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Case Series

Effectiveness of polyhexamethylene biguanide dressings vs. platelet-rich plasma in diabetic foot ulcer: a pilot study of case series

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ABSTRACT

Diverse treatments, including polyhexamethylene biguanide dressings, have been explored for managing diabetic foot ulcers. Platelet-rich plasma, known for its potential in chronic wound healing, has demonstrated efficacy both in vivo and in vitro, with possible intralesional or topical application. However, research on the production costs of PRP is scarce. This study compares the effectiveness and financial implications of polyhexamethylene biguanide dressings versus Platelet-rich Plasma in the treatment of diabetic foot ulcers. Conducted at the General Hospital of Mexico from July to August 2019, this case series involved 8 patients, split equally between the two treatment groups. Weekly assessments showed consistent reductions in wound size in both groups. By the fourth week, 75% of patients achieved clinical healing. The PHMB group demonstrated a 75.13% reduction in wound size, compared to a 37.38% reduction in the PRP group. However, due to the small sample size, no statistical significance was found between wound size, healing time, and dressing type. This report suggests no clear relationship between treatment, healing duration, and wound diameter. Additionally, PRP did not show a clear financial advantage over PHMB dressings. Randomized control trials with sufficient sample sizes are required to demonstrate overall advantage for each therapy choice.

Keywords: Polyhexamethylene biguanide dressings, Platelet-rich plasma, Diabetic foot ulcer

INTRODUCTION

In 2017, the worldwide prevalence of Diabetes mellitus was estimated at 8.8%, highlighting its significant global impact.[1,2] Diabetic patients often face severe complications that influence mortality rates, with diabetic foot ulcers (DFU) being a primary concern.[2-5] It is estimated that 15% of individuals with diabetes will experience a foot ulcer during their lifetime, and of these cases, 14 to 24% will necessitate amputation.[6,7] DFU poses a substantial public health challenge, leading to severe disability, economic losses, and necessitating specialized care.[8,9] The prevalence of DFU varies regionally, averaging globally at 6.4%. This prevalence is higher in men compared to women.[2,10] A variety of dressings have been explored for DFU management, including those composed of Polyhexamethylene Biguanide (PHMB). PHMB dressings exhibit effectiveness against a range of pathogenic microorganisms, including methicillin-resistant strains

and have been shown to outperform conventional dressings by reducing bacterial proliferation at various stages of lesion treatment.[11-18] Platelet-rich plasma (PRP), proposed for chronic wound healing and demonstrated to be efficient in vitro, can be applied intralesionally or topically.[19-22] However, research on the cost of PRP production is scarce, with some studies focusing on economic aspects, estimating the cost per kit and session at an average of €132.90. This cost analysis could significantly impact clinical decision-making.[22,23] This study evaluates the cost-effectiveness of PRP versus PHMB dressings in managing chronic wounds in DFU patients.

CASE SERIES

This case series involved a study conducted at the General Hospital of Mexico from July to August 2019, focusing on patients with diabetic foot ulcers (DFU). All adult patients diagnosed with DFU according to the Texas University classification were considered eligible for participation. Following the acquisition of informed consent, we used a baseline measurement instrument to evaluate the prognostic factors and clinical characteristics of the wounds.[24] The study included a total of 8 patients. We employed a straightforward randomization method for allocating patients to the intervention groups, utilizing SPSS v.25 (Statistical Package for the Social Sciences) software for this purpose. Patients were assigned to either the treatment group, receiving intralesional platelet-rich plasma, or the control group, treated with Polyhexamethylene Biguanide dressings, and then covered with gauze and microporous tape. Both groups underwent diabetic foot ulcer treatment adhering to national and international guidelines, which encompassed wound care procedures such as debridement, cleansing with 1% Benzalkonium Chloride, and irrigation using 0.9% saline solution. The autologous PRP for the treatment group was obtained following a standard technique.[25] We monitored the progression of wound healing in our patients through weekly assessments over four weeks.

Table 1: Demographic information and healing progression of the patients by week and final healing percentage.

Parameters	Case	Control	Total	P value*
Sex (M/F)	2/2	1/3	3/5	0.670
Age	62.25±23.7	58.75±15.6	60.5±18.7	0.426
Weight (kg)	60±10.7	83.25±22.11	71.63±20.33	0.273
Hight (M)	1.63±0.11	1.65±0.14	1.64±0.12	0.151
BMI	22.37±2.98	30.25±4.7	26.31±5.57	0.348
Wound size (mm)				
Week 1	1685±1611.08	730±891.22	-	0.511
Week 2	1451.25±1453.67	556.25±638.48	-	0.604
Week 3	1406.6±952.9	344±566.33	-	0.067
Week 4	1055±782.35	181.5±363	-	0.053
Healing %	37.38	75.13	-	-

*Chi-square test

To determine clinical healing, we adopted a criterion based on the surrogate endpoints established by Margolis et al which has been subsequently validated and extrapolated in recent studies.[26-30] Margolis et al comprehensive research, which included over 28,000 patients with diabetic foot ulcers, identified a 61% reduction in wound size at week four as a reliable predictor of complete wound healing at 20 weeks. In line with recent modeling efforts we adjusted this parameter to 50%, establishing a robust and evidence-based standard for evaluating the healing trajectory of wounds under our care.[27-30] Data are presented as mean±SD, and statistical analyses were performed using the Chi-square exact test, Spearman correlation, and the Mann-Whitney-Wilcoxon test. All analyses were conducted using SPSS v.25, and p-values were adjusted according to the false discovery rate method for comparing the two groups. A confidence level greater than 95% ($p<0.05$) was considered statistically significant. The study encompassed 8 patients, distributed across both groups, with a gender distribution of 3 males (37.5%) and 5 females (62.5%). The (Table 1) provides a detailed overview of the demographics and progression.

Figure 1: Evolution of diabetic foot wound on the dorsum treated with Polyhexamethylene Biguanide dressings; A) Initial state, B) Fourth week of treatment.

The most frequently affected areas were the sole (37.5%), the back of the foot (37.5%), the heels (12.5%), and the legs (12.5%).

Figure 2: Evolution of diabetic foot wound treated with PRP; A) Initial state, B) Fourth week of treatment.

Figure 3: Evolution of diabetic foot ulcer wound on the second toe treated with Polyhexamethylene Biguanide dressings; A) Initial, B) Second week of treatment, 100% epithelialization.

Figure 4: Progression of diabetic foot ulcer on the sole treated with PHMB dressings; A) Initial, B) 4th week of treatment, A 63.7% reduction in wound size is observed.

We analysed and documented the duration of the evolution of each diabetic foot ulcer (DFU) until healing in both groups. Our weekly comparative analysis of wound size revealed a consistent reduction across both groups. By the fourth week, 75% of patients had achieved clinical healing of their wounds, showcasing improvement in all cases as per the wound triangle assessment. The control group, treated with PHMB dressings, demonstrated a more pronounced improvement, showing a 75.13% reduction in wound size from weeks 1 to 4, compared to a 37.38% reduction in the treatment group receiving intralesional PRP. Despite these observations, the differences between wound size, healing time, and type of dressing did not reach statistical significance. However, the Mann-Whitney-Wilcoxon test indicated a trend towards significance in weeks 3 ($p=0.077$) and 4 ($p=0.067$), a finding mirrored by the Spearman correlation test results for weeks 3 ($p=0.067$) and 4 ($p=0.053$).

DISCUSSION

Identifying a treatment that is not only effective but also offers a favourable cost-benefit ratio is crucial in clinical decision-making processes. In managing diabetic foot ulcers, both polyhexamethylene biguanide dressings and intralesional platelet-rich plasma treatments have demonstrated efficacy in promoting wound healing.[14-22] Nevertheless, there is a substantial gap in the existing literature regarding the comparative economic and clinical advantages of these two treatments in DFU management. This study contributes to the ongoing discourse on this issue, providing preliminary insights that can assist clinicians in their decision-making processes. In a 2016 meta-analysis, surgical debridement was compared to conventional management with simple dressings. A healing rate of 95% was reported in the surgical group, compared to 79.2% in the conventional group[2]. Our preliminary study demonstrated that the combined therapy of surgical debridement and application of advanced dressings achieved 100% healing in all 4 patients in the control group (Figure 1), compared to a healing rate of 66.7% in the experimental group (Figure 2). Regarding the healing time in the surgical group of the meta-analysis, a healing time of 46±39 days was observed, compared to 129±86 days in the conventional group.[2] These results contrast with our study, where 100% healing was achieved in 28 days in the group treated with PHMB dressings. With one patient achieving complete wound closure after 14 days of PHMB therapy (Figure 3). In a 2011 clinical trial, with a population and methodology similar to our study, at 4 weeks it was found that the group using PHMB had a mean reduction in wound surface area of 35% compared to 28% in the placebo group.[14] Our results support their findings as we observed that in 75% of the cases, wound closure was greater than 50% (Figure 4). Also, 100% of the controls achieved “clinical healing”, with 75% achieving complete epithelization.

The kit required for preparing PRP using a closed system centrifuge, along with the materials needed for up to 100 PRP doses, varies in price from USD 810 to USD 930 on the market. In contrast, the production of autologous PRP for topical use demands low-cost material resources for blood collection and centrifugation, amounting to USD 29.31±USD 1.63 for a protocol spanning six sessions.[31] In comparison, PHMB dressings, offer a more cost-effective solution. Each 10.2×10.2 cm dressing is priced at approximately USD 0.73 per piece.[32] When considering a regimen of four applications per patient, the expense ranges from USD 0.73 to USD 2.92 per session. Unlike other treatments, PHMB dressings do not necessitate the use of additional devices, and the application can be directly managed by the attending physician. This simplicity and cost-effectiveness make PHMB dressings a viable alternative in comparison to PRP treatments. During the study, 8 participants were scouted between July and December 2019, as outlined in the protocol. The limited number of participants was a consequence of the predetermined study duration. Given this temporal constraint, it became necessary to reassess the study's aim and methodology.

CONCLUSION

Considering the findings from this preliminary investigation, constrained by a limited participant number, it becomes apparent that there is no discernible correlation between the type of dressing applied, the healing duration, and the wound's diameter. Additionally, the financial implications of utilizing platelet-rich plasma in comparison to polyhexamethylene biguanide dressings did not showcase a clear benefit for PRP. It is imperative to recognize the limitations brought about by the small sample size of this study, as it hampers our ability to make broad generalizations or definitive conclusions regarding the efficacy and cost-effectiveness of the treatments under investigation. For a more robust validation of these findings and to acquire a comprehensive understanding of the most effective therapeutic approach, future research should include a larger patient population and take into consideration additional variables, such as wound infection rates. This approach would enable a more nuanced and informed choice of therapy, ultimately contributing to enhanced patient outcomes in the management of diabetic foot ulcers.

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