactions, including irritant contact dermatitis, and allergic contact dermatitis.

Cases

We report a case series of 5 patients with diabetes mellitus referred for patch testing with localised skin reactions at the sites of their diabetic devices. Diabetic devices in use at time of patch testing included: 1 subcutaneous insulin pump (Medtronic 640), and 4 glucose monitoring devices (DexCom G6 (n=3), and DexCom G7 (n=1)).

Outcome

Two patients had allergic contact dermatitis – one to the dressing, scrapings, colophonium and Eurax cream (with negative acrylate series), and one to isobornyl acrylate and the dressings.

Discussion

Skin reactions including allergic contact dermatitis are being increasingly observed with diabetic devices, and healthcare professionals may need to consider patch testing for these patients. Manufacturers of GMDs should supply an inclusive list of all the components in their devices and adhesives, including possible allergens such as isobornyl acrylate and colophonium.

Introduction

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Novel diabetic devices have become increasingly popular in patients with diabetes mellitus in recent years, circumnavigating the need for regular finger pricking to order to obtain capillary blood glucose levels, which can lead to painful hardening of the fingertips.[1] These technological advances have led to improved quality of life and reduced frequency of complications such as hypoglycaemia and ketoacidosis.[2-5] Devices such as subcutaneous insulin pumps and interstitial glucose monitors are convenient, long-lasting, and discrete options for patients.[3] Insulin pumps have been used since the 1970's, and consist of a needle inserted into the skin, fixed with an adhesive patch, connected to a pump that allows continuous delivery of insulin.[5] Modern glucose monitoring systems can be classified as either continuous glucose monitoring devices (CGM), or flash glucose monitoring (FGM) systems. First introduced in 2006, CGM devices constantly monitor glucose levels and transmit their readings via Bluetooth to a smart device, e.g. Dexcom, giving them the ability to sound an alarm in the case of a detected emergency situation such as hypoglycaemia.[1] First made available in 2015, FGM devices only provide glucose levels if an associated scanner is 'flashed' or held in front of the sensor, e.g. Freestyle Libre.[1] Both devices are transdermal sensors applied to different parts of the body, e.g. the arm or abdomen, that monitor glucose levels in tissue fluid, and remain in place for a fixed duration of up to 14 days depending on the device specifications.[1,5,6] In order to function correctly and discretely, these devices the use of strong external cutaneous adhesives, and prolonged contact time with skin.[3] As a result, they can be associated with a variety of localised unwanted cutaneous reactions, including infection associated with subcutaneous catheter insertion, irritant contact dermatitis, and allergic contact dermatitis (ACD), which can vary in severity.[1,3,5] Jadviscokova et al estimated that up to 18% of patients using glucose monitoring devices (GMDs) may suffer from hypersensitivity reactions to them.[7] Several risk factors increase the risk of developing ACD to these devices, including exposure time, age, compromised skin barrier, and level or moisture or sweat at the site.[1]

Cases

Five patients were referred for patch testing with suspected ACD caused by their diabetic devices between June 2022 and June 2023. All patients were diagnosed with diabetes mellitus type I. All 5 patients were evaluated at the Department of Dermatology in the South Infirmary Victoria University hospital.

Patch tests were performed with a baseline series, and sometimes with additional series, such as acrylates, propylene glycol, facial, essential oils, sodium metabisulfite, octyl gallate, and parts of the GMD or adhesive.

Patch testing was performed according to the guidelines of the International Contact Dermatitis Research Group. The duration of occlusion was 2 days, and the test results were

evaluated on day 5. All patients were initially patch tested with part of their current GMD as well as related adhesives at time of testing.

Results

Patient characteristics are shown in Table 1. The median age of patients was 15 years, with a range of 2-46 years of age. The male:female ratio was 3:2, with 3 males and 2 females included. All patients were Caucasian. Potentially implicated devices at time of patch testing included: 1 subcutaneous insulin pump (Medtronic 640), and 4 GMDs (DexCom G6 (n=3), and DexCom G7 (n=1)).

Three patients reacted positively to either pieces of their diabetic device, or to the adhesive part of their respective device. Two patients had allergic contact dermatitis – one to isobornyl acrylate & dressings; and one to the dressing, scrapings, colophonium and Eurax cream, which had been recommended by the company for treatment of symptoms.

Positive patch test reactions were also observed to allergens from additionally tested series, including nickel, sodium metabisulfite, and octyl gallate.

Two patients were diagnosed with irritant reactions. One patient was given the diagnosis of Koebnerisation secondary to psoriasis.

Three patients switched to an alternative GMD following patch testing, and reported improvement in localised cutaneous symptoms.

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Table 1: Patient Characteristics and Patch Test Results

Patient	Age	Gender	PMH	Type of Device	Series	Result	Diagnosis
1	5	M	T1DM Atopy	Medtronic 640	Modified standard Full acrylates Propylene glycol Own products (wipes, tape, cavilon, spare pump, removal spray, eumovate)	*Positive* to nickel	Irritant reaction on a background of atopy
2	2	F	T1DM Psoriasis	DexCom G6	Short acrylate series	Negative	Psoriasis probably Koebnerising at sites of glucose monitor needle puncture site
3	11	M	T1DM	DexCom G7	Acrylates Other – white monitor adhesive patch, monitor scrapings, and green overpatch	*Positive* reactions to the white monitor adhesive patch and scrapings from the monitor, as well as the green overpatch.	Allergic contact dermatitis, likely to Colophonium and Eurax cream
4	46	M	T1DM Seafood allergy. Hayfever	Dexcom G6	Standard Facial Essential oils MA acrylates Other – parts of monitor and dressing.	*Positive* to sodium metabisulfite - uncertain significance	Probably irritant reaction to Dexcom G6

5	13	F	T1DM Hayfever Asthma	Dexcom G6	Modified Standard Facial MA acrylates Other – Dexcom dressing, pump dressing, scrapings from Dexcom G6 plastic	*Positive* to Isobornyl acrylate & Dexcom G6 dressing	Allergic contact dermatitis to Isobornyl acrylate

PMH, past medical history; T1DM, type 1 diabetes mellitus

Discussion

There have been several allergens implicated in skin reactions secondary to diabetic devices, including isobornyl acrylate, ethyl cyanoacrylate, colophonium, N,N-dimethylacrylamide, epoxy resin, phenoxypoly(ethyleneoxy) ethylacrylate (PEEA), β-carboxyethyl acrylate, 1-benzoyl-cyclohexanol, and 2,2'-Methylenebis(6-tert-Butyl-4-Methylphenol) monoacrylate.[2,5,6,8]

Isobornyl acrylate (IBOA) (CAS no. 5888-33-5), also known as acrylic acid isobornyl ester, is an acrylic monomer used commonly in the automobile industry for ultra-violet (UV) and weather protection.[1] It is also used in plasticisers, coatings, cosmetics, and paint.[4,6] It has been reported as a cause of ACD since 1995 as a component of adhesive in insulin pump infusion sets.[9] It is also found in the FreeStyle libre® device, specifically in the plastic shell around the needle of the sensor set.[2,4,6] It has also been suggested recently that IBOA could be a hidden allergen in commercial cosmetic samples of alkyl glucosides.[10]

Colophonium (aka rosin or colophony) is derived from the sap of coniferous trees, and is widely used in several products including adhesives, tapes, lubricants, sealants, soaps, cosmetic products, polishes, stringed instruments, paints, lacquers, and soldering products.[2,6] It is one of the commonest contact allergens, with an approximate prevalence of 2%.[6] It is found in certain medical dressings such as Duoderm Extra Thin.

Ethyl cyanoacrylate is known for its use in instant glues, including in liquid wound closure materials, as well as eyelash glue and artificial acrylic nails.[2,6] It was the first allergen identified as causing ACD in the GMD Platinum G4 Dexcom, reported by Schwensen et al in 2016 in a 2-year-old girl with a positive patch test reaction.[11] The reporting of further cases led to the manufacturer altering the composition of the adhesive element of the device, omitting ethyl cyanoacrylate from the formulation.[5]

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N,N-dimethylacrylamide (DMAA) (CAS no. 2680-03-7) is used as a monomer or polymer in adhesives, coatings, synthetic fibres, and drug-releasing hydrogels.[6] It is often used in combination with IBOA.

Some preventative measures have been proposed as a means to reduce the frequency of localised cutaneous reactions occurring at sites of GMD fixation.[5] Applying a thin protective pad such as a hydrocolloid plaster (e.g. Compeed) or stomaplates (e.g. Stomahesive) between the skin and the adhesive part of the sensor can improve tolerance.[1,5] However it is important to avoid a dressing that contains colophonium if the patient has reacted positively to that allergen. It is possible that skin protecting pads or dressings could potentially impair the function of the GMD.[6] In the United Kingdom, the Medicines & Healthcare Products Regulatory Agency has cautioned against the use of such barrier materials.[6] In these cases, patients may need to consider switching to an alternative GMD in collaboration with their diabetic specialist.[1,12] It is important to educate patients on the permanence of contact allergy, and the need to avoid the allergen in future to prevent further reactions from occurring.[6] Patch testing with IBOA, ethyl cyanoacrylate, colophonium, DMAA, and all components of the GMD is vital to reaching an accurate diagnosis, however this can prove difficult as the manufacturers will often neglect to provide the exact composition.[5,6]

In situations like this, chemical analysis may be required to test for the presence or absence of an allergen that caused the positive patch test reaction, however this form of analysis is laborious and expensive, and requires collaboration with local laboratories.[5] Amended legislation that enforces the requirement for complete labelling of medical devices could help to avoid this in future, for which dermatologists have advocated.[5,13] Finally, all localised cutaneous reactions related to GMD should be reported to pharmacovigilance and public authorities, to highlight a growing global issue.[5]

In conclusion, we report a case series of 5 patients with diabetes mellitus referred for patch testing with localised skin reactions to their GMDs. Skin reactions including allergic contact dermatitis are being increasingly observed in GMDs. Healthcare professionals may need to consider patch testing in patients experiencing skin reactions to GMDs. Manufacturers of GMDs should supply an inclusive list of all the components in their devices and adhesives, including possible allergens such as IBOA, ethyl cyanoacrylate, colophonium & DMAA.

Declarations of Conflicts of Interest:

None declared.

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Abbreviations:

ACD: allergic contact dermatitis
CGM: continuous glucose monitoring
FGM: flash glucose monitoring
GMD: glucose monitoring device
IBOA: isobornyl acrylate
UV: ultra-violet