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Factors Determining the Success of Brescia-Cimino Arteriovenous Fistula in Patients at Bhumibhol Adulyadej Hospital: A Prospective Study

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Abstract

Background: **The purpose of this study was to determine factors contributing to the success of Brescia-Cimino arteriovenous fistula. To investigate the feasibility of a Brescia-Cimino arteriovenous fistula if the internal diameter of the cephalic vein was less than or equals to 2.5 mm and if other factors, eg. age, gender, underlying diseases, radial pulse volume, visible cephalic vein, Allen's test, internal diameter of radial artery and immediate post-operative thrill also played a role in the success.**

Material and Methods: **A prospective study was undertaken in 120 patients with end-stage renal disease (ESRD) who underwent Brescia-Cimino AVF from March 2003 to August 2004 at Bhumibhol Adulyadej Hospital. The relation between the success of the native AVF and the size of the internal diameter of the cephalic vein as well as other factors including age, gender, underlying diseases, radial pulse quality, visibility of cephalic vein, Allen's test, internal diameter of radial artery and immediate post-operative thrill were analysed. Three months after surgery, the patients were re-assessed to determine the maturation of the AVF for hemodialysis. Thereafter, another 2 sessions of follow-up were required to determine the success of hemodialysis.**

Results: **The radiocephalic AVFs were performed on the right wrist in 24 patients, left wrist in 96 patients. The operated cephalic veins were externally visible in 101 patients (84.16%) and non-visible in 19 patients (15.83%). The internal diameter of the cephalic vein ranged from 1.0-4.0 mm. Thrill of the AVF immediately after surgery was positive in 111 (92.5%) and negative in 9 (7.50%). Dialysis was successful in 80 patients (66.77%) and failed in 40 (33.33%). There were only 3 factors which contributed to the success of a native AVF, i.e. the cephalic vein visibility, the internal diameter of the cephalic vein and the presence of post-operative AVF thrill. Other factors including age, gender, underlying diseases, radial pulse rate, Allen's test and internal diameter of radial artery had no effect on the success of the native AVF.**

Conclusion: **Factors contributed to the success of a native AVF included the cephalic vein visibility, the internal diameter of the cephalic vein and the presence of post-operative AVF thrill.**

Keywords: AVF, Arteriovenous fistula, Brescia-Cimino arteriovenous fistula

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Introduction

Patients with end-stage renal disease (ESRD) require long-term hemodialysis for which a vascular access is necessary.[1] Brescia-Cimino arteriovenous fistula (AVF) is currently the most preferred and the best vascular access.[2] This is due to its simplicity, low cost, greater longevity and fewer infection rates.[3,4] Brescia-Cimino arteriovenous fistula is a native arteriovenous fistula created by connecting a radial artery directly to a cephalic vein at the wrist.[5-9] This radiocephalic autologous AVF should be performed by experienced surgeons.[10,11]

The main purpose of this study was to determine if the internal diameter of the cephalic vein of less than or equaled to 2.5 mm affected the success of the Brescia-Cimino AVF. Also to study whether other factors, eg. age, gender, underlying diseases, radial pulse volume, visible cephalic vein, Allen's test, internal diameter of the radial artery and immediate post-operative thrill, affected the success of the Brescia-Cimino AVF.[12,13]

Definition

Brescia-Cimino arteriovenous fistula is the creation of a vascular access for hemodialysis by anastomosing the radial artery to the cephalic vein under local anesthesia. Successful Brescia-Cimino AVF is determined by the maturation of AVF for hemodialysis within 3 months and hemodiaysis after AVF maturation can be performed successfully for more than twice (due to time constraint).

The diameter of vessels is the diameter of the cephalic vein and the radial artery in mm. measured intra-operatively using a coronary dilator (set of 9, Pilling, USA).

The quality or volume of the radial pulse is graded as follows: normal pulse = grade 2+, less than normal pulse = grade 1+, undetectable pulse = grade 0.

A visible cephalic vein is a cephalic vein that is externally visible. The maturation period of an AVF is 3 months after operation. At maturation, the vein will dilate with detectable or palpable thrill.

Materials and Methods

Target population included all patients with ESRD who underwent a Brescia-Cimino arteriovenous fistula at the Bhumibhol Adulyadej Hospital from March 2003 to August 2004. Exclusion criteria included patients with ESRD and underlying diseases (such as SLE, vasculitis and HIV infection), patients with weaker pulse on one side and patients with systolic blood pressure lower than 10 mmHg on one side compared to the other side. The sample size used in calculating the study is n/gr = Z.

One hundred and twenty patients with ESRD who underwent Brescia-Cimino AVF from March 2003 to August 2004 were included in this study. Three months after surgery, the patients were re-assessed to determine the maturation of the AVF for hemodialysis. Thereafter, another 2 sessions of follow-up were required to determine the success of hemodialysis.[14]

Multiple analyses of the collected data were performed to determine the odds ratio of the relation between the size of the internal diameter of the cephalic vein and the success of the native AVF; as well as the relation between the success of the native AVF and other factors (age, gender, underlying diseases, radial pulse quality, visibility of cephalic vein, Allen's test, internal diameter of radial artery and immediate post-operative thrill).[15-18]

Ethical considerations included the followings: The patients and their relatives were allowed to take part in the decision-making as well as the study. The sample group had the right to withdraw from participation. Patients' data were considered confidential and the study was reviewed and approved by the Ethical Committee, Bhumibhol Adulyadej Hospital.

Expected benefits and application: The results from this study will help surgeons to determine whether performing a native AVF will be beneficial for patients with ESRD, or whether another type of vascular access is more appropriate.

Results

One hundred and twenty patients with ESRD who underwent Brescia-Cimino AVF were included in this study. There were 55 males (45.83%) and 65 females (54.16%) with ages ranged from 21-87 years (mean 57.79 years) (Table 1). Most of the patients (110) had hypertension (HT) as a pre-existing condition. Other pre-existing conditions included diabetes mellitus (DM) 54, HPL 20, ischemic heart disease 16, BPH 16, gallstones 4, cirrhosis 2, CVA 1, CA breast 1, thyroid

goiter 1, single kidney 1. Most of the patients (48) had only hypertension as a single pre-existing condition. Twenty-Five patients had two pre-existing conditions. Another 38 had three pre-existing conditions.

The radiocephalic AVFs were created on the right wrist in 24 patients (20.0%), left wrist in 96 patients (80.0%). Patients were found to have grade 1 radial pulse in 6 (5.0%) and grade 2 in 114 (95.0%). The operated cephalic veins were visible in 101 patients (84.16%) and non-visible in 19 patients (15.83%). The Allen's test was positive in 25 patients (20.83%) and negative in 95 patients (79.16%). The internal diameter of the radial arteries ranged from 1.5 to 4.0 mm (Table 2). The internal diameter of the cephalic vein ranged from 1.0 - 4.0 mm (Table 3). Thrill of the AVF immediately after surgery was positive in 111 (92.5%) and negative in 9 (7.50%). Dialysis were successful in 80 patients (66.77%) and failed in 40 (33.33%).

Data analysis was performed using a SPSS program whereby the odds ratio was read by the multivariate analysis to determine the relation of various factors with successful native AVF.[19,20] The results revealed that there were only 3 factors which contributed to the success of a native AVF, ie. the cephalic vein visibility, the internal diameter of the cephalic vein and the presence of post-operative AVF thrill. Other factors including age, gender, underlying diseases, radial pulse volume, Allen's test, internal diameter of the radial artery had no effect on the success of the native AVF (Table 4).

Table 1 Age range of patients

Age (years)	Number of Patients	%
20-29	4	3.33
30-39	10	8.33
40-49	24	20.00
50-59	23	19.17
60-69	28	23.33
70-79	27	22.50
>80	4	3.33
Total	**120**	**100.00**

Table 2 Internal diameter of radial arteries ranging from 1.5 - 4.0 mm

Internal diameter of the radial artery (mm)	Number of Patients	%
1.5	3	2.50
2.0	32	26.66
2.5	56	46.66
3.0	26	21.66
3.5	2	1.66
4.0	1	0.83
Total	**120**	**100.00**

Table 3 Internal diameter of the cephalic vein ranging from 1.0 - 4.0 mm

Internal diameter of the cephalic vein (mm)	Number of Patients	%
1.0	2	1.66
1.5	1	0.83
2.0	19	15.83
2.5	31	25.83
3.0	44	36.66
3.5	17	14.16
4.0	6	5.00
Total	**120**	**100.00**

Table 4 Effects of various factors on the success of AVF

Factors	Odds Ratio	95 % CI
Age	1.057	0.840-4.066
Gender	1.857	0.848-4.066
DM	0.860	0.401-1.841
HT	0.658	0.066-6.536
HPL	0.776	0.292-2.060
IHD	1.286	0.377-4.387
Radial pulse volume	0.492	0.182-1.331
Visible cephalic vein	5.938	2.051-17.191
Allen's test	0.636	0.254-1.595
Diameter of radial artery	4.158	0.366-47.297
Diameter of cephalic vein	11.400	3.461-37.545
Post-op thrill of AVF	0.121	0.024-0.615

Discussion

Preoperative ultrasonography has been reported to be a useful mapping tool in planning for creation of the AVF and detection of postoperative complications.[21-24] Molourh M. reported that the success rate of constructed AFV detected by pre-operative Doppler U/S was 80.2% with mean internal diameter of artery of 0.264 cm, resistance index of 0.5, arterial blood flow of 54.5 ml/min and increased internal diameter of vein after proximal vein compression in 59.3%.[25] It was concluded that significant factors for prediction of primary patency rates of AVF included increase in

internal diameter of artery, resistance index, arterial blood flow and internal diameter of vein after proximal vein compression.(1)

Brimkle KS. demonstrated that, by using Doppler Ultrasound prior to an AVF creation to measure the cephalic vein and/or the radial artery internal diameter, it would result in failure of the AVF if the internal diameter was less than or equals to 1.5 mm.[26]

Patients with ESRD in this study were mostly the elderly (mean age 57.79 years) with pre-existing conditions mainly DM and HT.[27] Some had many pre-existing conditions.[28] The ratio of males and females was fairly even, ie. 54.16 (female): 45.83 (male).

The native AVF was normally performed on the left arm (80.0%). Most had normal radial pulse (95.0%), i.e. 2+. In 101 patients (84.16 %) the cephalic vein was externally visible prior to the operation. Only very few cephalic veins were not visible (15.83%). At the end of the study, it was shown that a visible cephalic vein contributed to the success of the native AVF.

The Allen's test was positive in 25 patients (20.83%) as well as in 6 (5.0%) patients with weaker pulse, ie. 1+. It was certain that these patients would not suffer the steal syndrome after surgery as they were already excluded by the exclusion criteria. If the radial pulse was weaker than usual when compared to the other arm then the systolic blood pressure (SBP) had to be measured for comparison with the other arm. Only when the difference was less than 10 mmHg, which meant that there was no pathology in the assessed artery, a native AVF could then be performed.

The internal diameter of the radial artery ranged from 1.5 to 4.0 mm. Most were in the range of 2.0-3.0 mm. with smallest diameter (1.5 mm) in 3 patients and the largest (4.0 mm) in 1 patient. The analysis showed that the internal diameter of the radial artery had no effect on the success of a native AVF. This is in contrary to the report by Molourh M. which showed that the mean internal diameter of the radial artery should be >or = 0.264 cm in order to achieve a successful native AVF.25

The internal diameter of the cephalic vein ranged from 1.0-4.0 mm, most were in the range of 2.0-3.5 mm. It was found that a size of 2.5 mm or larger contributed to the success of AVF, the odds ratio being 11.400 ranging from 3.461 to 37.545 within the 95% CI. Based on the standard of the pre-operative evaluation, the diameter of a good vein (visible cephalic vein in external diameter) should be 3.0 mm or larger. If the diameter was 2.0 mm or smaller, the AVF would usually fail. Brimkle reported that AVF would be successful if the external diameter of the cephalic vein by pre-operative ultrasound was 1.5 mm or larger.

The patients returned for follow-up 3 months after surgery. The success and maturation of the AVF were determined.[29-31] The post-operative complications e.g. infection were also assessed.[32-34] Data relating to the success of hemodialysis were collected on 2 occasions afterwards.[35]

Conclusions

This prospective study was conducted to study factors contributing to the success of an arteriovenous fistula for long-term hemodialysis. It may be concluded that a visible cephalic vein, an internal cephalic vein diameter of 2.5 mm or more and the presence of a post-operative AVF thrill are factors which determine the success of AVF. This would be useful for surgeons and patients themselves in selecting the type of vascular access for long-term hemodialysis which is most appropriate for them and thus reduce the chance of having a failed vascular access.

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