



# Effect of the time to intervention on the outcome of thrombosed dialysis access grafts managed percutaneously

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## PURPOSE

We aimed to investigate the effect of the time interval from the clinical presentation of a thrombosed dialysis access graft to intervention on procedure success.

## MATERIALS AND METHODS

Records from two academic institutions for patients who underwent percutaneous thrombectomy of occluded surgical hemodialysis graft access sites in interventional radiology from 2006 to 2011 were reviewed retrospectively. The following data were recorded: gender, age, time and date of the initial request for a thrombectomy and the procedure, age of the surgical access, angiographic outcome, and clinical outcome (successful or unsuccessful postinterventional dialysis). Univariate and multivariate logistic regression were used to evaluate whether the time to intervention significantly affected the study endpoint.

## RESULTS

In total, 268 percutaneous thrombectomies were performed in 139 patients. Of these 224 (83.5%) were categorized as successful and 44 (16.4%) as unsuccessful. The time to intervention was  $19.9 \pm 30.1$  vs.  $22 \pm 35$  hours for successful and unsuccessful procedures, respectively. The difference between the two was not significant, and there were also no significant differences in covariate distributions between successful and unsuccessful outcomes.

## CONCLUSION

During the first 72 hours following clinical presentation of a thrombosed dialysis access graft, time to intervention may be considered independent of procedure outcome.

Patient vascular access is critical for patients with kidney failure who rely on regularly scheduled hemodialysis. Detailed evidence-supported guidelines have been developed regarding vascular access placement (1–4), and much has been written about the surveillance, maintenance, biology, cost, and interventional techniques for these accesses (5–15). Similarly, predictors of success following radiological intervention of these access sites have been evaluated, including pressure, the degree of stenosis, and procedure type (16, 17). Patient age, access site, underlying comorbidities, the serum albumin level, and systemic systolic pressure over time have been evaluated as potential predictors of graft patency following intervention (16, 18). Nevertheless, the optimal timing of intervention for thrombosed dialysis access remains unknown. This study investigated the relationship between the time elapsed from clinical thrombosis presentation and intervention on the procedural success as defined by anatomic (angiographic) and clinical (subsequent dialysis) outcome variables (19).

## Materials and methods

### Patients

Approval was obtained from the University Hospitals Institutional Review Board. Records from two academic institutions for patients who underwent percutaneous thrombolysis of occluded surgical hemodialysis graft access sites in interventional radiology from 2006 to 2011 were reviewed retrospectively. In all, 268 procedures in 139 patients were evaluated. Many of the patients included in this study underwent more than one percutaneous thrombolysis of a clotted hemodialysis graft during this time period. Each procedure, rather than each patient, was represented individually with a unique identifier and analyzed. The records were evaluated in terms of patient gender, patient age, the time and date of the initial request made for a thrombectomy, the time and date the procedure was performed, the age of the surgical access, angiographic outcome, and postinterventional functional patency (20). Patients younger than 18 years of age and those missing documentation regarding order placement, procedure time, or dialysis outcome were excluded.

### Procedure and data collection

The percutaneous thrombolysis procedures were performed in an interventional radiology suite using either a combination of pharmacomechanical thrombolysis or mechanical thrombolysis techniques, with percutaneous transluminal angioplasty (PTA) with or without stenting in most cases. Of the 268 procedures, tissue plasminogen activator (tPA;

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Alteplase [Genentech, San Francisco, California, USA], 2 mg via the sheath side-arm) was used in 188 (70%) and stenting in 84 (31%). Every case involved PTA and underwent a reverse embolectomy with a 5.5 F over-the-wire Fogarty balloon for restoration of flow. Of the stents placed, 63 were primary (the first stent placed in an existing access system) and 21 represented second or third stent placements. In all, 50 were placed at the venous anastomoses and 34 in the outflow tracts. None were placed centrally in a subclavian vein. The outcome of the percutaneous intervention, i.e., successful or unsuccessful angiographic restoration of flow, was then ascertained directly from the procedure report and Picture Archiving Communication System images. Success of postintervention dialysis was ascertained from paper and electronic medical records. At our institution, requests for consultation are entered electronically and time stamped. The time of the order entry was documented and used as the start point for calculating the time interval to the procedure. The study outcome was based on both angiographic and dialysis outcomes, with failure of either one being reflected as a negative study outcome.

Procedures were stratified by outcome, including successful outcome, failure as determined by angiography, and dialysis-only failure. A dialysis-only failure was defined as a successful procedure as determined by angiography, followed by unsuccessful dialysis. Ultimately, the outcome was considered unsuccessful if either the procedure failed or the patient was unable to be dialyzed subsequently.

All procedures were performed by operators who had been attending staff for at least five years.

#### Statistical analysis

The endpoint was the combined outcome (success vs. failure) following percutaneous thrombolysis in the angiography suite and subsequent hemodialysis. The primary covariate of interest was the time to intervention. Exploratory and descriptive analyses of age, gender, time to intervention, and age of the surgical access were performed and data quality was checked using frequency analysis. The t test

**Table 1.** Outcome failures

	Lysis technique		Stenosis management	
	Lytics+ mechanical	Mechanical only	Stent placement	PTA only
Subsequent dialysis failure (n=29)	9	20	1	28
Angiographic/technical failure (n=15)	4	11	9	6

PTA, percutaneous transluminal angioplasty. Data are given as number of subjects.

and chi-square test were used to evaluate differences between interval- and nominal-scale covariates, respectively.

Univariate and multivariate logistic regression were used to evaluate whether the time to intervention significantly affected the study endpoint. Time to intervention was tested using a binary elapsed-time variable,  $X_t$ , where  $t=0-24, 48, \text{ and } 72$  hours (e.g.,  $X_t=1$  if the time to intervention was less than  $t$  where  $t=2, 3, \dots, 24$  hours, otherwise  $X_t=0$ ); lack of significant differences in proportions of successful and unsuccessful procedures in each 24-hour period was confirmed before further analysis. Single predictor logistic regression models between  $X_t$  and age, gender, surgical access type, surgical access age, and their interaction terms were fit, in addition to a multivariate logistic regression model, adjusting for age, gender, surgical access type, and surgical access age. All of the analyses were performed using the statistical software STATA 11.0 (StataCorp LP, College Station, Texas, USA). For all tests,  $\alpha=0.05$  was used.

## Results

### Patient characteristics

In total, 268 percutaneous thrombolysis procedures performed in 139 patients between 2006 and 2011 at two academic institutions were analyzed; of the 139 patients, 55 had multiple procedures involving the same access site. Of the 268 procedures evaluated, 224 (83.5%) were categorized as successful, whereas 44 (16.4%) were categorized as unsuccessful. The time to intervention for these procedures overall was  $19.9 \pm 30.1$  and  $22 \pm 35$  hours, respectively, and the difference between the two was not significant. Of the failures, 29 (66%) were failures of dialysis following the procedure, and 15 (34%)

were angiographic failures. The time to intervention for these subgroups was  $20.5 \pm 38.5$  and  $24.8 \pm 27.6$  hours, respectively, and the difference was not significant. Similarly, there were no significant differences in covariate distributions between successful and unsuccessful outcomes. Two variants of treatment emerged across the cohort: those who underwent pharmacomechanical thrombolysis (tPA plus mechanical) versus mechanical only and those who underwent PTA and stent placement versus those who underwent PTA only. The distribution of these differences as they related to outcome failure is shown in Table 1. Table 2 contains the descriptive statistics for patient covariates grouped on outcome. Overall, 20 of the 75 patients (27%) whose time to intervention exceeded 24 hours had temporary dialysis catheters placed.

### Outcome

Of the 224 successful procedures, 211 (94.2%) procedures and 41 of the 44 (93.2%) unsuccessful procedures had intervention within the first 72 hours; the 13 successful and three unsuccessful procedures that underwent intervention after 72 hours were not included in subsequent analyses. Fig. and Table 3 show the proportions of successful and unsuccessful procedures for 0–24, 25–48, and 49–72 hours. For each 24-hour period, there were no significant differences between the distributions of successful and unsuccessful procedures, and in a single-predictor analysis of outcome success, there was no significant association with outpatient age, gender, or surgical access age.

There were no significant associations between any of the 24-hour periods and outcome success ( $P = 0.07$ ). After adjusting for age, gender, surgical

**Table 2.** Descriptive statistics and associated significance values for patient covariates grouped according to successful vs. unsuccessful procedure outcome

	Successful outcome	Unsuccessful outcome	<i>P</i> <sup>a</sup>
Gender			
Male	106	22	0.745
Female	118	22	
Age (years)	56.4±13.7	57.0±14.0	0.789
Surgical access age (months)	23.8±22.1	21.6±21.7	0.550
Time to intervention (hours)	19.9±30.1	22.0±35.0	0.711

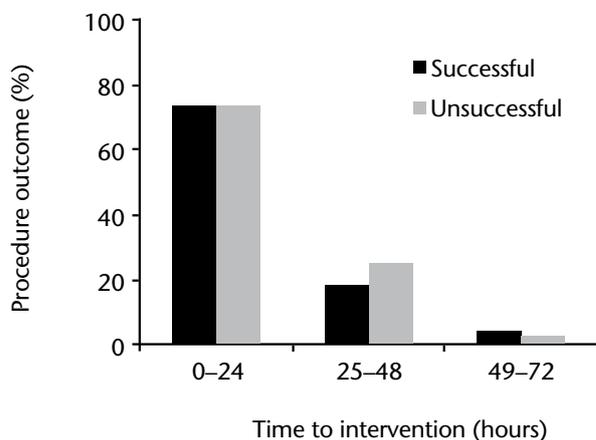
<sup>a</sup>To test for significant differences between successful and unsuccessful outcome, Pearson's chi-square test was used for the gender covariate, and the t test was used for the age, surgical access age, and time to intervention.

Data are given as number of subjects or mean±standard deviation.

**Table 3.** Distribution of procedure outcome

Time to intervention	Successful outcome	Unsuccessful outcome
0–24 hours	164 patients/7 hours	29 patients/7.2 hours
24–48 hours	39 patients/27 hours	11 patients/25.8 hours
48–72 hours	21 patients/99.3 hours	4 patients/118.6 hours

Data are given as number of patients/mean time to intervention.



**Figure.** Distributions of successful and unsuccessful procedure outcomes with time to intervention being 0–24, 25–48, and 49–72 hours. There were no significant associations between the 24-hour intervals and the procedure outcome ( $P > 0.05$ ).

access age, and their interaction terms, the fitted model yielded no significant correlation between outcome success and time to intervention ( $P = 0.29$ ).

### Discussion

Patent hemodialysis access is critical for the survival of patients who rely on regularly scheduled hemodialysis, and a loss of patency results in under-dialysis, leading to higher morbidity and mortality (21). Percutaneous

endovascular techniques have proven to be successful with the added benefits of lower cost and periprocedural morbidity when compared to surgical thrombectomy (3, 11). Studies have shown that surveillance of indwelling arteriovenous (AV) grafts can reduce the number of thromboses, and that procedure technique can influence success (11, 12, 22–24). Allon et al. (23) reported dramatic improvement in the maintenance of AV grafts in their di-

alysis population on implementation of a multidisciplinary approach that involved the transition of procedures to an outpatient setting, aggressive surveillance, and detailed logistical support. The potential relationships of numerous variables to patency over time have been evaluated for graft access procedures (12, 14, 16, 18, 22, 23) and several studies have addressed parameters for preventing thrombosis (5–7, 15). However, to the best of our knowledge, no study has addressed the effect of the time interval/delay from clinical presentation of a thrombosis to the procedure on intervention success.

A potential limitation of this study is the utilization of order entry time as the start point for our calculations. This study assumed a constant regarding the absolute time of thrombosis and the time interval from that event to clinical presentation, which might not be valid. However, it is worth noting that the potential bias introduced by this method would underestimate the clot age. A second limitation is the failure to include the number of recent interventions in our multivariate analysis. Serial interventions are associated with shortened graft life and ultimate thrombosis of the access. It is possible that this variable affected our success rate, and possibly the time-intervention outcome relationship as well.

The overall success rate for percutaneous declotting procedures in this study was 83.5%, after accounting for both failed declotting interventions and failed dialyses postintervention. There was no significant association between the elapsed time to intervention covariate,  $X_n$ , and successful outcome of the intervention, as defined by a complication-free percutaneous thrombolysis intervention and subsequent dialysis session. That is, at no time up to 72 hours from presentation to procedure was the elapsed time to intervention a significant factor in the procedure's outcome. After fitting the multivariate logistic regression model, it was found that none of the parameters of patient age, gender, or surgical access age were significant predictors of outcome success.

In conclusion, the time to intervention in the setting of a clotted surgical

hemodialysis access is independent of the intervention outcome, and that at no time up to 72 hours following clinical presentation does the time to procedure become a significant factor in outcome success.

#### Conflict of interest disclosure

The authors declared no conflicts of interest.

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