Pacemaker Dermatitis: A Hearty Review of This Cutaneous Manifestation

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Pacemaker dermatitis is a form of contact dermatitis. Although contact dermatitis has been well described, pacemaker dermatitis has not. However, given the adverse consequences of misdiagnosing pacemaker dermatitis, a better understanding of this cutaneous manifestation is important. This article reviews essential information on pacemaker dermatitis regarding its presentation, causal mechanism, histopathology, diagnosis, and treatment.

The first recorded reports of contact dermatitis are from 100 AD.[1] Even with these early beginnings, contact dermatitis continues to evolve as a disease entity. With the progression of technology, including an increasing number of new medical and pharmacologic treatments, the number of potential causal offenders has grown. An important example of this expansion is the first human pacemaker implantation. In 1970, Raque and Goldschmidt[2] described the first known case of pacemaker dermatitis, a rare but serious adverse reaction to this revolutionary instrument.

Although this significant description has lead to other similar published reports of pacemaker dermatitis, the number of reports is relatively limited despite the importance of this condition and the number of years since it was initially described. This may simply reflect the rare nature of pacemaker dermatitis; however, it may suggest difficulties in diagnosing pacemaker dermatitis or even a restricted awareness of this condition. For these reasons, this article provides a detailed examination of pacemaker dermatitis for greater diagnostic and clinical awareness. It also emphasizes the importance of considering pacemaker dermatitis in cases of cutaneous adverse reactions after pacemaker placement.

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DESCRIPTION AND CAUSAL MECHANISM

In 1958, the first pacemaker was implanted in a human; however, the first report describing pacemaker dermatitis was not published until 1970, when Raque and Goldschmidt[2] described a pruritic, circumscribed, eczematous dermatitis over the area of the implanted pacemaker. Subsequent reports have generally described pacemaker dermatitis as a circumscribed, erythematous dermatitis with variations of local scaling, pruritus, plaques, vesicles, swelling, and even necrosis overlying the pacemaker site.[3,4] However, in some cases the lesions were not limited to the pacemaker site, but included disseminated plaques, generalized dermatitis, pompholyx on the hands, generalized pruritic nummular eczema, and eczema on the lower limbs.[3,5-7] Other reported cutaneous reactions to pacemakers include a reticular telangiectatic erythema, pressure dermatitis, and infection.[8,9] Additionally, the time frame for developing lesions ranges from 2 days to months or years after pacemaker implantation.[3,4]

In their first description of pacemaker dermatitis, Raque and Goldschmidt[2] did not firmly establish a causal link between the lesions and the pacemaker. They instead believed that a strong relationship existed between the dermatitis and the pacemaker. Subsequent reports supported this relationship. These included Weiss,[10] who reported a tissue reaction that occurred twice; subcutaneously on the chest wall and also on the abdominal skin over the reimplanted pacemaker. These findings suggested pacemaker dermatitis. Although pacemakers are now known to cause overlying changes in the skin, there remains the question of etiology and whether it is irritant, allergic, or pressure dermatitis.

Raque and Goldschmidt[2] were not able to definitively prove that the causal mechanism was primary irritant contact dermatitis or allergic contact dermatitis, although it appears that they believed the etiology was more irritant.[8] Some of their uncertainty was from the negative patch tests to pacemaker components.[2] Years later, Wilkerson and Jordan[9] argued that an isomorphic (pressure), not allergic, response accounted for most reports of dermatitis after pacemaker implantation. According to Wilkerson and Jordan,[9] the existing cases either failed to establish an allergy to the pacemaker components, or the dermatitis did not clear up with a new or protective-coated pacemaker.[9] Moreover, no cutaneous reaction occurred when the pacemaker was moved to other anatomic sites, which further supported the authors' argument for pressure dermatitis.[9] Later reports showed positive results of a patch test to pacemaker components. Abdallah et al[11] also noted the continued reoccurrence of lesions at the site of the pacemaker despite moving the pacemaker to a different anatomical site, which suggested a local pressure response was not the causal mechanism.

Although irritant contact dermatitis and pressure dermatitis are possible reactions to pacemaker implantation, it is now known that the metallic and synthetic plastic components in a pacemaker, such as the pulse generator (similar to a tiny computer and complete with a battery, circuitry, and casing) and the leads likely account for many cases of pacemaker dermatitis. These components are comprised of several different types of metallic and synthetic plastic materials. Such materials include titanium, parylene, silicone, nickel, mercury, cadmium, cobalt, polyurethane, epoxy, and cobalt.[12] Titanium and nickel are the most widely reported allergens[4]; however, all of these materials are potential allergens.[12]

IMMUNOLOGIC AND HISTOPATHOLOGIC FEATURES OF PACEMAKER DERMATITIS

Irritant contact dermatitis is a nonallergic reaction of the skin due to cumulative damage to the outer protective layer of the skin; allergic contact dermatitis is a delayed hypersensitivity reaction to a contact allergen.[13,14] Several case reports suggest that the causal mechanism in pacemaker dermatitis is a delayed-type hypersensitivity reaction, which is a type of cell-mediated immunity.[3,4,14,15] In this reaction, the hapten (allergen) attaches to a protein carrier, usually a Langerhans cell (the antigen-presenting cell).[16] This combination forms the antigen to which the reaction will be directed against on reexposure.[16] After the allergen is again exposed, the antigen is formed, and the previously sensitized antigen-specific T lymphocytes evoke the release of chemokines and cytokines.[16] These antigen-specific memory T lymphocytes, along with other inflammatory cells, invade the skin and cause the response known as allergic contact dermatitis.[17]

This process occurs in 2 phases: sensitization (afferent) and elicitation (efferent).[17,18] In the sensitization phase, the antigen is presented to the Langerhans cell and later to the T lymphocytes.[18] Thereafter, the antigen-specific T lymphocytes are formed and migrate to the epidermis.[18] Thereafter, the elicitation phase occurs during the reexposure of the antigen and the subsequent proliferation of the antigen-specific T lymphocytes.[18] Once an individual is sensitized to an allergen, allergic contact dermatitis usually develops within hours to several days of exposure.[19]

The histology of contact dermatitis is similar to that seen in eczema. Characteristic spongiosis (intracellular edema) is prevalent, and depending on the amount of spongiosis, intraepidermal vesicles are present.[20] As lesion chronicity progresses, acanthosis (thickened epidermis) becomes more predominant than spongiosis.[20] Although considered by some to be antiquated, the histologic variations seen in contact dermatitis may also be classified by the form of contact dermatitis the patient has on presentation as acute, subacute, or chronic.

These histologic characteristics of contact dermatitis are nearly inclusive of the histologic changes reported with pacemaker dermatitis. Yamauchi et al[21] reported finding mild spongiosis, intracellular edema, moderate acanthosis, and perivascular infiltration. Similarly, Weiss[10] found mild spongiosis and lymphohistiocytic perivascular infiltrate, and Brun and Hunziker[2] identified a histiocytic infiltrate with slight spongiosis and acanthosis. Other findings identified in the reports included a granulomatous infiltrate, an epithelioid dermal infiltrate, and a foreign-body giant-cell reaction.[23-25]

DIAGNOSIS OF PACEMAKER DERMATITIS

Pacemakers may contain a variety of allergic components. It is this variety of components that has complicated testing for allergens. Hayes and Loesl[12] noted that testing for pacemaker dermatitis is sophisticated and must be done correctly. Even correct testing, however, may not reveal allergens.[3]

The most important initial diagnostic tool is awareness of pacemaker dermatitis and its cutaneous features. Once pacemaker dermatitis is considered, the clinician will be able to use the proper testing for diagnosis. Diagnosis is generally made by patch testing. Published cases have used multiple patch tests, including the standard series, metal series, and plastic series, according to the guidelines of the North American Contact Dermatitis Group.[8,26] Some patch tests have been tested on patients outside the United States and may not be commercially available in the United States.

Other patch tests for pacemaker dermatitis include the Finn Chambers on Scanpor tapes, the International Contact Dermatitis Research Group series, and the European standard series of allergen tests, as well as pacemaker component–specific patch tests that usually can be obtained from the pacemaker manufacturer.[6,19]

Selecting the proper patch test is critical. Patch tests must test the exact material of the pacemaker components. This task is accomplished by tracking the exact manufacturing lot of the pacemaker and pacing leads, then ensuring that all the pacemaker components and their materials are identified.[12] Without testing all the components, a potential allergen may be missed.

The next consideration is the duration of patch testing. Although patch testing customarily takes 24 to 48 hours, reactions may not occur during this time frame and potential allergens may be missed.[23] Iguchi et al[23] reported a reaction to a pacemaker that did not occur within the customary time frame but, rather, 5 days later. As a better alternative, the duration of total application time of the patch on the skin should be from 48 hours to 5 days.[3]

Another alternative is to perform 2 readings, with the first reading at the initial 48-hour inspection and the second reading from 4 to 7 days.[17] This second reading is especially important in elderly patients who receive pacemakers, as an allergic reaction may take longer to occur in such patients.[17]

Caution should be placed in relying solely on patch tests. Iguchi et al[23] obtained a negative patch test in half of the cases of pacemaker dermatitis in their study. Déry et al[3] noted that 6 of 17 patch tests were negative in patients whose symptoms resolved after pacemaker removal. Also, corticosteroid use may cause a false-negative patch test.[4] It is important to note that although a positive test is helpful, a negative test should not be used to definitively rule out contact dermatitis.

Another consideration is that not all metals can be properly tested. Brun and Hunziker[22] reported that patch testing for titanium, a common allergen in pacemakers, was unreliable because it was performed using a salt solution of titanium tetrachloride, which must be highly diluted with water and quickly hydrolyzes to insoluble titanium dioxide. A positive patch test for nickel has been seen in up to 20% of the general population.[3]

A complement to patch testing may be intracutaneous and lymphocyte-stimulation testing. Yamauchi et al[21] described a patient who had no reaction to patch testing for titanium. As an alternative, the authors extracted the patient's serum and kept small pieces of titanium in the serum for one month, after which they used the patient's incubated blood for intracutaneous and lymphocyte-stimulation testing. Positive sensitivity to titanium was shown in both tests, leading the authors to conclude that these intracutaneous and lymphocyte-stimulation tests were more reliable than patch tests.

A definitive way to diagnose pacemaker dermatitis after patch testing is by either replacing the pacemaker with one containing nonallergenic components or completely insulating the existing pacemaker. Lesion resolution strongly indicates that lesions are associated with pacemaker dermatitis.

MANAGEMENT OF PACEMAKER DERMATITIS

After pacemaker dermatitis is diagnosed via careful, comprehensive testing, its management is considerably much less complicated. Topical steroids have been shown to improve some symptoms (eg, erythema, plaques, vesicles, and swelling), but lesion recurrence is common.[4,7,15] Additionally, chronic use of topical steroids may cause skin atrophy and pigmentation changes.[27] Antihistamines do not resolve lesions but do help reduce some symptoms.[3] A systemic corticosteroid may be tried if these therapies fail; it may be more efficacious but should not be used long-term because of its extensive adverse-reaction profile.[15] Various immunosuppressant agents, including topical tacrolimus and pimecrolimus, have been shown to effectively treat atopic dermatitis, allergic contact dermatitis, and perioral dermatitis.[27-29] For these reasons, immunosuppressant agents may be deemed an effective treatment of pacemaker dermatitis.[15] It should be noted, however, that both tacrolimus and pimecrolimus have reportedly caused allergic contact dermatitis.[30,31]

Currently the only truly effective treatment is removing the allergen by replacing the pacemaker or coating the existing pacemaker. If the solution is to replace the pacemaker, the new pacemaker must be patch tested completely before placement. If coating the pacemaker is the solution, the pacemaker must be completely coated with a patch-tested, nonallergic material. Incomplete coating may cause continued pacemaker sensitivity after reinsertion.[3,11] Effective coating materials include gold, silicone, parylene, and a 0.2-mm-thick polytetrafluoroethylene (PTFE) sheet. Tamenishi et al[4] applied a 0.2-mm-thick PTFE sheet

to the entire pacemaker except for the tip and ring electrode. Their patient had prior episodes of contact dermatitis with skin necrosis around the pacemaker site and had been subjected to multiple pacemaker reimplantations. A 6-month follow-up showed no recurrence of contact dermatitis.[4]

Although Tamenishi et al[4] found that PTFE sheets were effective in protecting against contact dermatitis and noted that in Japan PTFE was considered to be efficacious, they cautioned that allergies to PTFE were possible. Careful, comprehensive testing must be employed with all coating materials, as some of these materials are known to be allergens or have not been used often enough to determine whether they may be potential allergens.[3,4,23]

CONCLUSION

Although first described nearly 40 years ago, pacemaker dermatitis is a relatively unknown dermatologic disease but carries considerable consequences if not diagnosed early and accurately. In addition, a patient's best interests are compromised, including their time and money. Thus, awareness of pacemaker dermatitis cannot be overstated. Equally important is the establishment of an early working relationship between the cardiologist and dermatologist to ensure that the proper diagnosis be made and the most effective treatment is provided. With these simple steps, the rarely documented consequences of pacemaker dermatitis may become even more rare.

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