AJKD

Original Investigation

Buttonhole Versus Rope-Ladder Cannulation of Arteriovenous Fistulas for Hemodialysis: A Systematic Review

Ben Wong, MD,[1] Maliha Muneer, BSc,[2] Natasha Wiebe, MMath,[2] Dale Storie, MA,[2] Sabin Shurraw, MD,[1] Neesh Pannu, MD,[1] Scott Klarenbach, MD,[1] Alexa Grudzinski, BSc,[3] Gihad Nesrallah, MD,[3] and Robert P. Pauly, MD[1]

Background: The buttonhole technique is an alternative method of cannulating the arteriovenous fistula (AVF) in hemodialysis (HD), frequently used for home HD patients. However, the balance of risks and benefits of the buttonhole compared with the rope-ladder technique is uncertain.

Study Design: A systematic review of randomized trials and observational studies (case reports, case series, studies without a control group, non-English studies, and abstracts were excluded).

Setting & Population: HD patients (both in-center conventional HD and home HD) using an AVF for vascular access.

Selection Criteria for Studies: We searched MEDLINE, EMBASE, EBM Reviews, and CINAHL from the earliest date in the databases to March 2014 for studies comparing clinical outcomes of the buttonhole versus rope-ladder technique.

Intervention: Buttonhole versus rope-ladder cannulation technique.

Outcomes: The primary outcomes of interest were patient-reported cannulation pain and rates of AVF-related local and systemic infections. Secondary outcomes included access survival, intervention, hospitalization, and mortality, as well as hematoma and aneurysm formation, time to hemostasis, and all-cause hospitalization and mortality.

Results: Of 1,044 identified citations, 23 studies were selected for inclusion. There was equivocal evidence with respect to cannulation pain: pooled observational studies yielded a statistical reduction in pain with buttonhole cannulation (standardized mean difference, −0.76 [95% CI, −1.38 to −0.15] standard deviations), but no difference in cannulation pain was found among randomized controlled trials (standardized mean difference, 0.34 [95% CI, −0.76 to 1.43] standard deviations). Buttonhole, as compared to rope-ladder, technique appeared to be associated with increased risk of local and systemic infections.

Limitations: Overall poor quality and substantial heterogeneity among studies precluded pooling of most outcomes.

Conclusions: Evidence does not support the preferential use of buttonhole over rope-ladder cannulation in either facility-based conventional HD or home HD. This does not preclude buttonhole cannulation as being appropriate for some patients with difficult-to-access AVFs.

Am J Kidney Dis. ■(■):■-■. © *2014 by the National Kidney Foundation, Inc.*

INDEX WORDS: Buttonhole; rope-ladder; cannulation technique; needling pain; arteriovenous fistula (AVF); vascular access; hemodialysis (HD); end-stage renal disease (ESRD); access-related infection; systematic review; chronic kidney disease (CKD).

The arteriovenous fistula (AVF) is the preferred vascular access among hemodialysis (HD) patients, owing to its lower infectious complications and fewer failures compared with all other types of access.[1-5] Consistently successful cannulation of an AVF is critical for achieving adequate HD and is the lifeline for HD patients. The conventional method of accessing the AVF for dialysis treatments is the rope-ladder or rotating-site cannulation technique. This involves needle placement sites that are rotated along the entire length of the fistula each time the patient receives dialysis. An alternative method, described by Twardowski and Kubara[6] in 1979, is called the buttonhole or constant-site technique. Here, the HD needles are inserted into precisely the same location, at an identical angle and depth for each treatment. The result is a permanent, self-sealing, fibrous tunnel through which the fistula can be accessed repeatedly over years, and it initially was advocated for use with fistulas having short useable segments or for patients experiencing significant cannulation discomfort.[6]

Although the buttonhole technique has not gained widespread popularity among conventional in-center HD patients, this technique has been used routinely by many self-cannulating home HD patients. Purported benefits of the buttonhole technique include less patient-perceived pain, more rapid hemostasis,

From the [1]Division of Nephrology and Transplant Immunology, University of Alberta; [2]University of Alberta, Edmonton, Alberta; and [3]Western University, London, Ontario, Canada.

Received January 20, 2014. Accepted in revised form June 9, 2014.

Address correspondence to Ben Wong, MD, University of Alberta, Canada. E-mail: bcw@ualberta.net

0272-6386/$36.00

http://dx.doi.org/10.1053/j.ajkd.2014.06.018

and fewer fistula complications, including local and systemic infections, aneurysm formation, and AVF failure.[7,8] Though initially thought to be a safe procedure, more recent literature raises concerns that the buttonhole technique may be associated with a higher incidence of access-related infections, including life-threatening metastatic infectious complications.

Given the absence of large high-quality studies of patient-relevant outcomes of cannulation technique, we sought to systematically review and summarize the risks and benefits of buttonhole compared to rope-ladder cannulation among HD patients using the AVF for vascular access.

METHODS

This systematic review was reported in accordance with published guidelines.[9,10] The review protocol was registered with the National Institute for Health Research PROSPERO database (registration number CRD42012002850).

Search Strategy

A health information specialist at the University of Alberta (D.S.) was involved in development of the search strategy. Databases included MEDLINE (1946 to March 21, 2014), EMBASE (1974 to week 12, 2014), Cumulative Index to Nursing and Allied Health Literature (CINAHL; 1937 to March 21, 2014), and Evidence-Based Medicine (EBM) Reviews (to March 21, 2014). Detailed search strategies are in Item S1 (provided as online supplementary material). Reference lists of included articles also were reviewed for relevant citations. Pairs of reviewers (B.W., R.P.P., G.N., A.G., and S.S.) independently performed title and abstract screening in duplicate, and any study considered potentially relevant by at least 1 reviewer was retrieved for full-text review.

Selection Criteria

Two reviewers (B.W. and M.M.) independently assessed the full text of each potentially relevant study for inclusion using predetermined eligibility criteria. Studies of adults 18 years or older using buttonhole cannulation in the home or in-center setting to cannulate incident or prevalent fistulas were included if they reported important clinical outcomes and included a rope-ladder control group. We included randomized trials and observational studies. We excluded abstracts, case reports, review articles, editorials without original data, and non-English publications. Disagreements were resolved by a third party (R.P.P.).

Data Extraction

All data were extracted in duplicate and included study characteristics (country, year, study design, sample size, and study duration), patient characteristics (age, sex, modality, dialysis vintage at baseline, and age of AVF at baseline), specifics of the buttonhole cannulation technique, and patient outcomes. The primary outcomes of interest were patient-reported cannulation pain and rates of AVF-related local and systemic infections. Secondary outcomes included access-related interventions, survival, hospitalization, and mortality, as well as hematoma and aneurysm formation, time to hemostasis, and all-cause hospitalization and mortality.

Risk of Bias Assessment

For randomized studies, we evaluated the risk of bias within studies using criteria adapted from Higgins et al[11]; a risk of bias assessment tool based on the Ottawa-Newcastle criteria was applied to observational studies.[12] These criteria include items of study design (selection of participants and matching for covariates and outcome definitions), statistical analysis (calculation of sample size and adjustment for potential confounding), and results (loss to follow-up).

Data Synthesis and Analysis

We compiled characteristics of each included study in tabular form and distilled this into individual outcomes tables according to dialysis modality: in-center HD versus mixed (in-center HD and home HD) or home HD. We analyzed data using Stata, version 13.1 (StataCorp LP). Median values were substituted for mean values and missing standard deviations were imputed according to Wiebe et al.[13] We calculated and pooled the standardized mean difference[14] for cannulation pain; the rope-ladder cannulation group mean minus the buttonhole cannulation group mean value divided by their pooled standard deviation corrected for small sample size bias using adjusted g of Hedges and Olkin.[15] By presenting the differences in mean values relative to standard deviation, we removed the heterogeneous effect of choice of pain instrument. Due to other differences (eg, study design, patient population, and variations in buttonhole cannulation technique) expected between studies, we combined results using the Knapp-Hartung random-effects model.[16] Statistical heterogeneity was quantified using the I^2 statistic.[17,18]

RESULTS

Search Yield

The search yielded 1,379 records (Fig 1). In total, 171 citations were retrieved for detailed evaluation. Of these, 23 primary articles were eligible for inclusion in this systematic review.[6-8,19-38]

Study and Participant Characteristics

There was significant heterogeneity among studies (Table 1). Of the 23 studies included, 5 were randomized controlled trials (RCTs)[7,19,21,23,29,38] (the second study by MacRae et al[38] was a long-term follow-up of their original RCT[19]), while the rest were observational studies of various designs: prospective cohort,[8,28,37] retrospective cohort,[20,30,34] prospective before-after,[27,31,35] retrospective before-after,[6,22,25,26,32,36] or cross-sectional.[24,33] Eight of 23 studies did not have an explicit or even implicit prespecified primary outcome. Objectives of the various investigations differed among the remaining studies and the authors reported only on outcomes matching their objectives; cannulation pain is not a necessary outcome of buttonhole research so not all studies in this systematic review addressed our primary outcome (needling pain). Needling pain was reported as the primary outcome in 5 studies, and infection rate, in another 6. No study included only incident patients or incident fistulas. Most (17 of 23) studies were restricted to in-center HD patients, whereas 3 were limited to home HD patients and 3 included both modalities. Sample size ranged from 14-447 patients. When reported, the mean age of patients ranged from 48.5-70.4 years, and most patients were men (range, 38%-82%). Dialysis vintage was reported in only 10 studies, with median and mean values ranging from 0.34-3.7 years.