Valsalva Maneuver Prevents Guide Wire Trouble Associated with 22-Gauge Safe guide®

Toshiyasu SUZUKI, Kazuhide TAKEYAMA, Jun HASEGAWA, Junichi NISHIYAMA and Mamoru TAKIGUCHI

Department of Anesthesiology, Discipline of Surgery, Tokai University School of Medicine

(Received July 26, 2001; Accepted September 21, 2001)

The Safe guide® is a central venous puncture needle that serves as both a pilot needle and as an introducer. A guide wire can be inserted into a vein through the side port at the hub of the 22-gauge Safe guide® needle initially inserted as a pilot needle. However, guide wire insertion may fail due to kinking or locking at the side port. Increasing airway pressure to 20 cm H_2O by squeezing a respiratory bag during insertion of the guide wire together with venous puncture was attempted to determine if would decrease guide wire trouble.

Subjects and methods: A total of 120 patients scheduled for central venous catheterization by right internal jugular puncture were divided into two groups. Patients in group-A (n = 60) were catheterized by the conventional method and those in group-B (n = 60) were catheterized by applying the Valsalva maneuver. Three observations were made: 1) Frequency of cases in which blood back-flow occurred during withdrawal only and not upon advancement of the puncture needle. 2) Frequency of cases in which kinking and/or locking of the guide wire occurred at the hub during its insertion. And 3) the occurrence of complications.

Results: 1) The patency of the vein was preserved and blood back-flow was obtained during advancement of the puncture needle in all cases in which the Valsalva maneuver was applied. 2) The incidence of kinking and/or locking during insertion of the guide wire decreased from 16.7% to 3.4% by applying positive airway pressure during the Valsalva maneuver. And 3) complications were negligible. Additionally, the application of the Valsalva maneuver allowed successful guide wire insertion in 6 out of 9 cases (67%) in group-A, in which the initial attempt using the conventional method had failed.

Conclusion: The application of positive airway pressure using the Valsalva maneuver may prevent the guide wire trouble associated with the 22-gauge Safe guide®.

Key words : Safe guide®, Valsalva maneuver, Guide wire trouble

INTRODUCTION

The Safe guide® kit is a central venous puncture needle that works as both a pilot needle and an introducer. A guide wire can be inserted into a vein with a single venous puncture using a side port at the hub of the 22-Gauge puncture needle. The advantage of this needle is that guide wire insertion requires penetration force as low as a pilot needle penetration force [5, 10, 12]. However, guide wire advancement through the side port may fail due to kinking or locking [3, 13]. Thus, the efficacy of increasing airway pressure up to 20 cmH_2O with a respiratory bag during insertion of central venous catheterization for the prevention of guide wire trouble was investigated.

APPARATUS

Structure of Safe guide®

The Safe guide® needle is a 22-Gauge metal needle that has a side port with a valve at the hub. A 0.018-inch guide wire can be inserted through the port (Fig. 1).

SUBJECTS AND METHODS

(1) The subjects were 120 patients requiring central venous catheterization. Informed consent was obtained from the patients prior to the study. The patients were divided into 2 groups. Patients of group-A (n = 60) were

Toshiyasu SUZUKI, Department of Anesthesiology, Discipline of Surgery, Tokai University School of Medicine, Boseidai, Isehara, Kanagawa 259-1193, Japan Fax: 0463-91-9260 Tel: 0463-93-1121

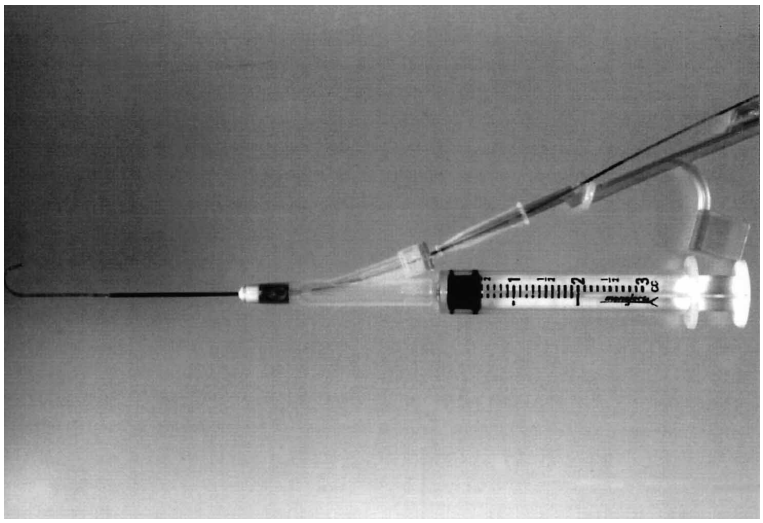

Fig. 1 Structure of Safe guide®
The Safe guide® needle is a 22-Gauge metal needle that has a side port with a valve at the hub. A 0.018-inch guide wire can be inserted through the port

catheterized by the conventional method and those in group-B (n = 60) were catheterized while applying the Valsalva maneuver. After the induction of general anesthesia and endotracheal intubation, the patient's head was turned approximately 30 degrees to the left and the patient was placed in the Tredelenburg's position. 22-Gauge Safe guide® was inserted into the right internal jugular vein using a central approach. The needle was inserted at an angle of approximately 40-degree from the top of a triangle formed by the right clavicle and clavicular and sternal branches of the sternocleidomastoideus muscle. All central venous punctures and catheter placements were performed by first or second year resident's supervised by an instructor in anesthesiologist. For group-B, an assistant was squeezing the respiratory bag manually to increase and maintain airway pressure at 20 cmH_2O during central venous puncture. The bag was temporarily released after blood back-flow was confirmed, and airway pressure was applied again in the same manner for the guide wire insertion from the side port. The Safe guide® needle was removed from the vein leaving the guide wire in place. The dilator was inserted after cutting the skin and subcutaneous tissue at the insertion site. Finally, a central venous catheter was passed over the guide wire and placed in position. The following 3 observations were made:

1) Frequency of cases in which blood back-flow was obtained at the needle withdrawal with no blood back-flow at needle advancement.
2) Frequency of the guide wire kinking or locking during insertion through the side port.
3) Complications

Mann-Whitney's U-test was used for statistical analysis. ($p < 0.05$).

If insertion was unsuccessful, the Valsalva maneuver was applied in second attempt for group-B. The following 3 observations were made;

1) Presence or absence of blood back-flow from the side port.
2) Success or failure of guide wire insertion.
3) Assessment of the position of the puncture needle with an ultrasonic echogram.

(2) Measurements of the internal jugular vein applying the Valsalva maneuver:

The diameter of the internal jugular vein was measured in 64 surgical patients. Patients with preoperative cardiovascular abnormalities and emergency operation were excluded. The study was explained to the patients and consent was obtained in advance.

After induction of general anesthesia and

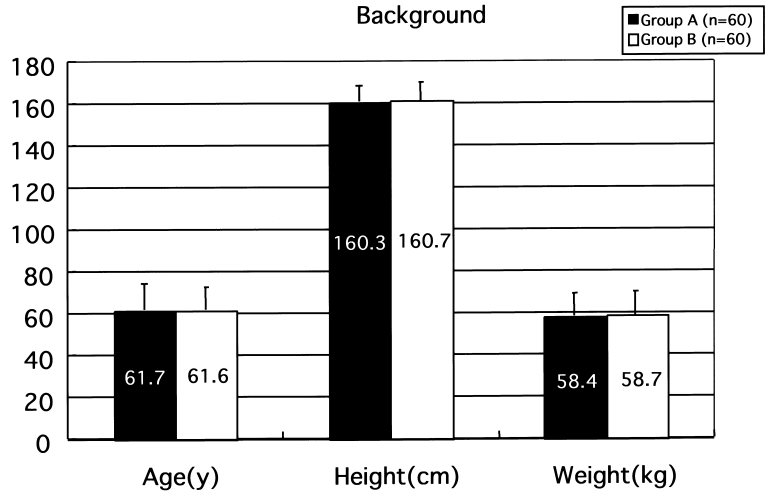

Fig. 2 Patient background Each value represents mean ± SD.

endotracheal intubation, the patient's head was tilted approximately 30 degrees to the left and placed the patient was in the Tredelenburg's position. Ultrasonic echograms of the internal jugular vein were taken from the top of a triangle formed by the right clavicle and clavicular and sternal branches of the sternocleidomastoideus muscle. Aloka SSD with a 7.5 MHz linear type probe was used for imaging. Airway pressure was maintained at 20 cmH_2O by the Valsalva maneuver. This pressure was maintained for 10 seconds, and then the following measurements were taken, including the maximum diameters of the right internal jugular vein, with the patient's in either position (1), or (2)

Patients' positions:

1) Trendelenburg's position
2) Trendelenburg's position (Valsalva maneuver applied)

Measurements:

1) Distance between skin surface and the right internal jugular vein (mm)
2) Diameters of right internal jugular vein (vertical and horizontal) (mm)

Student' T assay was used. ($p < 0.05$), and the results were indicated at mean ± standard deviation.

RESULTS

(1) Patient background

The black bar shows group-A and the white bar shows group-B. There were no differences between group-A and group-B regarding age, height and weight (Fig. 2)

(2) The clinical study:

1) Blood back-flow could be obtained only upon withdrawal of the needle in 3.4% of group-A, whereas back-flow was also obtained during advancement in all of group-B.
2) Guide wire kinking or locking during insertion through the Safe guide® side port occurred in 16.7% of group-A and 3.4% of group-B.
3) Accidental puncture of common carotid artery occurred in 1.7% of group-A and 3.4% of group-B (Fig. 3).

(2) Success rate and the position of the puncture needle in group-A cases, in which the Valsalva maneuver was applied after unsuccessful attempts to insert the guide wire:

In group-A, 9 cases failed in guide wire insertion. The addition of the Valsalva maneuver for another attempt allowed successful placement in 6 (67%) of those 9 cases, but 3 remained unsuccessful. In the 3 unsuccessful cases, the blood back-flow from the side port was weak and ultrasonic echograms indicated that the needle tip was at the anterior wall of the vein (Table 1).

(3) Measurements of the internal jugular vein applying the Valsalva maneuver:

The differences in distance between the skin surface and internal jugular vein

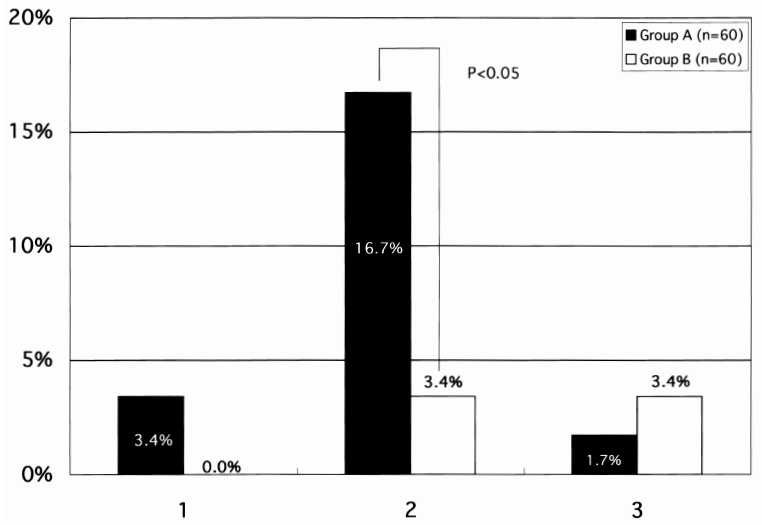

Fig. 3 Results
The black bar shows Group-A and the white bar shows Group-B
1) In 3.4% of group-A, blood back-flow was obtained upon the needle withdrawal, whereas blood back-flow obtained at the needle advancement for all cases in group-B.
2) Guide wire kinking or locking during insertion through the Safe guide® side port occurred in 16.7% of group-A, and in 3.4% of group-B. It is thought that the Valsalva maneuver may prevent guide wire trouble during its insertion.
3) Accidental carotid artery puncture occurred in 1.7% of group-A, besides it occurred in 3.4% of group-B.

between the 2 positions were not statistically significant. The vertical and horizontal diameters of the vein increased 1.2 times, respectively, by applying the Valsalva maneuver (Table 2).

DISCUSSION

Unlike peripheral vein puncture, the course of the vein cannot be confirmed macroscopically when performing internal jugular vein puncture. Consequently, the direction of the puncture needle may deviate from the course of the vein. In such cases, blood back-flow may not be obtained and insertion of the guide wire may fail. A successful guide wire insertion depends on where the anterior wall of the vein was penetrated and on the direction of the puncture needle. Application of the Valsalva maneuver with the patient placed in Tredelenburg's position is accepted as a general safety measure for internal jugular vein puncture. This measure is considered to increase the diameter of the vein and to decrease overlapping with the common carotid artery [1, 2, 6, 11, 12, 13]. However, the efficacy of the Valsalva maneuver for guide wire insertion using the Seldinger technique has not been widely reported. Therefore, in this study, a efficacy was investigated using the Safe guide® needle. Safe guide® is a central venous puncture needle developed in this department. Its required penetration force has been clinically and experimentally proven to be smaller than other puncture needles. Also, its usage is associated with limited complications, making it easy to use even for beginners [3–5, 10–12]. From this study, blood back-flow was obtained at the needle advancement in the majority of cases, and the difference between the 2 groups was not significant. The Valsalva maneuver increases venous wall tension by increasing venous pressure. This should decrease the venous compression due to needle puncture. It is considered to be effective especially for needles that require rather large penetration force such as 18 or 20 gauge size. In this study, unsuccessful rate of the guide wire insertion through the side port was 16.7% of the cases attempted by the conventional method. However, with the

Table 1 Success rate and a position of puncture needle in-group-A cases in which the Valsalva maneuver was applied after unsuccessful attempts to insert the guide wire

case	Blood back-flow upon Valsalva maneuver	Guide wire insertion	Puncture needle position (Longitudinal echogram)
1	comfirmed	successful	Posterior wall
2	comfirmed	successful	Posterior wall
3	none	failed	Anterior wall
4	comfirmed	successful	Posterior wall
5	none	failed	Anterior wall
6	comfirmed	successful	Posterior wall
7	none	failed	Anterior wall
8	comfirmed	successful	Posterior wall
9	comfirmed	successful	Anterior wall

In group-A, 9 cases failed in guide wire insertion. The addition of the Valsalva maneuver for another attempt allowed successful placement in 6 (67%) of those 9 cases, but 3 remained unsuccessful. For the unsuccessful 3 cases, the blood back-flow from the side port was weak and ultrasonic echograms indicated that the needle tip was at the anterior wall of the vein.

Table 2 Measurements of the internal jugular vein during the Valsalva maneuver (n = 68)

	Distance from skin (mm)	Horizontal diameter (mm)	Vertical diameter (mm)
Trendelenburg's position	10.5 ± 2.7	14.6 ± 3.7	9.8 ± 2.7
Trendelenburg's position (airway positive pressure maintained)	10.6 ± 2.6	*17.4 ± 4.1	*12.0 ± 2.4

Each value represents mean ± SD. *$P < 0.05$ versus Trendelenburg's position
The differences in distance between the skin surface and internal jugular vein among the 2 positions were not statistically significant. The vertical and horizontal diameters of the vein increased 1.2 times, respectively, by applying the Valsalva maneuver.

Valsalva maneuver, the failure rate was reduced to 3.4%. Furthermore for the 9 unsuccessful cases of group-A, reinsertion was successful in 6 cases with the Valsalva maneuver. Three cases remained unsuccessful. To investigate the cause of the failures, patterns of the changes in internal jugular vein diameter were studied using ultrasonic echogram. The vertical and horizontal diameters of the vein increased 1.2 times, respectively, by applying the Valsalva maneuver, but the distance between the skin surface and internal vein did not change. The results indicate that with the Valsalva maneuver, the internal jugular vein expands outward toward the lateral and posterior walls but does not effectively expand toward the anterior wall. For internal jugular insertion, the vein tends to be compressed when compared with subclavian vein insertion. Expansion toward the anterior wall is even less likely during internal jugular vein puncture because the anterior wall would be compressed by the puncture needle. This kind of puncture needle may migrate slightly forwered towards the posterior or postero-lateral wall if the needle tip is unstable. Likewise, the needle may be unintentionally withdrawn partially from the anterior wall. In this case, the Valsalva maneuver would not be effective for the guide wire insertion. In fact, for those 3 failed cases, the puncture needle tip was located close to the anterior wall. However, if the needle tip migrates forward and is placed against the posterior or postero-lateral wall, the Valsalva maneuver should expand the vein and lead to successful guide wire insertion. For all 6 cases in

which the Valsalva maneuver allowed successful guide wire insertion after an unsuccessful attempt using the conventional procedure, longitudinal images from an ultrasonic echogram indicated that the needle tips were all located at the posterior wall. Because ultrasonic echograms are not 3-dimensional, the effect of the Valsalva maneuver cannot be evaluated in cases in which the needle is inserted toward the postero-lateral wall. Beginners, however, have a tendency to advance the puncture needle laterally from the standard insertion point to avoid accidental common carotid artery puncture. Thus, the puncture needle passes through the right end of the horizontal diameter of the vein and advances laterally. In such cases, the Valsalva maneuver may be less effective. It is important to obtain certain blood back-flow by the Valsalva maneuver upon of guide wire insertion through the side port. This indicates that the needle tip, which was placed against the posterior or postero-lateral wall, was retrieved back into the lumen of the vein. The structure of the puncture needle is also an important factor for successful guide wire placement. If the needle bevel is too long, guide wire insertion may fail despite obtaining blood back-flow. This is because blood back-flow can be obtained even when the bevel is partially in the vein. It may happen particularly when the puncture needle tip remains close to the anterior wall or is placed against the postero-lateral wall [3]. Our previous study indicated that the shape of the guide wire also plays a major role in the success/failure of insertion [13]. The curvature of a J-shaped wire is strong, making its exit from the needle sudden compared to wires with a weaker curvature such as straight- and angled-type wires. This may lead to the increased possibility of guide wire insertion failure for the J-shaped wire. The results of this study suggest that for successful internal jugular vein catheterization the Valsalva maneuver should be used upon venous puncture with the patient in the Trendelenburg's position and to apply the Valsalva maneuver again to guide wire insertion. One disadvantage of this procedure is that it is necessary to have an assistant when applying it, to intubated patients. In patients who are awake, however, this procedure may be performed without difficulty. A similar effect may be obtained by requesting the patient to hold his/her breath during venous puncture and guide wire insertion.

Additionally, requirements for a central venous puncture needle would be a short bevel and a low penetration force in which the Safe guide® needle has. And finally, the use of a straight- or angle-type guide wire is advisable instead of a J-shaped type for a successful insertion.

REFERENCES

1) Denys BG, Uretsky BF, and Reddy PS: Ultrasound-assisted cannulation of the internal jugular vein. A prospective comparison to the external landmark-guided technique. Circulation 87: 1557–1562, 1993
2) Gordon AC, Saliken JC, Johns D, et al: US-guided puncture of the internal jugular vein: complications and anatomic considerations. J Vasc Interv Radiol 9: 333–338, 1998
3) Hasegawa J, Suzuki T, Honda M, et al: Clinical evaluation of a 20-guage Safe-guide®. The Journal of Japan Society for Clinical Anesthesia 19: S147, 1999
4) Ito K, Suzuki T, Fukuyama H, et al: Improvement of SAFE GUIDE®: A Further Up-Grade of the Central Venous Catherization Kit. Rinsho Masui 6: 857–859, 1998
5) Kanazawa M, Suzuki T, Kinefuchi Y, et al: Clinical evaluation of a new central venous catherization kit in 100 cases. Circulation Control 17: 386–389, 1996
6) Kitagawa N, Nakahira K, Koyanagi H, et al: Valsalva maneuver decreases the overlap between internal jugular vein and carotid artery. The Journal of Japan Society for Clinical Anesthesia 7: 853–857, 1998
7) Saito S, Suzuki T, Kanazawa M, et al: Appropriate puncture position for subclavian venous puncture using a Safe guide®. BJA 78: supplement 12, 1997
8) Sulek CA, Gravenstein N, Blackhear, and RH et al: Head rotation during internal jugular vein cannulation and the risk of carotid artery puncture. Anesth Analg 82: 125–128, 1996
9) Suzuki T, Kinefuchi Y, and Takeyama K, et al: How to cannulate the internal jugular vein with ease. : Ultrasonnographic aid. Circulation Control 14: 313–319, 1993
10) Suzuki T, Kanazawa M, Kinefuchi Y, et al: A pilot/introducer needle for central vein cannulation. Tokai J Exp Clin Med 20: 223–225, 1996
11) Suzuki T, Kanazawa M, Kinefuchi Y, et al: An improved puncture-insertion kit for Swan-Ganz catheter. Circulation Control 17: 543–546, 1996
12) Suzuki T, Hasegawa J, Ito K, et al: The usefulness of the 22-guage Safe guide® based on Penetration Force and Pattern of Venous Regurgitation. Circulation Control 21: 427–433, 2000
13) Suzuki T, Nishiyama J, Hasegawa J, et al: Modification of guide wire for 22-gauge Safe guide® Tokai J Exp Clin Med (inprint) 26: 63–70, 2001
14) Troianos CA, Jeves DR, and Ellison N: Ultrasound-guided cannulation of the internal jugular vein. A prospective randomized study. Anesth Analg 72: 313–319, 1993