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Original Article

A Comparison of Two Commonly Used Methods for Securing Intravenous Cannulas

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Background: There is a wide variety of techniques to secure intravenous cannulas but little objective evidence to support their relative efficacy. This study compares the security of the two most common methods used within a major Australian Emergency Department.
Methods: The plastic sheaths of four needle-less intravenous cannulas were secured to the skin surface (not intravenously) of 40 volunteers using two different taping styles, an "under and over" method with one of the tapes applied to the posterior surface of the hub then crossed anteriorly to adhere to the opposite skin surface or "horizontal" taping with the tapes applied horizontally across the anterior surface of the hub. The peak force required to dislodge the taped cannulas using each of these different methods was then measured in both an anterograde and retrograde direction of force using a force transducer.
Results: The force required to dislodge a cannula taped in an 'under and over' taping style was significantly higher than that required for the horizontal taping in both anterograde and retrograde directions of force ($p < 0.001$).
Conclusions: The results of this study suggest that the "under and over" taping technique offers significantly more security than "horizontal" taping and should be considered as a more effective method for securing intravenous cannulas.

Key words: *cannula, dislodgement, force, security, taping*

Introduction

Reliable intravenous access is a basic yet essential requirement for management of many patients within the pre-hospital environment, the emergency department (ED) and the hospital as a whole. Although minimally invasive, intravenous cannulation has several well documented complications including thrombophlebitis (up to 67%), bacteraemia (0.3%), extravasation (36%) and dislodgement (up to 42 %).[1,2] A secure dressing not only decreases rates of dislodgement but also limits movement related mechanical trauma to the vascular endothelium, which is believed to be a causal factor in thrombophlebitis and extravasation.[2-8] These side effects of cannulation can cause significant patient morbidity and delays in treatment[8] as well as contribute significant cost to the hospital system through increased staff work load for recannulations.[4,5,8,9]

The Centre for Disease Control (CDC) guidelines suggest a peripheral cannula need not be routinely resited for up to 96 hours.[10] However, as few as 15% of cannulas have been shown to last this duration, with dislodgement being one of the most common reasons for failure.[2,4,5,8] It has even been sug-

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gested that routine resites for uncomplicated cannulas are unnecessary,[1,4] making a secure dressing to prevent dislodgement even more beneficial in extending the possible duration of a cannula.

There is published research comparing different types of adhesive materials for cannula dressings,[11-19] as well as comparing adhesives with specific cannula securement devices.[2,4-8] However, there are few studies comparing actual taping configurations[20,21] and none comparing two commonly used techniques in ED i.e., "horizontal" taping or "under and over" taping.[22] Whilst there are a multitude of methods of securing cannulas, the "horizontal" taping style was chosen as it is the recommendation from 3M™ (who provide the cannula dressings in our ED)[22] as well as that used exclusively by the cannulation nurses in our department. The "under and over" technique was chosen as it is commonly utilised in paediatric cannulation where cannula security is perhaps seen as a greater priority.

The objective of this study was to compare the force required to dislodge intravenous cannulas secured by two commonly used taping styles i.e., "under and over" vs. "horizontal" taping techniques. It is hypothesised that the "under and over" method provides more security in both an anterograde and retrograde direction of force.

Methods

This prospective, blinded, cross over comparison trial was conducted in the ED at Royal North Shore Hospital, a tertiary referral hospital in Sydney. It was approved by the Human Research Ethics Committee (HREC), North Shore Central Coast Area Health Service as a low risk project # 0911-310M (LR). The trial was registered with the Australian and New Zealand Clinical Trials Registry # ACTRN 12615001014549.

Forty ED clinical staff volunteered as the subjects for this trial. They were all nursing or medical staff of varying seniority, male and female, with ages ranging 21-60 years. They were of varied skin type and race. Each subject acted as their own control. All were informed of the potential for some mild discomfort or skin irritation at the taping site and provided informed, signed consent prior to participation. Exclusion criteria were excessive hair in the cubital fossae, failure to consent to the trial or known sensitivity to adhesive tapes. Participants were allowed to withdraw at any time.

Adhesives used were standard prepackaged 3M™ Tegaderm IV Kits used widely in EDs throughout Sydney. The pack comprises a transparent film dressing with 'trouser legs' measuring 7 × 8 cm and two tapes measuring 7 × 1.3 cm.

The IV cannulas used were 20 gauge (1.1 × 30 mm) BD™ Instyle Autoguards. The metal stylet was removed and only the plastic sheaths were used.

A Shimpo™ FGV-100 strain gauge used to measure the force to dislodge the cannulas. This device measures forces up to 500N with an accuracy of +/- 0.2%, and was sourced from Westmead Childrens Hospital. The transducer had a premade plastic extension set with hook that would allow attachment of the cannula to the transducer (Fig. 1).

Taping Techniques

The taping was done by the second author for the entire study and strictly standardised to the format below.

In the "Under and Over" technique, the first tape was applied at its mid-point at the posterior aspect of a 20 gauge plastic cannula hub below the "notch" and each end wrapped anteriorly at roughly 45 degrees to tape to the opposite side of the skin. A second tape was then applied horizontally over the anterior surface below the notch. The adhesive dressing was placed over the surface such that the opaque border of the dressing was at the level of the tapes underneath (Fig. 2).

With the "Horizontal Taping" technique, the first tape was applied horizontally across the cannula below the notch anteriorly. The adhesive dressing

Fig. 1. Force transducer and cannula attachment.

was then applied across the top once again so that the opaque border was level with the proximal border of the tape below. The second tape was applied over the top of this adhesive dressing at the level of the initial tape (Fig. 3).

At each stage with both techniques, an attempt was made to apply a constant amount of downward pressure to ensure standardised adhesion between tape and cannula.

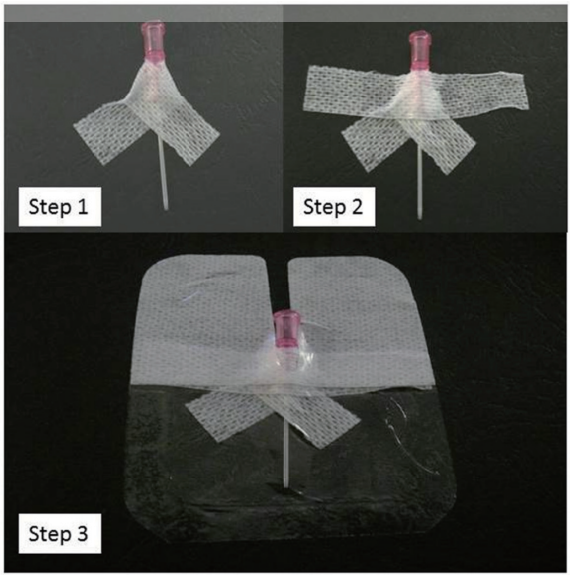

Fig. 2. "Under and Over" technique sequence.

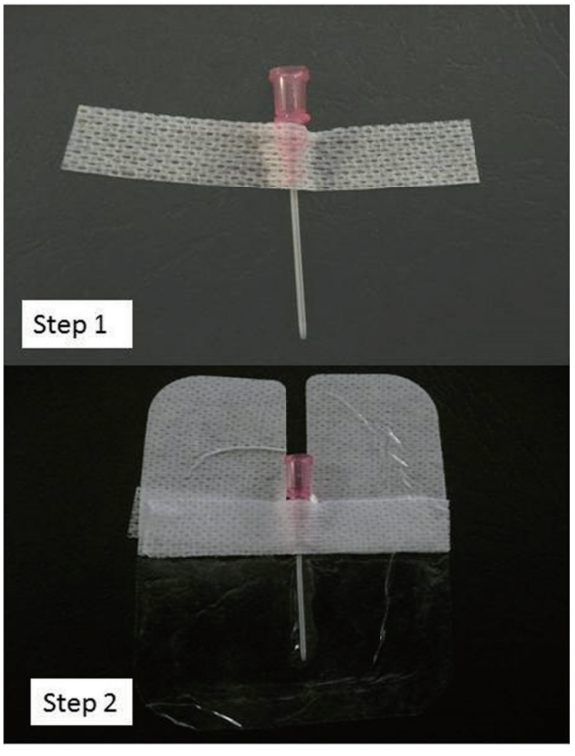

Fig. 3. "Horizontal Taping" technique sequence.

Both cubital fossae of the 40 volunteers were utilised as the skin surface to which the plastic tubing of the intravenous cannulas were taped. The needle was discarded and no cannulas were inserted within the skin. The skin was pre-cleaned with alcohol wipes and allowed to dry for 20 seconds prior to the application of the tapes.

The second author applied the cannula sheath to the subject's right cubital fossae using either the "horizontal" or "under and over" taping technique in random fashion with the researcher being blinded to the technique used by covering the site with a cloth. The time between dressing application and removal was strictly standardised to two minutes using a stop watch.

The force transducer was attached to the cannula hub via the premade extension set and zeroed immediately prior to the force being applied. With the subject seated and the taped arm elevated at right angles in front of the body in elbow extension, the researcher applied an anterograde force (away from the subject's trunk towards the hand) with the transducer in a rapid but steady fashion in a direction parallel to the cannula.

The peak force required to completely dislodge the cannula from the skin was recorded in newtons. This was then repeated on the left cubital fossa of the same subject using the alternate taping technique.

The above procedure was repeated but this time using a retrograde direction of force. This was performed with the subject once again seated with the arm elevated at right angles in front of the body but with the researcher pulling the transducer towards the subjects shoulder.

Therefore in total, four cannula sheaths were taped to each subject, two "under and over," two "horizontal" and each separate technique was stressed with both anterograde and retrograde force.

The second author randomly altered the order of taping for the subjects and recorded them whilst the researcher recorded the results of the trials separately. The results were unmasked on completion of the trial. The researcher was therefore blinded to the taping used to prevent any possible measurement bias in removal of the tapes with the force gauge and the second author blinded to the results in an attempt to limit any bias in the taping.

Data Analysis

Power calculation yielded 35 comparisons required to demonstrate a difference of at least 1 standard deviation with a confidence interval of 95% and power of 90%.

The results followed a normal distribution allowing a Students t Test for paired means to be used to compare the two taping styles in both directions of force. These results were analysed utilising the statistical package-SPSS-PASW 22.

Results

There was a statistically significant increase in force required to dislodge a cannula taped with the "under and over" technique compared to that secured by the "horizontal" method (Table 1) regardless of direction of force.

In the anterograde direction, the mean force in newtons to dislodge the cannula was 19.1 (95% CI 15.9-22.4) with "under and over" technique compared to 7.8 (95% CI 7.0-8.7) with the "horizontal method." This was statistically significant with a p value < 0.001.

In the retrograde direction, the mean force for dislodgement was 22.5 (95% CI 19.1-25.8) with the "under and over" method as compared to 9.1 (95% CI 8.2-10.1) with the 'horizontal' technique. Again, this difference was statistically significant with a p value < 0.001.

Discussion

There was a highly statistically significant increase in force required to dislodge a cannula taped with the "under and over" technique compared to the "horizontal" method.

It was found that to dislodge the cannula with the "under and over" technique, the entire dressing needed to be pulled from the skin (i.e., in 100% of cases of the "under and over" technique, regardless of force direction, the cannula was dislodged with its taping and film dressing adherent), whilst in the "horizontal taping" method the cannula slid out of the dressing, again in 100% of cases, (regardless of force direction) leaving the dressing still adherent to the skin. There were no cases of cannula fragmentation or dressing/tape breakage.

Wrapping the tape around the cannula as in the "under and over" style increases the surface area of the cannula in contact with the tape and may be one reason for increased security. The calculated surface area of tape to cannula contact is 3.2 cm^2 with the "under and over" technique vs. 1.5 cm^2 with the "horizontal taping" method.

However, we also calculated the skin-to-restraint tape surface areas which showed almost double the area of direct skin-to-restraint tape contact with the "over and under" method (15.1 cm^2 vs. 7.6 cm^2). This occurs because both the tapes are secured to the skin in the "under and over" style whereas in the "horizontal" style the second tape is adherent only to the cannula and the surface of the adhesive dressing. This may be an additional reason for the higher security of the "under and over" technique.

Increased cannula security may have considerable clinical implications by reducing dislodgement rates and therefore minimising treatment delays, decreasing staff time required for re-cannulation and limiting circumstances where vascular access is "lost"

Table 1. Mean force (both directions)

Anterograde direction of force		
Taping style	Mean force (N)	95% Confidence intervals
Horizontal	7.8	7.0-8.7
Under/over	19.1	15.9-22.4
$p < 0.001$		
Retrograde direction of force		
Taping style	Mean force (N)	95% Confidence intervals
horizontal	9.1	8.2-10.1
Under/over	22.5	19.1-25.8
$p < 0.001$		

in a critically ill patient or in a patient whom venous access is difficult to obtain. It is hypothesised that increased cannula mobility may contribute to thrombophlebitis and extravasation, thus making cannula stability even more important.

Whilst these results show a statistically significant difference in security between the two taping styles, it is acknowledged that there may not be a clinically significant difference. It is unknown what forces a cannula is exposed to in normal clinical situations. It is possible that these are either much smaller or much larger than those needed to remove the cannulas in this model, making it less clinically relevant how they were taped.

During preliminary trials it was evident that the time allowed for the tapes to adhere to the skin significantly affected the forces required for dislodgment, making it vital that time before removal was standardised. In real life scenarios, this time is highly variable but usually substantially greater than the two minutes chosen here due to time constraints and subject availability. It is unclear whether the results can therefore be extrapolated for these longer periods of adherence.

Although this study was designed to compare cannula security, it is accepted that there are several other factors in deciding on the method of taping. These include visibility of the insertion site for infection surveillance, ease and speed of application, concern of kinking of the cannula and ease of removal on patient discharge. None of these aspects were addressed in this study.

This is the first research that specifically compares these two taping techniques. Much of the prior literature has focused on comparing security and complications of gauze versus polyurethane dressings or various dressings with custom made cannula securing devices. Only two papers comparing actual taping configurations were found[20,21] neither of which used the same cannula security kit we used, making direct comparison with these results difficult. These two prior studies used a force transducer to compare dislodgement forces for taped cannulas but utilised a variety of dressings and configurations preventing any meaningful comparison of taping styles. Whilst Patel et al found a correlation between dislodgement force and surface area of tape in contact with skin this was not substantiated by Found and Banes.[20,21] Generally, the forces required to dislodge the cannulas in both studies were much higher than in ours. This is likely due to the different materials used (non-sterile tapes such as "Leukoplast") and perhaps the increased time the tapes were allowed to adhere to the skin before dislodgement which was not stated in either study.

This study had a number of limitations. Firstly, the results were obtained from an experimental model rather than a true clinical situation. The cannulas were placed superficially on top of the skin for ethical reasons. It is unproven whether these results can be extrapolated to intravenous insertions as the veins and subcutaneous tissues could possibly provide some additional security between the two groups. Cannulas can be dislodged from a multitude of directions and by studying dislodgment using both anterograde and retrograde forces an attempt was made to increase the generalizability to clinical scenarios. It is however beyond the scope of this research to comment on the security of taping in any other direction of force.

The methods used to blind both researchers may not have completely neutralised researcher bias and may have been another potential source of error. However, using the one person to tape for the entirety and having a strict, predetermined method of taping would be expected to minimise the variability between each trial.

In conclusion, with this experimental model, the "under and over" taping method proved a much more secure taping technique in both anterograde and retrograde directions of force. Whilst there may be some limitations to extrapolating this to clinical situations, consideration to using it as a standard of practice should be made, especially in those situations where security of the cannula is of prime importance.

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