



HIGH- VOLTAGE PULSED CURRENT (HVPC) ELECTRICAL STIMULATION FOR TREATMENT OF DIABETIC FOOT ULCER (DFU) - A REVIEW

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ABSTRACT

Diabetes is a group of Metabolic Syndrome either because of insufficient insulin production or decreased response of body's cells to insulin or both. The sensory, motor and autonomic dysfunctions are commonly noted in Persons with Diabetes. Specifically blood flow will be altered because of the autonomic dysfunction following diabetes. This is the reason a diabetic individual has a risk of developing a diabetic foot ulcer (DFU), which leads to limb amputation. Apart from regular medical management, Physical Therapy treatment specially electrotherapy modalities has gained crucial importance in the management of DFU. Among those the contribution of High Voltage Pulsed Current (HVPC) is noteworthy. HVPC is a monophasic pulsed electric current that improves blood flow and capillary density. This review is carried out to examine whether the clinical use of HVPC is beneficial for healing of Diabetic foot ulcer. An electronic search was done in CINAHL, OVID, PubMed, Pro Quest, Science Direct, Ind Med, & Google Scholar from 1970 to 2016 that used HVPC as a electrical stimulation for diabetic foot ulcer treatment. Quality of the article was assessed by quality index score which consists of five domains with a highest score of 32. HVPC has been appears to be one of the best adjunctive therapy that is underutilized in the area of treatment of diabetic foot ulcer.

KEYWORDS: *Diabetic foot ulcer, Diabetic induced foot ulcer, Electrical stimulation, High Voltage Pulsed Current HVPC, Wound*



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Received on: 05-07-2017

Revised and Accepted on: 27-09-2017

DOI: <http://dx.doi.org/10.22376/ijpbs.2017.8.4.b360-364>



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INTRODUCTION

Diabetes mellitus (DM) is a global lifestyle disorder. Uncontrolled diabetes or without treatment it may lead to ulceration in the leg. A diabetic person has a 25% risk of developing a diabetic foot ulcer (DFU). Risk of going for amputation following DFU is one in every six patients². Since last few decades varieties of treatment for DFU has emerged, including pharmacological and non pharmacological like electrical stimulation. Types of electrical stimulation which is commonly used in treatment of chronic wounds are (figure 1)³. HVPC is a monophasic pulsed electric current. As the term says high voltage so it may go up to 500V, with a frequency of 1-125pulse/sec. that consists of double-peaked impulses (5–200 μ s). HVPC is capable of improving blood flow and capillary density. However, there is a use of HVPC as a adjunct of choice for DFU is rare. There is a lack of literature reviewing clinical use of HVPC and the healing of Diabetic foot ulcer. Therefore this review is design in such a way to focus the evidence regarding use of HVPC in DFU.

METHODS

SEARCH STRATEGY

An electronic search was done in CINAHL, OVID, PubMed, ProQuest, Science Direct, Ind Med, & Google Scholar from 1970 to December 2016. Search terms used were diabetic foot ulcer, electrical stimulation and high voltage pulsed current electrical stimulation. The Boolean terms used in the same search were "AND", "OR", "WITH".

Number of articles searched - 140

Types of Studies included :

English language articles, involving human subjects.

RCTs

Types of Intervention- HVPC

Outcome measure: Ulcer Size or healing rate

Foreign language articles and animal studies, and article with wound other than diabetic origin were excluded.

Number of articles selected - 29

Number of articles included - 03

A summary of the selection of articles has been

Projected as per the PRISMA guidelines (Figure 2). The review protocol was registered in the PROSPERO (CRD42016043729)

DATA EXTRACTION

For collection of data, two review authors independently screened each article, abstracted primary and secondary data. Checklist for measuring study quality was assessed using the Downs and Black Quality Index⁴. The scale has five domains with total score of 32, which include reporting (11), external validity (3), bias (7), confounding (6), and power (5). Any disagreements while extracting and analysing the data were solved by consensus or third author. Data were

collected and analysed as a descriptive pattern. No meta-analysis or Forest plot analysis done due to heterogeneity in data and this is one of the limitation of this study which is described under the limitation column.

RESULTS AND DISCUSSION

Total of 140 studies from which 03 were finally included in this review based on inclusion and exclusion criteria. A summary of all this is projected in {Table 1}. The Quality Index Score details of all study which is included for review is listed out in {Table 2}. There are several trials which investigate electrical stimulation use in ulcer with good evidence however trial specifically targeting diabetic wound is limited in number. Few studies with target population are diabetic but their type of electrical stimulation varies in wide range between direct, alternate and pulsed current. Evidence related to pulsed specifically high voltage pulsed current use in DFU is rarely studied. Edgar J Peter (2001)⁵ in their RCT consisting of 2 groups, 20 patient of diabetic with foot ulcer in every group. Presence of diabetic was confirmed according to WHO criteria⁶ and classification of wound was done according to Texas wound classification system (1A-2A)^{7,8}. Treatment dose was delivered with the dose of 50V for 10 sec. (80 twin peak monophasic pulses per second). This was followed by 10 minutes of 8 pulse/sec of current. Both group received regular wound care, pressure reduction and shear reduction strategy. 65% of the patients healed in HVPC treatment group where as in control group or placebo group 35% healing was reported. Peter EJ et al⁵ observed no significant difference in the rate of wound healing between treatment and placebo groups. Study suggests that enhancement of wound healing will take place when used with wound care and shear reduction if treatment duration of HVPC used for more than 20 hours per week. Another study which was carried out by Houghton et al 2003⁹. Randomized double blind Prospective clinical trial with sample size of 27. Treatment group with 14 and sham group 13. Types of ulcer were included are not only diabetic origin. Distribution of ulcer according to causative agents are (table 3) Treatment dose was delivered HVPC (100microsecond, 150v, 100Hz) for 45 minutes, 3 times per week for 4 weeks. Other than HVPC regular wound care given for both the group. Results were observed by author⁸ is treatment for wound with the help of HVPC will accelerate closure of wound and almost one half of the wound surface area reduced by treatment of above mention dose and time. Another retrospective study done by Jeremy j burdge 2009¹⁰ has reported HVPC is useful adjunct to limb salvage management for DFU. However in their study suggest that prospective, RCT to ensure HVPC as a part of multidisciplinary limb salvage programme are warranted.

Table 1
Summary of articles included in the review (n=03)

Author (Year)	Design	Sample size	Types of wound	Intervention	Outcome measures	Result
Peters.et al 2001	RCT*	40	DFU**	HVPC*** Every night 8 hours for 12 week or until wound closure+ local wound care	Proportion of wound, rate of wound healing	Enhances wound healing when used in conjunction
Houghton et al 2016	RCT	27	DFU	HVPC 3 times weekly for 4 weeks (45 minute each session)	Wound surface area	Accelerate wound closure
Burdge et al 2009	Retrospective cohort	30	DFU	HVPC 16 Weeks or until wound closure 2-3times/week, (45 minute each session)	Wound surface area, UT Grades of wound	Useful in limb salvage management

*Randomized Controlled Trial, ** Diabetic Foot Ulcer, ***High Voltage Pulsed Current

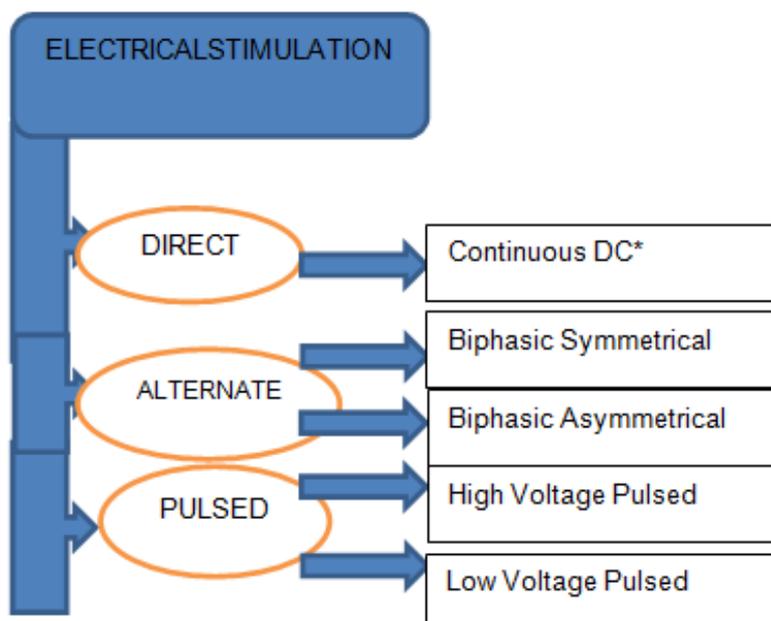
Table 2
Quality Index Score of studies included in the review

Author (Year)	Reporting	External validity	Bias	Confounding	Power	Total
Peters.et al 2001	10	1	5	4	5	25
Houghton et al 2016	9	1	5	3	5	23
Burdge et al 2009	9	1	6	5	5	26

Table3
Types of ulcer according to causative agents

Types of ulcer	Subject who received HVPC*	Subject who received sham treatment
Diabetic	2	3
Arterial	2	0
Venous	7	6
Mixed	3	3

*High Voltage Pulsed Current



DC- Direct current

Figure1
Types of Electrical Stimulation

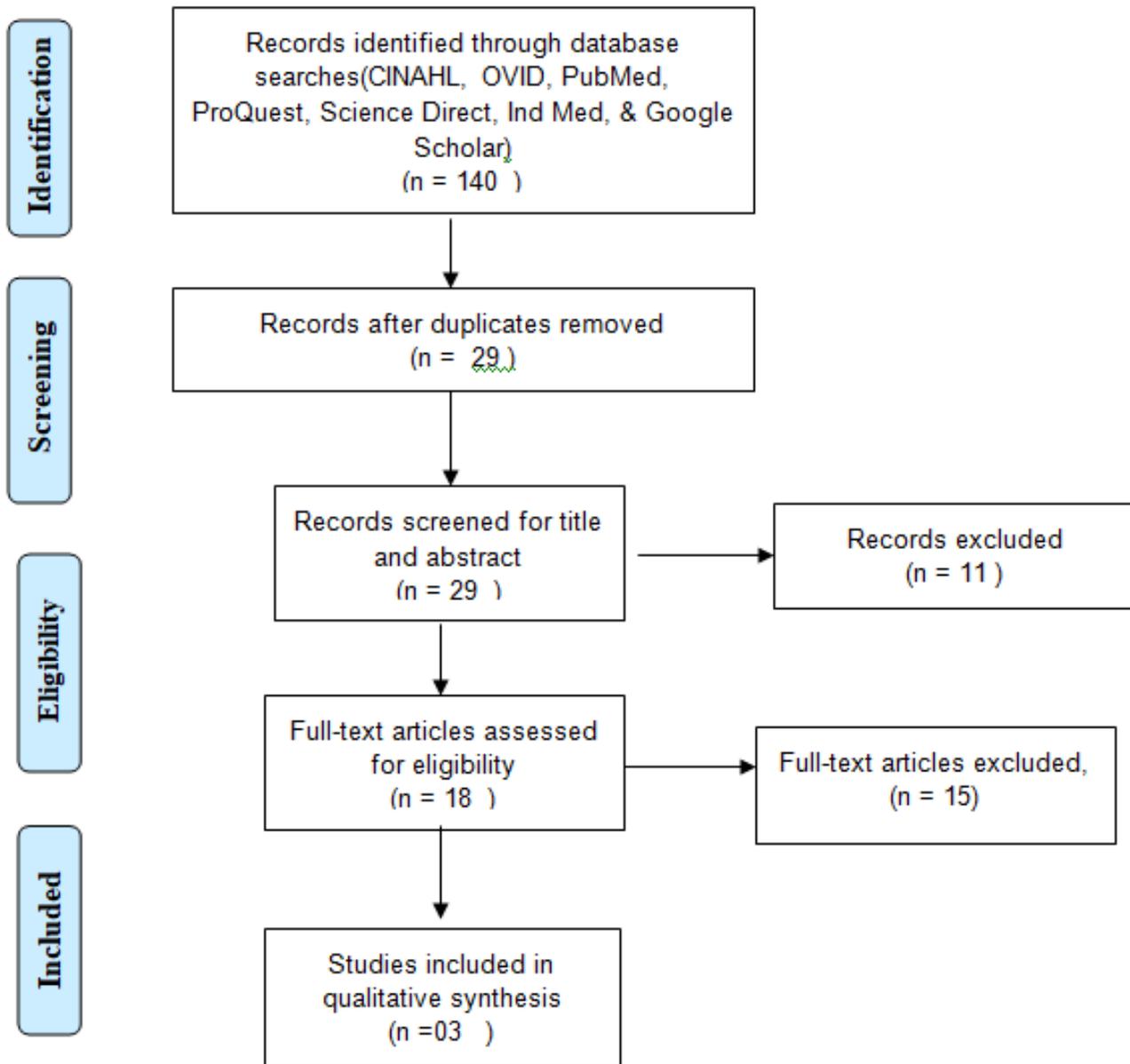


Figure 2
PRISMA Flow Diagram

CONCLUSION

As the existing articles included in this literature review has showed reduction in wound surface area and acceleration of closure of the wound. Thus, HVPC appears as a one of the important adjunct treatment for DFU.

LIMITATIONS

The authors acknowledge the publication bias (less number of included articles, lack of specific DFU & HVPC articles) which exists in this review. No meta-analysis OR Forest plot analysis done due to heterogeneity in data and pooling of data from included article was not performed because of less number of articles were included in this review

FUTURE RECOMMENDATIONS

Large clinical trials, with less confounders are warranted to evaluate and effect of HVPC to treat DFU.

CONTRIBUTIONS DETAILS

First authors Mukesh Kumar Sinha, Kovala Rakesh Krishna contributed for concept, design and formulating the hypotheses. and Second author Dhanesh Kumar K U contributed for data acquisition and writing manuscript. Other than this all the authors contribution while scoring quality index score for article included in this review

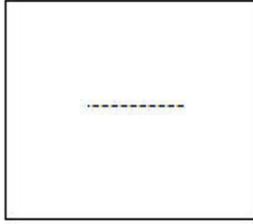
CONFLICT OF INTEREST

Conflict of interest declared none.

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We sincerely thank the above reviewers for peer reviewing the manuscript