Original Article

Documented Contact Allergy Impacts Risk for Surgical Adhesive–Associated Contact Dermatitis after Shoulder Arthroplasty

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Purpose: The purpose of this study is to report on the incidence and risk factors for allergic contact dermatitis (ACD) in patients who received Prineo after total shoulder arthroplasty (SA). **Methods:** A retrospective case–control study was conducted to investigate patients who experienced ACD after having SA by a single surgeon during a defined period when Prineo was routinely used as an adjunct to wound closure. Known risk factors for ACD (e.g., history of contact dermatitis, smoking) were analyzed for association development of Prineo-associated ACD using Fisher exact and Wilcoxon rank sum tests. **Results:** From June 2019 through July 2021, 236 consecutive patients were identified as having Prineo applied after SA. Nine cases of Prineo-ACD (3.8%) were documented, whereas 227 patients were unaffected. In all 9 affected patients, the complication was identified and treated without compromising the outcome of the SA. Previous allergy to medical adhesives was a statistically significant risk factor for Prineo-associated ACD in this series ($P = .01$). The odds of having Prineo-associated ACD among those with adhesive or contact allergy was 38.5 times that of their nonallergic counterparts in a multivariate model. **Conclusions:** Prineo adhesive ACD had an incidence of 3.8% in this study, and a history of adhesive or contact allergy was highly associated with its development. **Level of Evidence:** Level III, case–control study.

Skin adhesive closure systems have become increasingly popular in elective orthopaedic surgery procedures since their approval by the Food and Drug Administration in 1998.[1,2] Although there are many advantages to using medical adhesives, allergic contact dermatitis (ACD) has been on the rise since their introduction.[3,4] ACD is a type IV delayed hypersensitivity reaction that usually occurs 5 to 14 days after contact with the offending agent.[5] Recent studies in the orthopaedic literature have raised concerns about medical adhesive–associated ACD.[5-10]

In 2014, Ethicon introduced Dermabond Prineo (Ethicon, Bridgewater, NJ),[2] a closure system that uses the combination of a liquid adhesive containing 2-octyl cyanoacrylate with a self-adhesive polyester mesh.[2] Following the closure of an incision with a running stitch, the mesh is placed over the incision and is coated with the liquid adhesive to create an antimicrobial and waterproof seal.[1,11] Prineo has several purported benefits described by the manufacturer: decreasing the need for additional dressings, the appearance of scars, and the risk of postoperative infection and wound-healing complications.[11] Like any medical adhesive, Prineo may cause ACD. In particular, a dramatic case report published in 2020, illustrating a severe and progressive reaction to Prineo that required debridement and skin grafting, raised awareness for the authors about this particular complication.[12]

ACD following orthopaedic procedures and Prineo application can easily be confused with cellulitis and other surgical-site infections.[3] Furthermore, early identification and treatment of ACD can significantly impact wound healing and improve clinical outcomes.[13] Lastly, risk factors for ACD have previously

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been identified, and further characterization of these might be beneficial in helping patients and surgeons manage this risk in shoulder surgery. The purpose of this study is to report on the incidence and risk factors for ACD in patients who received Prineo after total shoulder arthroplasty (TSA). The study hypothesis was Prineo-ACD would be associated with a history of adhesive allergy.

Methods

A retrospective case–control study was conducted by 2 independent reviewers (D.O., V.M.) using a defined time period (June 5, 2019, to July 7, 2021) during which Prineo was used as a wound closure method for the majority of shoulder arthroplasties by a single, fellowship-trained arthroplasty shoulder surgeon. The study was designated as institutional review board exempt. Potential patients were identified and screened by searching for Current Procedural Terminology codes 23470, 23472, 23473, and 23474 during the study period using AthenaOne, a cloud-based electronic medical record.

Operative reports and nursing records were then used to identify the final wound closure method used. All patients who had Prineo were closed with a running, 3-0 MONOCRYL suture (Ethicon) in the subcuticular layer, and an occlusive dressing (Mepilex; Molnlycke Healthcare, Gothenburg, Sweden) was placed over the Prineo after curing. Patients who had other closure systems applied to their wound (e.g., incisional wound vac, Steri-Strips, Dermabond) were excluded from the study. Prineo-associated ACD was determined clinically by the surgeon (R.H.). Demographic information and known risk factors for ACD were collected, including smoking history, current allergies, and medical history of ACD. Complications documented from any postoperative visits were noted.

Statistical Methods

Statistical analyses were conducted using SAS 9.4 software (SAS Institute, Cary, NC). Continuous variables are reported as medians and standard deviations. Categorical and ordinal variables are reported as percentages. The Fisher exact test was used to assess the relationship between Prineo ACD and the categorical variables of interest, whereas the Wilcoxon rank sum test was used to assess age since this was not normally distributed. A multivariate model using exact logistic regression was used to model Prineo ACD and variables of interest simultaneously to control for potential confounding variables. Significance was set to 5%.

Results

During the study period, 269 shoulder arthroplasties were performed. Thirty-three had closure methods other than the Prineo system (e.g., adhesive bandage strips, incisional wound vacuum system) and were excluded. Table 1 shows demographic and surgical data for the 236 included patients. Eight patients were current smokers, and 4 patients had an allergy or previous reaction to adhesives.

Table 1. Demographics and Surgical Data for Included Study Patients

Shoulder arthroplasty	
Hemiarthroplasty	3
TSA	208
Revision TSA	25
Total	236
Age, y*	72 [70.1-72.4]
Female (%)	126 (53)
Male (%)	110 (44)

TSA, total shoulder arthroplasty.
*Median [95% confidence interval].

Nine patients (3.8%, confidence interval 1.76-7.12) developed Prineo-associated ACD (Fig 1). In the univariate analysis (Table 2), only allergy or previous reaction to adhesives (N = 2, 22%) was associated with ACD ($P = .0075$). Current tobacco use was not reported in any of the patients with Prineo-associated ACD. Age was not associated with Prineo ACD ($P = .2$). In the multivariable model, the odds of having Prineo-associated ACD was 38.5 times (confidence interval 2.3-667) that of their nonallergic counterparts ($P = .01$). In all 9 affected patients, ACD was treated using topical steroids, on oral antihistamine and prophylactic antibiotics with complete resolution and without compromising the outcome of the TSA.

Thirteen patients (5.3%) developed complications not associated with Prineo application. These other complications included small postoperative hematomas requiring only observation (N = 10), superficial wound infections treated with oral antibiotics (N = 2), and postoperative acromion fracture (N = 1).

Discussion

The current study confirmed our hypothesis that history of adhesive allergy or contact dermatitis was a clinically relevant and statistically significant risk factor for the development of Prineo-ACD.[5] In comparing the 3.9% incidence of Prineo-ACD in the current study with that reported in the literature, the authors find this to be high. Chalmers et al.[5] reported a Dermabond Prineo-associated ACD incidence rate of 0.5% and predicted a 0.5% to 2% incidence of medical adhesive-associated ACD in patients in whom the dressing is used. One possible explanation is the use of Prineo with an occlusive dressing in the current series, which is a known risk factor for adhesive-associated ACD.[6]

In the current study, age was not associated with Prineo-ACD, which is not surprising, given the narrow age distribution of patients in the study. Atwater et al.[7]

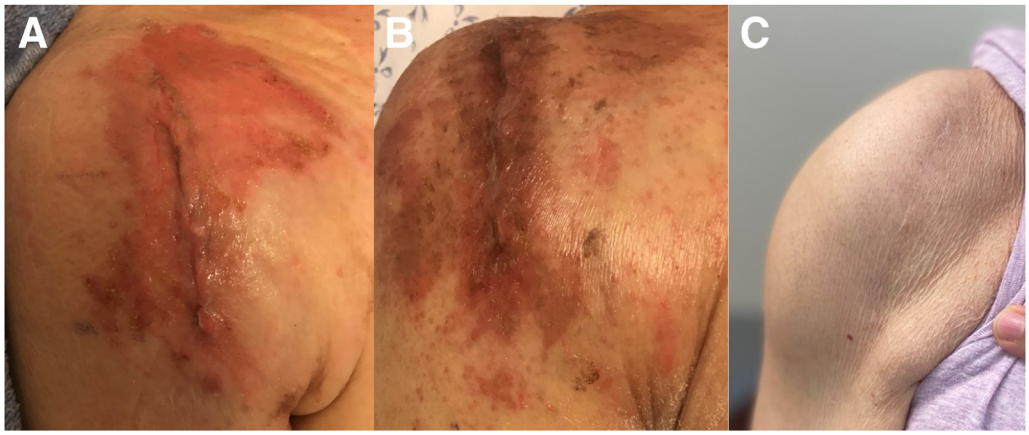

Fig 1. Anterolateral view of right shoulder allergic contact dermatitis secondary to Prineo dressing in a patient status post reverse shoulder arthroplasty (A) 10 days, (B) 14 days, and (C) 1 year.

performed one of the largest reviews of medical adhesive–associated ACD and found that patients younger than the age of 40 years were most likely to present with ACD following medical adhesive application. In 2017, the national average age of patients who underwent TSA was 67.4 years,[14] whereas the median age of the Prineo-associated ACD group in this study was 72 years. Thus, it is possible that the incidence of Prineo-associated ACD in a general shoulder arthroplasty population could be lower than the incidence rate found in this study.

In contrast with our finding of association with allergy history, Pate and Neumeister[12] reported in 2020 that a history of previous reactions to medical adhesives was not seen in their medical adhesive–associated ACD cases. The authors' current clinical practice is similar to that reported by Pate and Neumeister in that specific querying of patients about adhesive allergy history is not routine. In addition, the current study did not find a significant association between Prineo-associated ACD and female sex in contrast with prior studies.[5-10] These differences between in risk factor associations could be due to sampling errors or underpowering.

Prineo-associated ACD is interesting in that primary sensitization may occur during the administration of Dermabond (Ethicon) and/or other medical skin adhesives that contain acrylates.[5-10] The results of our study reveal the importance of eliciting a detailed allergy history for these agents for the surgeon who uses an adhesive closure system routinely.

Table 2. Univariate Analysis

Characteristic	Total	No ACD N = 227	Prineo ACD N = 9	Fisher Exact *P*
Sex				
Female	126	120	6	.51
Male	110	107	3	.51
Adhesive allergy				
None	232	225	7	.01
Present	4	2	2	.01
Current smoker				
None	228	219	9	1
Yes	8	8	0	1
Other complication				
None	223	215	8	.4
Present	13	12	1	.4
Revision surgery				
None	211	204	7	.24
Present	25	23	2	.24

ACD, allergic contact dermatitis.

Limitations

The current study is subject to the limits of retrospective research, including recall bias. The use of electronic medical record systems that were not intended for data collection can leave room for human error and gaps in information.[15] Our patients' medical history and ACD risk factors were self-reported. The authors neither performed allergy testing before surgery to determine Prineo-associated ACD risk nor allergen testing post-ACD to determine the etiology of each patient's ACD. Lastly, there is a risk of type 2 error and power limitations from an underpowered study.

Conclusions

Prineo adhesive ACD had an incidence of 3.8% in this study, and a history of adhesive or contact allergy was highly associated with its development.

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