Original Article

Clinical Experience with the Use of a Handheld Doppler in the Detection of Cutaneous Perforators and its Application and Reliability in Pre-Operative Planning of Perforator Based Flaps

Imran Adeel[1], Ghazanfar Ali[3], Muhammad Imran[2] and Manqoosh ur Rehman[2]

ABSTRACT

Objective: To determine the accuracy & reliability of handheld Doppler in preoperative planning of a perforator based flap.
Study Design: Descriptive case series study.
Place and Duration of Study: This study was conducted at the Department of Orthopaedics and Plastic Surgery, Multan Medical & Dental College/ Ibne Siena Hospital& Research Institute, Multan from July 2018 to Jan 2019.
Materials and Methods: A total of 25 patients with skin & soft tissue defects were included in the study. A handheld Life Dop Doppler with an 8 MHz probe was used to detect the cutaneous perforators pre-operatively while planning a perforator based flap and its results were correlated with intra-operative actual perforator location.
Results: A total of 71 perforators were marked for perforator based flaps in 25 patients, 55 in lower limbs, and 16 in upper limbs. Out of 55 lower limb perforators, 47 were correct, 3 were false positive & 5 were false negative. Out of 16 upper limb perforators, 13 were correct, 1 was false positive & 2 were false negative.
Conclusion: Despite of the limitations associated with handheld Doppler, in selective patients, it is still a simple & reliable option in the planning of perforator based flaps for skin & soft tissue reconstructions.
Key Words: Handheld Doppler, Perforator based flaps, Cutaneous perforators, Reconstructive surgery

Citation of articles: Adeel I, Ali G, Imran M, Rehman M. Clinical Experience with the Use of a handheld Doppler in the Detection of Cutaneous Perforators and its Application and Reliability in Pre-Operative Planning of Perforator Based Flaps. Med Forum 2019;30(2):116-119.

INTRODUCTION

Perforator flaps have gained much respect and popularity over the last few years. They have now become an important tool and indispensable part in the armamentarium of a reconstructive surgeon dealing with complex soft tissue defects related to extremity trauma and orthopaedics.[1-4] The major advantages of perforator based flaps are preservation of main vessel and underlying muscle, decrease in the donor site morbidity and good color and texture match.[5]

[1.] Department of Plastic Surgery / Orthopaedics[2], Multan Medical & Dental College/ Ibne Siena Hospital & Research Institute, Multan.
[1.] Department of Surgery, Quetta Institute of Medical Sciences, Quetta.

Correspondence: Dr. Imran Adeel, Assistant Professor of Plastic Surgery, Multan Medical & Dental College/ Ibne Siena Hospital & Research Institute, Multan.
Contact No: 0333-6366429
Email: imran_adeel117@yahoo.com

Received: January, 2019
Accepted: January, 2019
Printed: February, 2019

These flaps can be used either as pedicle flaps or as free flaps in the reconstruction of local, regional or distant skin and soft tissue defects. [6, 7] Because of the variable vascular anatomy between individuals, a safe planning of a perforator flap requires an accurate preoperative assessment of perforators. [1] It also helps in facilitating flap harvest and reducing the operative time.[2,8,9] Various tools are available in preoperative assessment of vascular perforators with variable advantages and disadvantages. These include hand held Doppler (HHD),[1,2,8,10-12] Color duplex sonography (CDS),[1,2,12,13] Digital subtraction angiography (DSA),[1,2] Computed tomography angiography (CTA)[14-18] and Magnetic resonance angiography (MRA)[1,2,5,8,19]. Except for the hand held Doppler (HHD), rest of the methods are costly and time consuming, requiring expertise to perform and interpret and cannot be used Intra-operatively.[2] Another issue associated with these advanced tools is their easy availability as they are not readily available in all centers in our part of the world.

Hand held Doppler (HHD) is no doubt one of the most commonly used methods in the detection of vascular perforators preoperatively.[7] It is an inexpensive, readily available tool that doesn't require much expertise to perform and interpret and it can be used Intra-operatively.[1,2,8] The main drawback associated with the

use of hand held Doppler is that it only detects perforators to a depth of 20mm only.[7,9,10] Because of this issue, in areas where perforators are deep, its reliability is decreased. Moreover it does not provide much information regarding the flow in a perforator and its caliber.

The objective of this study is to determine the accuracy and reliability of handheld Doppler in preoperative detection of a cutaneous vascular perforator and its correlation with intra-operative actual perforator location while planning and harvesting a perforator based flap in the reconstruction of skin and soft tissue defects.

MATERIALS AND METHODS

This descriptive case series study was carried out in the Departments of Orthopaedics and Plastic Surgery, Multan Medical & Dental College/Ibne Siena Hospital & Research Institute, Multan from July 2018 to Jan 2019 for duration of six months. Nonprobability purposive sampling is used. Both males and females patients of the age 15-60 years were included in the study.

Inclusion Criteria: Any patient of the age range of 15-60 years with skin &soft tissue defect without any co morbidity and congenital anomaly

Exclusion Criteria: Any patient having any co-morbidity or with congenital anomaly

A total of 25 patients with skin & soft tissue defects in upper or lower limbs, fulfilling the inclusion and exclusion criteria were included in the study. A prior informed verbal & written consent for the procedure was taken from all the patients. All the procedures were done by the main author and the procedure was explained to the patients prior to commencement of procedure. A handheld LifeDop Doppler with an 8 MHz probe was used to detect the cutaneous perforators pre-operatively while planning a perforator based flap and its results were correlated with intra-operative actual perforator location. (Figure-1) The results were analyzed and stratified according to the age, gender and outcome measurements.

RESULTS

25 patients were included in the study. Results were stratified according to age, gender and outcome measurements. According to age stratification, 8 were between 15-30 years of age (32%), 10 were between 31-45 years (40%) and 7 were between 46-60 years (28%) with a mean age of patients was 36.32 years. (Table-1)Out of 25 patients, 19 were males (76%) and 7 were females (24%). (Table-2) A total of 71 perforators were marked, out of which 16 were in the upper limb (22.5%) and 55 were in the lower limb(77.5%). Outcome was measured in terms of number of correct results, number of false positive and false negative results and positive predictive value. Out of total 71 perforators,60 were detected correctly, 4 were false positive and 7 were false negative, with a sensitivity of 89.55% and positive predictive value of 93.75%. Out of 55 lower limb perforators, 47 were detected correctly, 3 were false positive and 5 were false negative with a sensitivity of 90.38% and positive predictive value of 94%. Out of 16 lower limb perforators, 13 were correct, 1 was false positive and 2 were false negative with sensitivity of 86.67% and positive predictive value of 92.85%. (Table-3)

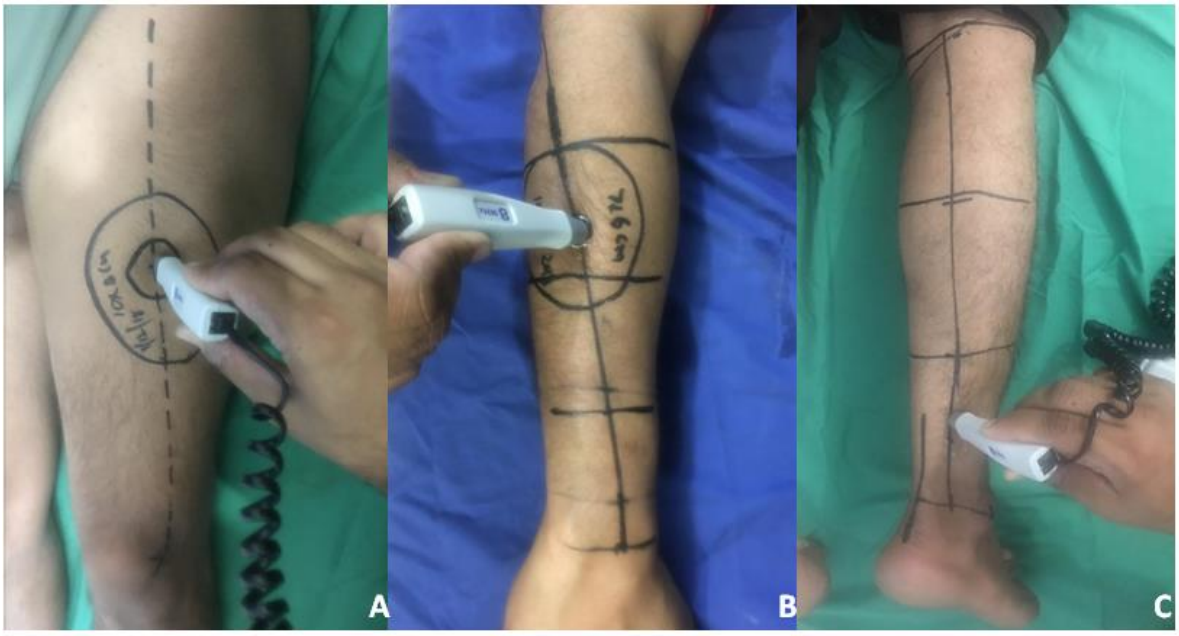

Figure-1: A: Perforator detection for anterolateral thigh flap B: Perforator detection for posterior interosseous artery flap C: Perforator detection for reverse sural flap

Table No.1: Summary of age distribution of patients

Age Groups (Years)	15-30 years	8 (32%)
	31-45 years	10 (40%)
	46-60 years	7 (28%)

Table No.2: Summary of gender distribution of patients

Gender	Male	19 (76%)
	Female	6 (24%)

Table No.3: Summary of results of perforators in upper and lower limbs

Site	Correct n (%)	False Positive n (%)	False Negative n (%)	Sensi-tivity (%)	PPV* (%)
Upper Limb Perforators (n=55)	47 (85.4)	3 (5.4)	5 (9)	90.38%	94%
Lower Limb Perforators (n=16)	13 (81.2)	1 (6.2)	2 (12.5)	86.67%	92.85%
Total Perforators (n=71)	60 (84.5)	4 (5.6)	7 (9.8)	89.55%	93.75%

*Positive Predictive Value

DISCUSSION

The preoperative identification of a cutaneous vascular perforator is the first and one of the most important step in the planning of perforator based flaps.[1,2] Multiple tools are available for the detection of for preoperative detection of cutaneous perforators.[5] These include handheld Doppler, Color duplex sonography, Digital subtraction angiography, Computed tomography angiography and Magnetic resonance angiography. [2,5,8] Among the above mentioned available tools, Handheld Doppler is one of the most commonly used options in detecting a cutaneous perforator while planning a perforator based flap. Multiple studies are available to assess the reliability and accuracy of handheld Doppler in preoperative planning of a perforator flap and its comparison with other available tools for perforator assessment with variable results.

Khan and Miller in one study, has shown it to be a reliable option in the planning of perforator flaps in extremities with high predictive value but unacceptably high false positive results for smaller caliber vessels.[1] Taylor GI et al have indicated that it is a simple and reliable option and provides a useful link between anatomical dissecting room and the operation theatre.[9] Blondeel and Beyens G, et al has labeled it as a handy and inexpensive tool but show false positive results of perforator detection in axial vessels running very superficially.[6] They found color duplex scanning as superior to handheld Doppler in providing detail information about perforators. Comparative studies of color duplex scanning, digital subtraction angiography, computed tomography angiography and magnetic resonance angiography with handheld Doppler, show superiority of these advance tools over handheld Doppler. [2,5,8,20] All these tools are superior to Handheld Doppler in terms of perforator detection, flow characteristics, vessel diameter etc. The drawback associated with these tools is their lack of easy availability, expensiveness, time consuming and expertise to perform and interpret them. Another problem with these tools is their inability to use them intra-operatively by the reconstructive surgeon.

Despite of its all limitations drawback, handheld Doppler is still one of the most common choice of reconstructive surgeon in the identification and detection of a cutaneous perforator while planning a perforator based flap pre-operatively. It is easily available, portable, and cost effective and has a high positive predictive value.[1,9,10,20] Another advantage of handheld Doppler is its Intra-operative use which makes it a handy choice forthe reconstructive trauma surgeons.[2,7] But because of the drawback associated with its use, it cannot be used as the single diagnostic tool for perforator detection.

CONCLUSION

Handheld Doppler is a simple and reliable option in identifying cutaneous perforators due to its simplicity, easy availability, portability and high positive predictive value. It can be used as a useful tool in preoperative planning of perforator based flaps for skin and soft tissue defects reconstruction. Because of its limitations in providing detail information about the perforator characteristics and false positive and false negative results, we suggest its cautious use in selective patients.

Author's Contribution:

Concept & Design of Study:	Imran Adeel
Drafting:	Ghazanfar Ali
Data Analysis:	Muhammad Imran, Manqoosh ur Rehman
Revisiting Critically:	Imran Adeel, Ghazanfar Ali
Final Approval of version:	Imran Adeel

Conflict of Interest: The study has no conflict of interest to declare by any author.

REFERENCES

1. Khan UD, Miller JG. Reliability of handheld Doppler in planning local perforator based flaps for extremities. Aesth Plast Surg 2007;31:521-525.
2. Blondeel PN, Beyens G, Verhaeghe R, et al. Doppler flowmetry in the planning of perforator flaps. Br J Plast Surg 1998;51:202-209.

3. Demirtas Y, Ozturk N, Kelahmetoglu O, et al. Pedicle perforator flaps. Ann Plast Surg 2009; 63:179-183.
4. Pignatti M, Pasqualini M, Governa M, et al. Propeller flaps for leg reconstruction. J Plast Recosntr Aesthet 2008;61:777-783.
5. Ono S, Hayashi H, Ohi H, Ogawa R. Imaging studies for preoperative planning of perforator flaps: An overview. Clin Plast Surg 2017;44(1): 21-30.
6. Lee JW, Kim HK, Kim SR, Han YS, Park JH. Preoperative identification of a perforator using computed tomography angiography and metal clip marking in perforator flap reconstruction. Arch Plast Surg 2015;42:78-83.
7. Smit JM, Klein S, Werker PMN. An overview of methods for vascular mapping in the planning of free flaps. J Plast RecosntrAesthet Surg 2010;63: 674-682.
8. Stekelenburg CM, Sonneveld PMDG, Bouman MB, et al. the hand held Doppler device for the detection of perforators in reconstructive surgery: what you hear is not always what you get. Burns 2014;40:1702-1706.
9. Uppal RS, Casaer B, Van Landuyt K, et al. The efficacy of preoperative mapping of perforators in reducing operative times and complications in perforator flap breast reconstruction. J Plast Reconstr Aesthet Surg 2009;62:859-864.
10. Hallock GG. Doppler sonography and color duplex imaging for planning a perforator flap. Clin Plast Surg 2003;30:347-357.
11. Yu P, Youssef A. Efficacy of the handheld Doppler in preoperative identification of the cutaneous perforators in the anterolateral thigh flap. Plast Reconstr Surg 2006;118:928-935.
12. Guinta RE, Geisweid A, Feller AM, The value of preoperative Doppler sonography for planning free perforator flaps. Plast Reconstr Surg 2000;105: 2381-2386.
13. Hutchinson DT. Color duplex imaging. Application to upper extremity and microvascular surgery. Hand Clin 1993;9:47-57.
14. Klein MB, Karanas YL, Chow LC, et al. Early experience with computed tomographt angiography in microsurgical reconstruction. Plast Reconstr Surg 2003;112:498-503.
15. Smit JM, Dimopoulou A, Liss AG, et al. Preoperative CT angiography reduces surgery time in perforator flap reconstruction. J Plast Reconstr Aesthet Surg 2009;62:1112-1117.
16. Imai R, Matsumura H, Tanaka K, et al. Comparison of Doppler sonography and multi-detector-row computed tomography in the imaging findings of deep inferior epigastric perforator artery. Ann Plast Surg 2008;61:94-98.
17. Rozen WM, Ashton MW, Grinsell D, et al. Establishing the case for CT angiography in the preoperative imaging of abdominal wall perforators. Microsurg 2008;306-313.
18. Ribuffo D, Atzeni M, Saba L, et al. Angio computed tomography preoperative evaluation for anterolateral thigh flap harvesting. Ann Plast Surg 2009;62:368-371.
19. Masia J, Kosutic D, Cervelli D, et al. In search of the ideal method in perforator mapping: non contrast magnetic resonance imaging. J Reconstr Microsurg 2010;26:29-35.
20. Taylor GI, Doyle M, McCarten G, et al. The Doppler probe for planning flaps: Anatomical study and clinical application. Br J Plast Surg 1990;43:1-16.