Original paper

Topical administration of mupirocin ointment and fusidic acid in bacterial infection-induced skin diseases

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Abstract

Introduction: Bacterial skin diseases have strong virulence to penetrate deep into the skin.
Aim: To evaluate the therapeutic effects of 2% mupirocin ointment and 2% fusidic acid cream on bacterial skin diseases and their safety.
Material and methods: One-hundred patients with bacterial skin diseases treated from May 2021 to May 2024 were randomly divided into a control group and a treatment group (n = 50) and they were given 2% mupirocin ointment and 2% fusidic acid cream, respectively. The skin injury areas, eczema area and severity index (EASI) scores, therapeutic effects and adverse reactions were compared before and after two courses of medication. The antibacterial activities of these two drugs against *Staphylococcus epidermidis* and *Propionibacterium acnes* were detected by the agar diffusion method.
Results: After treatment, the EASI and itching scores of both groups significantly decreased compared with those before treatment (t = 30.804, 19.018, p < 0.001; t = 24.594, 12.680, p < 0.001), and the treatment group had significantly lower scores than those of the control group (p < 0.05). The overall effective rate of the treatment group (96.00%) was higher than that of the control group (90.00%) (p > 0.05), and the distribution of therapeutic effects of the treatment group was significantly better (p < 0.05). The two groups had similar incidence rates of adverse reactions (χ^2 = 1.0147, p = 0.3074) that were remitted without additional therapy. Both mupirocin ointment and fusidic acid cream had clear inhibition zones for *S. epidermidis*, with similar diameters (31.69 ±7.12 mm vs. 31.78 ±6.54 mm, t = 0.0949, p = 0.9245). However, only fusidic acid cream had an obvious inhibition zone for *P. acnes* on reinforced Brucella agar plate.
Conclusions: The therapeutic effects of fusidic acid cream on bacterial skin diseases were superior to those of mupirocin ointment.

Key words: bacterial infections, fusidic acid, itching, mupirocin, skin diseases.

Introduction

Bacterial skin diseases are mainly caused by a variety of pathogenic bacteria such as staphylococci and streptococci, which have strong virulence to penetrate deep into the skin [1]. They are clinically manifested as pain, redness, swelling and abscess. If patients are not treated promptly and effectively, they are prone to lymph node swelling and fever, thereby causing death and seriously threatening their life and health [2, 3]. In recent years, the infection rate of bacterial skin diseases has risen yearly, which is related to the increase of antibiotic-resistant strains that are mainly divided into primary and secondary diseases [4]. The former refers to normal skin bacterial infection caused by a single pathogen, and the latter is caused by various pathogenic bacteria [5].

At present, the diseases are commonly treated with mupirocin ointment and fusidic acid cream [6]. Besides, traditional Chinese medicine component saikosaponin has also been reported to exert antibacterial effects [7]. As an antibiotic, fusidic acid was first extracted from the fermentation broth of the fungus *Fusidium coccineum* in the 1960s [8]. It can interfere with elongation factor G by inhibiting ribosome translocation to prevent the synthesis of bacterial proteins. This mechanism of action avoids cross-resistance to other antibiotics [9]. In clinical practice, fusidic acid is often used to treat wound infection, paronychia and skin soft tissue infection. As a topical antibacterial agent, mupirocin can specifically bind bacterial isoleucyl-RNA synthetase, thereby blocking the supply of isoleucine, inhibiting bacterial protein synthesis and promoting bacterial death [10].

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Aim

We herein compared the therapeutic effects of 2% mupirocin ointment and 2% fusidic acid cream on bacterial skin diseases, aiming to provide valuable evidence for clinical medication.

Material and methods

Subjects

This prospective study was approved by the ethics committee of our hospital (approval No. CHNMU202105003), and written consent was obtained from the guardians of all children. One hundred patients with bacterial skin diseases treated in our hospital from May 2021 to May 2024 were enrolled. Inclusion criteria: Children with bacterial skin diseases diagnosed by bacterial culture. Exclusion criteria: 1) Children with skin area of > 25 cm^2; 2) those complicated with severe dysfunction of vital organs such as the heart and kidney; 3) those complicated with severe nervous or endocrine diseases; 4) those allergic to mupirocin ointment or fusidic acid cream; 5) those who used antibiotics within 48 h. The patients were randomly divided into a treatment group and a control group (n = 50).

Experimental strains

A standard stain of *Staphylococcus epidermidis* (ATCC1288) and that of *Propionibacterium acnes* (ATCC6919) were provided by National Institutes for Food and Drug Control (China). A total of 104 *S. epidermidis* strains and 61 *P. acnes* strains were isolated from 70 cases with common acne (40 boys and 30 girls). Fusidic acid cream was purchased from LEO Laboratories Ltd. (Ireland). Mupirocin ointment was bought from Sino-American Tianjin SmithKline & French Laboratories (China).

Treatment methods

Before treatment, the skin injuries of both groups were washed with normal saline. Then the treatment group was given 2% fusidic acid cream, three times daily. The control group was treated with 2% mupirocin ointment, three times daily. The cream or ointment was evenly applied onto the injured skin. Seven days were set as a course of medication, and both groups were continuously treated for two courses.

Evaluation of outcomes

Assessments of skin injury area, eczema area and severity index (EASI) score

The severity of the signs of skin injuries was graded in terms of erythema, oedema, excoriation and lichenification. The severity of each of the four signs was assessed on a scale of 0–3 points, corresponding to none, mild, moderate and severe, respectively [11].

Assessment of itching score

Itching sensation was evaluated on a scale of 0–3 points, corresponding to none, occasional, continuous and intense, respectively [12].

Evaluation criteria for therapeutic effects

Cured: All foci vanished and recovered to normal appearance, with negative bacterial culture results; markedly effective: > 70% of foci disappeared, with negative culture results; effective: 30–70% of foci disappeared, but with positive culture results; ineffective: < 30% of foci or almost none disappeared and even increased, with positive culture results. Overall effective rate = cured rate + markedly effective rate + effective rate [13].

Detection of in vitro antibacterial activities

The turbidity of *S. epidermidis* suspension was adjusted to 0.5 McFarland, and that of *P. acnes* suspension was adjusted to 1.0 McFarland.

Culture medium of *S. epidermidis*: Mueller–Hinton agar medium was autoclaved, cooled to 45°C, the prepared bacterial suspension (20 ml of medium, 2 ml of bacterial suspension) was added, mixed well, poured into a 90 mm sterile Petri dish to obtain the bacteria-containing medium, and naturally dried on a sterile table.

Culture medium of *P. acnes*: reinforced Brucella agar (43 g of Brucella agar powders, 1 ml of hemin stock solution and 1 ml of vitamin K1 working solution were added to 1000 ml of distilled water) was autoclaved, cooled to 45°C, 50 ml of sterilized defibrinated sheep blood and the suspension of *P. acnes* (20 ml of medium, 2 ml of bacterial suspension) were added, thoroughly mixed, poured into a 90 mm sterile Petri dish to obtain the bacteria-containing medium, and naturally dried on a sterile table.

Antibacterial activity detection: two holes with the diameters of 3 mm were made on the medium, and then fusidic acid cream and mupirocin ointment were added, respectively. *S. epidermidis* was cultured in an aerobic environment at 37°C for 24 h, and *P. acnes* was cultured for 48 h in an anaerobic environment. Subsequently, the inhibition zone around each hole was observed, and the diameter was recorded.

Statistical analysis

All data were analyzed by SPSS 21.0 software (IBM Inc., USA). The measurement data were expressed as mean ± standard deviation. The clinical data between groups were compared by the t test, and *in vitro* experiments were subjected to the paired t test. The count data were expressed as percentage. Intergroup comparisons were performed by the χ^2 test. $P < 0.05$ was considered statistically significant.

Results

Baseline clinical data

The treatment group consisted of 32 boys and 18 girls aged 2–18 years old (14.78 ±4.74) on average. There were 21 cases of folliculitis, 17 cases of purulent acne, 8 cases of wound infection and 4 cases of paronychia. The control group comprised 31 boys and 19 girls aged 2–18 years old, with the mean of (14.85 ±4.79). There were 22 cases of folliculitis, 16 cases of purulent acne, 9 cases of wound infection and 3 cases of paronychia. The two groups had similar baseline clinical data ($p > 0.05$).

ESAI scores before and after treatment

Before treatment, the two groups had similar EASI scores ($p = 0.947$) (Table 1). After treatment, the scores of both groups significantly decreased compared with those before treatment ($t = 30.804$, 19.018, $p < 0.001$). The treatment group had a significantly lower score than that of the control group ($p < 0.001$), indicating that 2% fusidic acid cream was superior to 2% mupirocin ointment for relieving skin injury.

Itching scores before and after treatment

Before treatment, the two groups had similar itching scores ($p = 0.910$) (Table 2). After treatment, the scores of both groups significantly decreased compared with those before treatment ($t = 24.594$, 12.680, $p < 0.001$). The treatment group had a significantly lower score than that of the control group ($p < 0.001$), suggesting that the anti-itching effects of 2% fusidic acid cream surpassed those of 2% mupirocin ointment.

Overall effective rates after two medication courses

The overall effective rate of the treatment group (96.00%) was slightly higher than that of the control group (90.00%) ($p = 0.240$) (Table 3). However, the distribution of therapeutic effects of the treatment group was significantly better ($p < 0.05$).

Drug adverse reactions

The treatment group had 1 case of burning sensation, and the incidence rate of adverse reactions was 2.00%. The control group had 1 case of red rash and 2 cases of local burning sensation, and the incidence rate was 6.00%. The adverse reactions were remitted without additional therapy, and the two groups had similar incidence rates ($\chi^2 = 1.015$, $p = 0.307$).

Inhibition zones for *S. epidermidis*

Both mupirocin ointment and fusidic acid cream had clear inhibition zones for *S. epidermidis*, with similar diameters (31.69 ±7.12 mm vs. 31.78 ±6.54 mm, $t = 0.095$, $p = 0.925$).

Inhibition zones for *P. acnes*

On reinforced Brucella agar plates, only fusidic acid cream had an obvious inhibition zone for *P. acnes*, with the diameter of 18.21 ±4.14 mm. Thus, mupirocin ointment barely inhibited the growth of *P. acnes*.

Discussion

This study compared the effects of mupirocin ointment and fusidic acid cream on the treatment of bacterial skin diseases. Narayanan *et al*. reported that bacterial skin diseases are mainly caused by staphylococcus and streptococcus [14]. Mupirocin ointment is a broad-spectrum antibiotic, with obvious effects on *Streptococcus viridians*, *S. epidermidis* and *Staphylococcus aureus* [15]. Nevertheless, the long-term effect of mupirocin ointment is not obvious [16]. Fusidic acid, which belongs to a non-broad-spectrum antibiotic, has evident antibacterial activities against *S. epidermidis* and *Corynebacterium parvum* [17]. It can penetrate the surface layer quickly to

Table 1. ESAI scores before and after treatment

Group	Before	After	*t*	*P*-value
Treatment (*n* = 50)	10.13 ±1.78	2.11 ±0.47	30.804	< 0.001
Control (*n* = 50)	10.09 ±1.83	4.83 ±0.69	19.018	< 0.001
t	0.066	23.038		
P-value	0.947	< 0.001		

Table 2. Itching scores before and after treatment

Group	Before	After	*t*	*P*-value
Treatment (*n* = 50)	2.71 ±0.43	1.03 ±0.22	24.594	< 0.001
Control (*n* = 50)	2.70 ±0.45	1.74 ±0.29	12.680	< 0.001
t	0.114	13.792		
P-value	0.910	< 0.001		

Table 3. Distribution of therapeutic effects after two medication courses

Group	Cured	Markedly effective	Effective	Ineffective	Overall effective rate
Treatment (*n* = 50)	31 (58.00)	11 (26.00)	6 (12.00)	2 (4.00)	48 (96.00)
Control (*n* = 50)	21 (42.00)	16 (32.00)	8 (16.00)	5 (10.00)	45 (90.00)
t	4.006	1.268	0.332	1.383	1.383
P-value	0.045	0.260	0.564	0.240	0.240

remove bacteria, and has strong selectivity to *S. aureus*, with a fast onset. Therefore, fusidic acid is an ideal drug for treating bacterial skin infection [18].

We herein found that the EASI score and the degree of itching were significantly different between the two groups after treatment, being consistent with the findings of the previous literature [19]. After two medication courses, the total effective rate of the treatment group was slightly higher than that of the control group, but the difference was not statistically significant. In terms of effect distribution, the cured rate of the treatment group was significantly higher than that of the control group. The results were basically in agreement with those reported before [20]. Probably, fusidic acid had the advantage of a lower likelihood of developing resistance than mupirocin, especially in long-term use [21]. Moreover, there was no significant difference in the incidence rates of adverse reactions between treatment and control groups, and all of them were relieved by themselves. Hence, fusidic acid cream had a better effect than mupirocin ointment on the treatment of bacterial skin diseases, also with high safety [22, 23].

We also verified by *in vitro* susceptibility test that fusidic acid cream effectively inhibited *S. epidermidis* and *P. acnes* at the lesion, while mupirocin ointment only had an inhibitory effect on *S. epidermidis* at the lesion. Possibly, mupirocin ointment had a strong inhibitory effect on aerobic Gram-positive bacteria, but no effect on anaerobic bacteria [24, 25].

Conclusions

Compared with mupirocin ointment, fusidic acid cream had a higher cured rate for bacterial skin diseases, and better relieved pain and itching, with fewer adverse reactions and higher safety. Hence, it is worthy of promotion and application in clinical practice.

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Ethical approval

This study has been approved by the ethics committee of our hospital, and written consent has been obtained from the guardians of all children.

Conflict of interest

The authors declare no conflict of interest.

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