

Role of Preoperative Vascular Ultrasonography in Hemodialysis Vascular Access Operation

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Objective: Preoperative vascular mapping increase rate of successful hemodialysis vascular access operation. Several studies recommend using this procedure routinely. But some studies recommend using this procedure in selected patients. So this study aims to determine the impacts of preoperative vascular mapping in unfavorable-examined patients.

Material and Method: 55 patients were studied retrospectively from August 2006 to October 2009. Before April 2008, the operative plans were based on physical examination (group 1). After April 2008, the surgeon did preoperative vascular mapping prior to the operation in unfavorable-examined patients (group 2). The results were compared.

Results: There were high maturation rates in favorable-examined patients. In unfavorable-examined patients, preoperative vascular mapping can identified nonpalpable favorable vein which successful maturation of 18.75%. Complementary duplex scan decrease rate of unsuccessful operation significantly ($p = 0.037$) but does not increase maturation rate.

Conclusion: Careful physical examination is important part before operation. Preoperative vascular mapping has benefit only in patients with unfavorable-examined patients. It finds some nonpalpable favorable vein and decrease unsuccessful exploration.

Keywords: Vascular mapping, Arteriovenous fistula, Dialysis, Vascular access, Duplex

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Hemodialysis is the major mode of renal replacement therapy in patients with end stage renal disease (ESRD) in Thailand. The National Kidney Foundation's Dialysis Outcomes and Quality Initiative (DOQI) and the Fistula First Initiative (FFI) recommend increasing use of arteriovenous fistula (AVF) in hemodialysis patients and have emphasized the importance of dialysis by native AVF to reduce morbidity from arteriovenous grafts (AVG). Adopt this policy in clinical practice can increase native fistula placement with superior primary and secondary patency^(1,2). Several strategies have been used with aim to increase placement of native AVF and one measure proposed is the use of preoperative vascular mapping by duplex scan to assess the upper extremities

for the presence of suitable vessels prior to the surgical creation of an AVF among both pre-dialysis chronic kidney disease and end stage renal disease patients on hemodialysis.

Multiple studies and guidelines have found that use of preoperative vascular mapping by duplex scan can increase creation of native AVF^(3,4), maturation rate⁽³⁻⁵⁾, improve cumulative patency rate⁽⁶⁾, and decrease unsuccessful operation⁽⁴⁾ and recommend to do routine preoperative vascular mapping⁽⁴⁻⁷⁾. But most of these studies were retrospective studies and compared outcome of surgery from patients with routine preoperative vascular mapping to patients with surgery based on physical examination alone. However some studies found only modest benefit from preoperative vascular mapping⁽⁸⁾ and did not recommend its routine use^(9,10) but summarized that it can add benefit in selected group of patients such as in unfavorable examined patients^(9,10), obese patients^(9,11) and possible patients with venous or arterial diseases⁽⁹⁾.

The purpose of this study is to determine the

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impacts of implementation of complementary preoperative vascular mapping with physical examination in unfavorable examined patients compared with no preoperative vascular mapping, by comparing rate of native fistula placement, unsuccessful operation, functional maturation rate, and rate of patient whom need second operation.

Material and Method

55 patients whom had undergone 63 operations for vascular access operations by the author (BS) were studied retrospectively from August 2006 to October 2009. The author (BS) began to do preoperative vascular mapping in April 2008 with aim to increase rate of native fistula creation and decrease unsuccessful operation. The patients were divided into 2 groups based on the policy used for preoperative vascular mapping. In the first group, the author did not use preoperative vascular mapping at all and the decision to do which type of access placement is based on physical examination alone (before April 2008). In the second group, preoperative vascular mapping was done by the author (BS) when physical examination didn't find favorable site for native fistula creation.

We used the following criteria to indicate the physical findings that are favorable for native fistula creation 1) good arterial pulse examination of the upper extremities and 2) cephalic vein diameter of at least 2.5 mm with a tourniquet with good compressibility along its course and no any discontinuity of vein. Other findings were considered as equivocal examination when some segment of vein couldn't be palpated definitely and considered as no favorable vein when no any palpable vein can be identified.

Techniques for Duplex scan examination were as follow 1) all ultrasound examinations were performed by using Phillip Intelligent ultrasound 22 with 12 MHz probe 2) the preoperative diameter criteria that were considered favorable for access placement are (a) all arteries of 2.0 mm or larger and (b) all cephalic veins in both forearm and upper arm of 2.5 mm or larger for native fistula creation and 4.0 mm or larger for prosthesis graft creation^(4,6). The diameter was measured in anteroposterior view in transverse plane with minimum amount of pressure on the vessel⁽⁴⁾ 3) the examined arm was placed comfortably on Mayo stand with elbow flexion of approximately 30-45°. A tourniquet was placed at lower arm when forearm cephalic vein was being examined and at upper arm when arm cephalic vein was being examined 4) transverse scan was used to identify favorable forearm cephalic vein and then arm cephalic

vein. The preference is to use forearm cephalic vein first before arm cephalic vein and on nondominant side before dominant side. If no favorable forearm and arm cephalic vein were seen on both side. Then the favorable vein for arteriovenous graft creation was being identified 5) if the favorable vein was identified, it was tested for compressibility and continuity of vein to the proximal draining vein. The vein should be fully compressible with good continuity to draining vein with no any sudden change in diameter before considered favorable. 6) The artery at favorable vein site was measured for anteroposterior diameter in transverse plane.

The patient demographic data were collected which included age, sex and related medical data included diabetes, hemodialysis status of patient at time of referral for access placement, previous operation for vascular access placement, and physical examination results. Operative data were recorded including preoperative planning, operative findings, types and sites of access placement and immediate operative results. Postoperative follow-up data included immediate thrill and maturation rate were collected.

Demographic data, rate of native fistula creation, unsuccessful exploration, maturation rate and patients whom need second operation were compared between two groups of patients. We used Chi-square test for nonparametric data, t-test for parametric data and if the expected value is less than 5 in more than 20% then Fisher's exact test was used instead.

Results

There were total number of 55 patients undergone 63 vascular access operations from 11 August 2006 to 2 October 2009 which achieved maturation rate of 84.76 % (50 out of 59 operations exclude 3 missed data and 1 patient that is still not need hemodialysis). There are 27 operations (42.86%) in group 1 and 36 operations (57.14%) in group 2. The demographic data between two groups are not different as shown in Table 1. Operative techniques uses in 2 groups of patients were classified in Table 2 with no significant difference in rate of native fistula access placement.

Patients' characteristics, type of operation, and results in both groups were shown in Fig. 1. When considered patients with favorable examined results, there were 15 out of 26 patients (57.69%) in group 1 and 16 out of 36 patients (44.44%) in group 2. In group 1 with favorable examination, all patients had undergone

Table 1. Demographic data compared between 2 groups of patients

	Group 1	Group 2	p-value
Sex (m:f)	13:14	20:16	0.560
Age (mean, SD)	56.30,16.04	61.69,12.46	0.180
Diabetes mellitus	12/27 (44.44%)	17/36 (47.22%)	0.827
Previous Operation	7/27 (25.93%)	11/36 (30.56%)	0.687
Favorable PE Result ^a	15/26 (57.69%)	16/36 (44.44%)	0.303
On hemodialysis ^b	20/26 (76.92%)	28/36 (77.78%)	0.506

^a PE = physical examination

^b There is 1 missing data in group 1

NB: All demographic data use Chi-square test except in age group use independent t-test

Table 2. Type of vascular access placement

	Group 1	Group 2	p-value
Radiocephalic fistula	21	16	
Brachiocephalic fistula	2	8	
Forearm loop graft	4	6	
Arm straight graft	0	6	
Rate of native fistula placement	23/27 (85.19%)	24/36 (66.67%)	0.095

NB: Difference in rate of native fistula placement was compared using Chi-square test

native fistula access operation which include 13 radiocephalic fistulas and 2 brachiocephalic fistulas. There were 2 unsuccessful operations (13.33%) for radiocephalic fistula creation due to unfavorable artery found intraoperatively. All 13 patients with successful operation had 100% immediate thrill postoperatively with functional maturation rate of 90% (9 out of 10 patients with 3 missing data). In group 2 with favorable examination, all patients had undergone native fistula access operation with include 12 radiocephalic fistulas and 4 brachiocephalic fistulas. There were no unsuccessful exploration with 100% immediate thrill postoperatively and functional maturation rate of 93.8% (15 out of 16 with one patient still not need hemodialysis with good thrill on postoperative follow-up examination).

For patients with unfavorable physical examination, there were 11 out of 26 patients in group 1 (42.31%) and 20 out of 36 (55.56%) in group 2. In group 1 with unfavorable examination, 7 out of 11 patients (63.64%) had undergone native fistula access operation (all with radiocephalic fistula) with 3 unsuccessful operations (3 out of 7; 42.86%) with maturation in 3 out of 4 patients with successful operation (75%). So 4 out

of 7 patients that had undergone native fistula access operations (57.14%) need second operation. In other 4 out of 11 patients (36.36%) had undergone prosthetic graft access operation (all with forearm loop graft) with no unsuccessful operation and 100% maturation rate.

In group 2, there were 4 equivocal examined patients which had undergone native fistula creation after duplex scan confirmation with 100% maturation rate. In 16 patients with no favorable vein found by physical examination, duplex scan could find 4 patients (25%) with favorable vein criteria for native fistula creation with 2 patients had undergone radiocephalic fistula creation and 2 patients had undergone brachiocephalic fistula creation with maturation in 3 patients (75%) [1 patient that failed radiocephalic fistula maturation found to have venous stenosis at midforearm level later]. Another 12 patients had successful operative graft placement with 6 patients had undergone forearm loop graft placement and 6 patients had undergone arm straight graft placement with maturation rate in 11 of 12 patients (91.67%).

Outcome data were compared separately between 2 groups based on physical examination findings are shown in Table 3. There were no difference

Table 3. Outcome data compared between groups based on physical examination findings

	PE ^a favorable		p-value	PE ^a non favorable		p-value
	Group 1	Group 2		Group 1	Group 2	
Unsuccessful operation	2/15 (13.33%)	0/16 (0%)	0.226 ^c	3/11 (27.27%)	0/20 (0%)	0.037 ^c
Maturation	9/10 (90%)	15/16 (93.8%)	1.000	7/8 (87.5%)	18/20 (90%)	1.000
Patient whom need second operation	3/12 (25%)	0/16 (0%) ^b	0.067 ^c	4/11 (36.36%)	2/20 (10%)	0.151

^a PE = physical examination, ^b One patient still not need hemodialysis, ^c Fisher's exact test, NB: All outcome data use Chi-square test

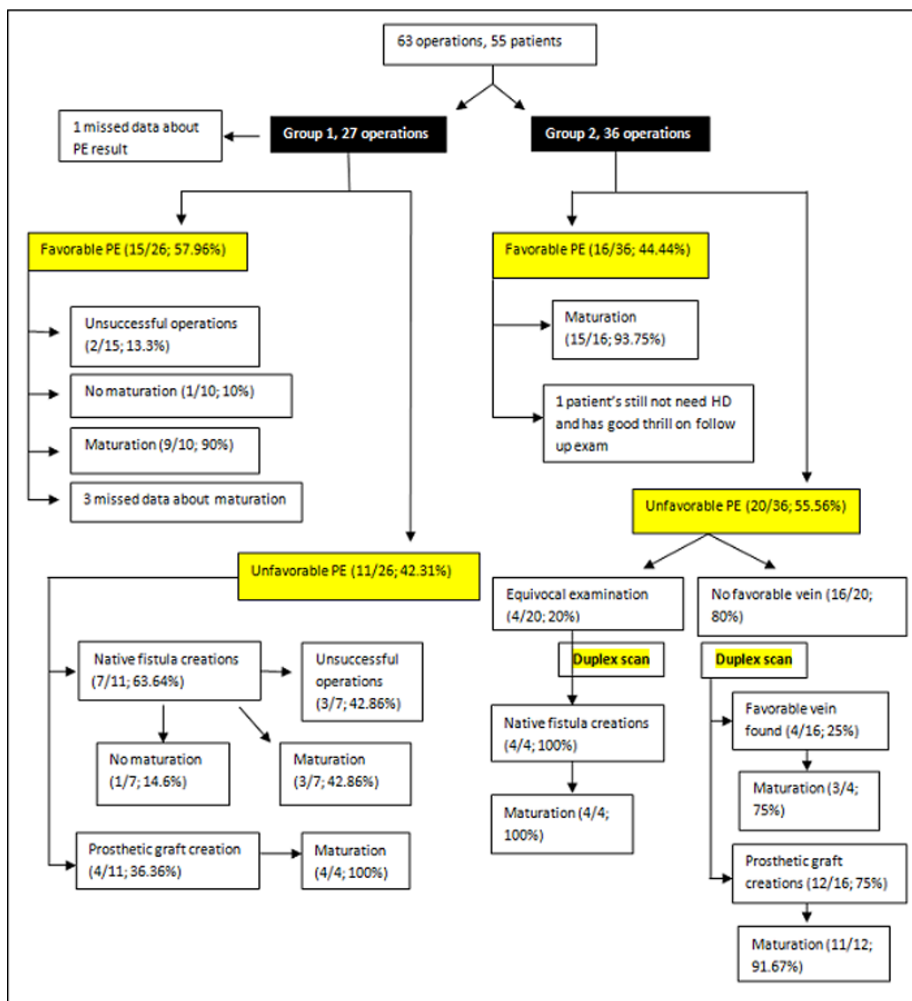


Fig. 1 Patients' characteristics, type of operation, and operative results

in unsuccessful operation rate, maturation rate and rate of patients whom need second operation between two groups of patients with favorable physical examination. In patients with unfavorable examination, preoperative vascular mapping could decrease rate of unsuccessful operation significantly ($p = 0.037$) and had trend to decrease rate of patients whom need second operation from 36.36% to 10% but didn't reach statistical significance ($p = 0.151$).

Discussion

In this study we found favorable physical examination in 57.69% and 44.44% of patients in group 1 and group 2 respectively with high maturation rate of 90% in group 1 and 93.8% in group 2. So, we conclude that careful physical examination is important part of preoperative planning in vascular access operation for hemodialysis patients and preoperative vascular mapping in these patients are not necessary. Although strict to the ultrasound criteria for choosing appropriate artery and vein for vascular access placement give high rate of maturation but it can miss some smaller vein that can be matured. These points should be thoroughly discussed with the patients when marginal anatomy is found by preoperative vascular mapping and decision to do which type of operation is chosen by the patients with high acceptance of primary failure.

In patients with unfavorable physical examination who had undergone native fistula creation without preoperative complementary duplex scan had very high unsuccessful operation rate of 42.86% with large number of patients required second operation (57.14%). So in this type of patients, when decide to do native fistula creation without preoperative vascular mapping, details of outcomes should be clearly discussed with the patients before operation.

Complementary duplex scan confirms the quality of vein in equivocal examination and give operative outcome with high maturation rate (100%) in our study. Complementary duplex scan also can find nonpalpable favorable cephalic vein for native fistula creation and give operative outcome with successful maturation in 3 out of 16 patients (18.75%) consistent with Robbin⁽⁴⁾ that found nonpalpable favorable vein in 15% of patients. Complementary duplex scan decrease rate of unsuccessful operation in unfavorable physical examined patients significantly ($p = 0.037$) which also consistent with finding by Robbin⁽⁴⁾ that can decrease unsuccessful exploration form 11% to 0% but it does not increase maturation rate.

In conclusion, in patients with favorable

physical examination can undergo surgery for arteriovenous fistula without complementary duplex scan. Patients with unfavorable physical examination should undergo preoperative vascular mapping before operation. Complementary preoperative vascular mapping can find some favorable nonpalpable cephalic vein, decrease native fistula creation rate and decrease rate of unsuccessful operation.

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บทบาทของการอัลตราซาวด์หลอดเลือดเพื่อวางแผนก่อนผ่าตัดทำหลอดเลือดสำหรับล้างไต ในผู้ป่วยโรคไตวายเรื้อรัง

บุญยิ่ง ศิริบำรุงวงศ์, ประกิตพันธ์ุ ทมทิตชงค์, กิตติ กรรภิรมย์

วัตถุประสงค์: เพื่อศึกษาถึงผลกระทบของการนำการทำอัลตราซาวด์หลอดเลือดก่อนการผ่าตัดทำหลอดเลือดสำหรับ
ฟอกเลือด มาใช้วางแผนก่อนผ่าตัดในผู้ป่วยโรคไตวายเรื้อรัง ที่มีผลการตรวจร่างกายไม่พบหลอดเลือดที่เหมาะสม

วัสดุและวิธีการ: ทำการศึกษาแบบย้อนหลังในผู้ป่วย 55 คนที่เข้ารับการผ่าตัดทำหลอดเลือดฟอกไตตั้งแต่ สิงหาคม พ.ศ.
2551 ถึง ตุลาคม พ.ศ. 2553 โดยตั้งแต่ สิงหาคม พ.ศ. 2551 ถึง เมษายน พ.ศ. 2552 การเลือกวิธีการผ่าตัด จะเลือก
โดยใช้ข้อมูลที่ตรวจได้จากการตรวจร่างกายหลังจาก เมษายน พ.ศ. 2552 มีการทำอัลตราซาวด์หลอดเลือดก่อนผ่าตัด
ในผู้ป่วยที่ตรวจร่างกายไม่พบหลอดเลือดที่เหมาะสม ผลการรักษาถูกเปรียบเทียบในผู้ป่วย 2 กลุ่ม

ผลการศึกษา: อัตราการ maturation สูงในผู้ป่วยที่ตรวจร่างกายพบหลอดเลือดที่เหมาะสมในผู้ป่วยทั้ง 2 กลุ่ม ในกลุ่ม
ผู้ป่วยที่ตรวจร่างกายไม่พบหลอดเลือดที่เหมาะสม การทำอัลตราซาวด์ก่อนสามารถพบหลอดเลือดที่เหมาะสม
และประสบความสำเร็จในการใช้ล้างไต 18.75% นอกจากนี้ยังสามารถลดอัตราการผ่าตัดที่ไม่ประสบความสำเร็จ
อย่างมีนัยสำคัญที่ $p = 0.037$ แต่ไม่เพิ่ม maturation rate

สรุป: การตรวจร่างกายที่ดีเป็นส่วนประกอบสำคัญในการวางแผนก่อนผ่าตัด และการทำอัลตราซาวด์หลอดเลือด
ก่อนผ่าตัดมีประโยชน์เฉพาะในผู้ป่วยที่ตรวจร่างกายไม่พบหลอดเลือดที่เหมาะสมโดยสามารถพบหลอดเลือดที่เหมาะสม
ได้ในผู้ป่วยบางคน และลดอัตราการผ่าตัดที่ไม่ประสบผลสำเร็จ
