A timesaving method to create a fixed puncture route for the buttonhole technique

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Abstract

Background. Up to now, for a successful buttonhole puncture of the vascular access vessel, the fistula should be punctured by the same experienced medical staff for 2–3 months, using sharp needles, until a fixed puncture route is established.

Methods. We developed a timesaving method to create the fixed puncture route for the buttonhole technique. In this method, after the usual haemodialysis (HD), a newly developed thumbtack-shaped polycarbonate peg is thrust toward the access vessel along the same path as the puncture needle that has just been removed. Then, at the beginning of the next HD, the peg is removed and a dull puncture needle is inserted along the track already formed by the peg left in place. These steps are repeated at each HD session for 14 days. Thereafter, the vascular access is achieved at HD sessions by inserting a dull puncture needle through the established puncture route.

Results. This buttonhole puncture approach was used in 37 patients for 3 months. While the polycarbonate peg was in place, patients experienced no restrictions in their normal activities of daily living, except during bathing and showering. As for puncture pain, no patient found the pain of the buttonhole technique to be greater than that of the conventional puncture technique. Moreover, no significant bleeding was noted during HD. With this buttonhole puncture approach, only one patient had enough erythema at the puncture site to suggest possible infection. After HD, the time for bleeding to stop was <10 min in 95% of patients.

Conclusion. This study showed the new timesaving method for creating a buttonhole to be safe and useful.

Keywords: blood access; buttonhole puncture; chronic haemodialysis; dialysis shunts

Introduction

A few studies have indicated that inserting haemodialysis (HD) needles at exactly the same spot for consecutive dialyses may cause fewer complications than using a different puncture site for each HD treatment [1–5]. This constant-site puncture method developed by Twardowski [2] has been renamed the ‘buttonhole puncture technique’ by Krönung [1].

Twardowski [2] indicated that, to make successful buttonhole punctures of the vascular access vessel, following an initial period of several weeks allowed for fistula maturation, the fistula should be punctured by the same experienced medical staff and using sharp needles, until a fixed puncture track is established. Only after a good puncture route has been created are less experienced staff members to be allowed to puncture the site.

In many HD facilities, however, it may not be feasible to have the same experienced person in charge of puncturing the access vessels for 2–3 months. It was for this reason that we developed a timesaving method to create a fixed puncture route for the buttonhole technique. In this method, following each dialysis session, for a period of 2 weeks a newly developed thumbtack-shaped polycarbonate peg (BH Stick; Nipro Co., Osaka, Japan) is inserted and left in place in the path of the removed HD needle for a total of 2 weeks, so as to create a fixed puncture route for the buttonhole technique.

In this study, we present details on this timesaving method and then discuss its safety and usefulness.

Subjects and methods

Timesaving method to create a fixed route for buttonhole puncture

As shown in Figure 1, the polycarbonate peg left in place is thumbtack shaped. The peg is 5 mm in length, short enough...
Fixed puncture route for the buttonhole technique

Fig. 1. The indwelling polycarbonate peg. The peg is 5 mm in length, and the diameter of its penetrating portion is the same as that of the puncture needle. Its tip is dull, and a spherical stopper (3 mm diameter) is provided on the opposite end.

Fig. 2. After withdrawing a puncture needle and stopping bleeding at the end of a standard haemodialysis, the newly developed thumbtack-shaped polycarbonate peg is thrust toward the access vessel along the path of the puncture needle just removed. The peg is short enough so that its tip does not reach the access vessel wall.

for its tip not to reach the access vessel wall, and its diameter is the same as that of the puncture needle. The tip of the peg is rounded and dull, so as not to pierce the vessel even if the tip reaches the vessel wall. A spherical stopper (3 mm diameter) is provided on the opposite end of the dull tip.

After a standard HD, the peg is thrust toward the access vessel along the path of the puncture needle that has been just removed (Figure 2). Then, the spherical stopper of the peg on the skin surface is covered with two waterproof adhesive plasters (i.e. a smaller one first, and then a larger one on it) before the patient is discharged.

Before the next HD, the peg is removed and the access vessel is punctured through the tunnel left by the peg using a standard sharp needle with a plastic cannula. After the HD, a new peg is inserted along the path of the plastic cannula that has just been removed to again be left in place; and the spherical stopper is covered with the two adhesive plasters. These steps are repeated for 2 weeks, except that at the start of subsequent HD sessions the blood access vessel is punctured with a dull needle instead of a sharp one. A peg is in place, therefore, for 2 weeks during the interdialytic periods.

Patients are instructed to refrain from activities in which the indwelling peg could get wet, such as taking a bath or sauna or swimming, and to wear a plastic sheet on the arm with the indwelling peg when taking showers.

After the 2 weeks, once the fixed puncture route is established by this method, before every HD the scab that has developed on the skin on the entry of the buttonhole during the preceding interdialytic period is removed. The access vessel is then punctured with a dull needle through the buttonhole. This buttonhole is used three times a week.

We have observed that, for unknown reasons, with the fixed route created by this method, the puncture point on the access vessel wall shifts slightly forward. Therefore, in order to insert the dull needle into the vessel, its tip must be slid forward while pushing the vessel wall after it reaches it. By puncturing the blood access vessel in this manner with a dull needle, no puncture errors have resulted to date.

Patients

We selected 86 patients with Cimino-Brescia fistulae, all of whom volunteered for buttonhole puncturing. These patients were randomly assigned either to the buttonhole group, in which the fixed puncture route was to be newly created by the method under study, or to the control group, in which the access vessels were punctured by the method in established use. Although 43 patients were assigned to the buttonhole group, six of them decided not to participate immediately before the study began. Therefore, the control group consisted of 43 patients, and the buttonhole group 37 patients.

There were 17 males and 20 females with a mean age of 60 ± 16 years in the buttonhole group, and 16 males and 27 females with a mean age of 64 ± 13 years in the control group. The kidney diseases in the buttonhole group were chronic nephritis in 21, diabetes mellitus in 11, gout in two, nephrosclerosis in one, polycystic kidney in one and gestational toxicosis in one. Among controls, on the other hand, the kidney diseases were chronic nephritis in 24, diabetes mellitus in 11, nephrosclerosis in three, lupus nephritis in two, polycystic kidney in one, gout in one and gestational toxicosis in one. The average time from the insertion of the Cimino-Brescia fistula until this study was 42.6 ± 40.0 months in the buttonhole group and 45.1 ± 41.6 months in the control group.

In the buttonhole group, the observation period was 3 months after the initiation of buttonhole puncturing using the fixed route created by the new method; in the control group, it was 3 months starting from the day they had been assigned to the group.

Outcome measures

Comparison of puncture pain between the buttonhole and conventional methods. One week after the initiation of the buttonhole puncturing using the newly created fixed route, all the patients in the buttonhole group were asked which of the puncture methods was less painful—the buttonhole method they were currently using or the conventional method they had been using.

Comparison of the incidence of infection at the puncture sites between groups. During the 3 month observation period, nurses in charge of puncturing the access vessels before each HD session determined whether or not a puncture site was infected. In this study, at least one of the following findings was considered to indicate infection: (i) redness, (ii) swelling, (iii) tenderness, (iv) exudate and (v) pus.

Comparison of bleeding at the puncture sites during HD between groups. The nurses in charge of puncturing the access
vessels assessed the severity of bleeding at the puncture site during the last HD in the 3 month observation period in both groups, according to the following criteria: (i) no bleeding, (ii) only light blood stains around the puncture site, (iii) bleeding requiring an astringent and (iv) bleeding requiring a change in the puncture site.

**Comparison of bleeding at the puncture sites after needle withdrawal between groups**. At the end of the 3 month observation period, nurses in charge of the end-of-dialysis protocols further classified both groups into the following three subgroups based on the time until bleeding stopped at the puncture site after withdrawal of the puncture needle at the end of HD: (i) within 5 min, (ii) between 5 and 10 min and (iii) 10 min or more.

**Restrictions on activities of daily life when peg is in place**. On the last day of the indwelling peg period, the patients in the buttonhole group were all asked about restrictions in their activities of daily living (with the exception of activities by which the indwelling peg could become wet, such as taking a bath or sauna or swimming with the peg in place).

**Results**

**Comparison of puncture pain between the buttonhole and conventional methods**

Some 40.5% of patients replied that there was significant pain at the time of puncture by the conventional method they had used before the study, but none with the buttonhole technique. Another 40.5% of these patients replied that the pain with the buttonhole technique was less than with the conventional method. The remaining 18.9% of patients experienced the same mild pain with either approach. No patient found the pain with the buttonhole technique to be greater than they had experienced with the conventional technique before the study.

**Comparison of the incidence of infection at the puncture sites between groups**

In the buttonhole group, on one occasion during the observation period, one patient had erythema at the puncture site, indicating a possible infection. In the control group, no patient had any sign of infection at the puncture site.

**Comparison of bleeding at the puncture sites during HD between groups**

In 86.5% of patients in the buttonhole group, no bleeding was noted when assessing during the last HD in the observation period. However, in 10.8% of patients, there was mild blood seepage around the puncture site on at least one occasion during the observation period. In 2.7% of the patients, an astringent was needed to stop bleeding on at least one occasion during the observation period.

In the control group, 95.3% of patients had no bleeding, and no patient had mild blood seepage around the puncture site during the observation period. In 4.6% of the patients, an astringent was needed to stop bleeding on at least one occasion during the observation period.

**Comparison of bleeding at the puncture sites after needle withdrawal between groups**

In the buttonhole group, the time until bleeding stopped was <5 min in 54.1% of the patients, 5–10 min in 40.5% and >10 min in 5.4%. In all patients, there was no resumption of bleeding once it stopped. In the control group, the time for bleeding to stop was <5 min in 27.9% of the patients, 5–10 min in 58.1% and >10 min in 14.0%.

**Restrictions on activities of daily life when peg is in place**

None of the patients in the buttonhole group felt restricted in their normal daily activities, except for activities in which the indwelling peg could become wet, such as taking a bath or sauna or swimming with the peg in place.

**Discussion**

The time until a fixed puncture route is established is much shorter with our new method than with the method of Twardowski [2]: 14 days with our method, against 2–3 months with the original method.

In the new method, although a thumbtack-shaped polycarbonate peg is in place for a total of 14 days, none of the patients felt restricted in their normal activities of daily living (not during dialysis), except for being prohibited from getting the peg wet. This may be because the peg is short enough so that its tip does not reach the access vessel wall. Since the tip of the peg is not embedded in the wall of the vessel, patients do not have to worry about bleeding while it is in place; and since the peg is short, they do not feel any discomfort in their arms.

In this study, we used pegs of the same length for all patients. Still, we encountered no puncture complications during the interdialytic period, notwithstanding the fact that the thickness of the subdermal fatty layer and the subcutaneous position of the vein varied somewhat between individuals. This may be because the axial extension line of the indwelling peg crosses the access vessel, even when the distance between the tip of the peg and the vessel wall is greater than the length of the peg. Moreover, when the distance between the tip of the peg and the vessel wall is shorter than the length of the peg, the dull tip of the peg may well only press down on the vessel wall, but not damage or pierce it.

A comparison of the fixed puncture routes created by the new technique and the original method revealed...
that, for at least 3 months after establishing the fixed puncture route by the new method, the insertion of the dull needle through the fixed puncture route created by the new method did not feel as smooth as insertion through the fixed puncture route created by the original method (not described in Results). This was especially true in patients with abundant subdermal fat and considerable distances between the skin and the access vessel.

In the early stage of the development of this timesaving method, we had been creating a buttonhole by leaving the polycarbonate peg in place continuously for 14 days. During that uninterrupted indwelling period, the vascular access was punctured at sites away from the indwelling peg site (our first-generation method). However, in some patients it had been difficult to find a suitable puncture site other than the indwelling peg site. Therefore, we devised the present timesaving method to create a fixed puncture route (the second-generation method).

The first-generation timesaving method was used in 55 patients for a total of >18,142 times for up to 25 months (16.3 ± 7.8 months). During this mid-term observation period, there were no serious complications and the pain of puncture was reduced, if not completely eliminated [6]. Since both the first- and second-generation methods are substantially similar, our earlier results could reinforce the present ones, indicating that the second-generation timesaving method is effective and safe.

Since both buttonhole puncturing protocols relying on the fixed route created by the first- and second-generation timesaving methods have been used and observed for relatively short periods, it remains uncertain whether the long-term results of buttonhole puncture through the route created by our methods will be the same as those achieved by the original method of Twardowski [2].

Conflict of interest statement. The patent regarding this submitted article was claimed by Shinzato, Toma and Nipro Co., Ltd.

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