Prospective study to develop surface landmarks for blind axillary vein puncture for permanent pacemaker and defibrillator lead implantation and compare it to available contrast venography guided technique

S. Mehrotra a,*, Manoj Kumar Rohit b
a Assistant Professor, Dept of Cardiology, PGIMER, Chandigarh, India
b Additional Professor, Dept of Cardiology, PGIMER, Chandigarh, India

ABSTRACT
Objective: To develop surface landmarks for blind axillary vein puncture for pacemaker lead implantation.

Methods and results: Patients for routine coronary angiography were counseled for participating in our study. 20 patients who gave consent were taken up for axillary venogram after proper positioning at the time of coronary angiogram. The venograms of these 20 patients, were reviewed and the landmarks were used to develop a blind axillary puncture technique. Success rate of 100% was achieved with surface landmark guided axillary vein puncture. The implantation time while using surface landmark guided axillary puncture was not significantly longer than when venography based approach was used. Another interesting observation made from the study was that increasing BMI had a positive correlation with the time taken for venous access, the fluoroscopic time and the volume of contrast used, all the associations being statistically significant. Thus, the surface landmark guided technique is more safe and expeditious in non obese patients and probably in pediatric patients as well. Moreover, the new surface landmark guided approach is a significant safety step in terms of reducing the unwanted and avoidable radiation exposure to the hands.

Conclusion: The results of this study demonstrate that placement of endocardial permanent pacemaker and ICD leads via the developed surface landmarks is effective and safe and is devoid of the harmful effects of radiation and contrast exposure.

Copyright © 2015, Cardiological Society of India. All rights reserved.
1. Introduction

Although device therapy is increasingly a subspecialty in its own right, permanent pacemaker (PPM) implantation remains one of the core skills of cardiologists. Although varied approaches for transvenous permanent pacemaker implantation have been in use since the early 1960s, controversies still exist regarding which approach affords minimal complications yet provides easy access to the central venous system. Subclavian vein puncture has the beauty of being simple and quick to use. Unfortunately, it is associated with both acute and longer term complications. Pneumothorax and subclavian crush phenomenon can be serious complications, the latter especially in ICD systems. Cephalic vein cutdown, free of the latter complication, can still fail in 25–50% of cases. Moreover, cephalic vein is not a good modality for negotiation of multiple leads.

Contrast/fluoroscopic guided axillary vein puncture has a number of advantages. However, these techniques have certain limitations.

1) Requirement of adequate peripheral venous access.
2) Small risk of contrast nephropathy and anaphylactic reaction (1:40,000—1:100,000).
3) Harmful effects of radiation exposure to the hands.
4) Requirement of a C arm, which may not be feasible in developing countries, especially in the peripheries.

To overcome these limitations we attempted to develop surface landmarks for blind axillary vein puncture.

2. Patient population and methods

Patients for routine coronary angiography were counseled for participating in our study. 20 patients who gave consent were taken up for axillary venogram after proper positioning at the time of coronary angiogram. The venograms of these 20 patients, as shown in Fig. 1, were reviewed and the landmarks were used to develop a blind axillary puncture technique.

Patients for routine pacemaker implantation were counseled for participating in our study. An informed consent was taken after explaining the procedure in detail. 20 patients who agreed were enrolled into the study. All the punctures were done by two experienced operators. The study population was randomized to two groups – A and B. In group A, contrast guided axillary puncture was done. In group B, the developed blind axillary puncture technique was tried.

2.1. Contrast guided axillary vein puncture

A total of 10 cc of contrast dye diluted 1:1 with normal saline to reduce viscosity and facilitate the bolus injection was injected via an ipsilateral peripheral vein and flushed with 20 cc of saline. The opacified axillary vein was then punctured under fluoroscopy, at the border or medial to the rib cage margin, with repeated boluses of semi-diluted contrast material if needed (as shown in Fig. 2). In case of unsuccessful puncture, a subclavian puncture was performed.

2.2. Development of blind surface landmarks

Review of venographies performed in antero-posterior projection indicated that the axillary vein usually coursed about one to one and a half fingerbreaths medial and parallel to the deltopectoral groove and pointing towards the most prominent point of the clavicle (Fig. 3).

The needle was placed in a pocket created two finger-breaths below the clavicle and aligned one and a half fingerbreaths medial and parallel to the deltopectoral groove and pointing towards the most prominent point of the clavicle (Fig. 3). The needle was then advanced in the direction of the most prominent point of the clavicle until blood was aspirated. In the event of failure to aspirate blood the procedure was repeated with serial cranial advancement of the needle till the most prominent point of the clavicle was reached. If venous access was still not obtained the needle was re-placed at the starting point and the procedure repeated with slight lateral realignment of the needle.

2.3. Blind axillary vein puncture

The developed blind axillary puncture technique was used. If venous access was not obtained within approximately 120 s, contrast guided puncture was done as previously described, to minimize the risk of complications.
Time taken from needle puncture to aspiration of venous blood was recorded, as well as the number and volume of contrast injections. All the procedure-related complications were noted. A routine chest roentgenograms was performed to detect the development of pneumothorax. Patients were examined on the following day and at two months after the procedure.

The blind axillary vein puncture was compared with venography guided technique.

From June 2008 to June 2009, 10 patients each underwent pacemaker and defibrillator implantation via surface landmark guided and contrast venography guided technique respectively.

### 3. Statistical analysis

Unpaired Student’s t-test will be used to compare continuous variables between the two groups. Fisher’s exact test will be used to compare implantation success and complication rates. A p value <0.05 was considered statistically significant. Values are expressed as means ± SD.

### 4. Results

The study included 20 patients (age 21–90 years, 16 males) in whom a total of 23 pacemaker leads and 12 AICD leads were implanted. The mean BMI in Group A was 24.6 ± 2.07 while the mean BMI in group B was 21.8 ± 4.4 (p = 0.085).

Efficacy of the axillary vein puncture in the two groups is shown in Fig. 4.

Success rate of 100% was achieved with surface landmark guided axillary vein puncture. One patient failed negotiation of the axillary vein via venography guided method and thereafter underwent pacemaker implantation via the subclavian vein yielding a success rate of 90.0%. Axillary vein puncture was ultimately successful in 95.0% patients overall.

The time to puncture was 37.3 ± 11.78 s in group A as against 29.90 ± 11.75 s in Group B (p = ns). Venography required 2.1 ± 0.7 contrast injections per patient, representing a mean of 21 ± 7.4 cc of contrast material. The mean fluoroscopic time was 53.20 ± 12.5 s.

When relationship of BMI and time was studied it was seen that increasing BMI had a positive correlation with time taken for the procedure and this association was statistically significant (Table 1).

When relationship of BMI and Fluoroscopic time was studied it was seen that increasing BMI had a positive correlation with fluoroscopic exposure and this association was statistically significant (Table 2).

When the relationship of BMI and volume of contrast used was studied it was seen that increasing BMI had a positive correlation with volume of contrast used and this association was statistically significant (Table 3).

#### 4.1. Procedure related complications

Pneumothorax occurred in one patient in Group A (10% of hemithorax) which subsided on low flow oxygen and none in Group B.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Correlation of BMI with time to puncture.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass Index</td>
<td>Pearson correlation</td>
</tr>
<tr>
<td>n</td>
<td>Sig. (2-tailed)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Correlation of BMI with fluroscopy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass Index</td>
<td>Pearson correlation</td>
</tr>
<tr>
<td>n</td>
<td>Sig. (2-tailed)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Correlation of BMI with contrast volume.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass Index</td>
<td>Pearson correlation</td>
</tr>
<tr>
<td>n</td>
<td>Sig. (2-tailed)</td>
</tr>
</tbody>
</table>
5. Discussion

In this study successful lead placement was accomplished in 100% of patients randomized to undergo lead placement via the surface landmark guided approach to the axillary vein as compared with 90% of patients randomized to the Venography guided approach. The implantation time while using surface landmark guided axillary puncture was not significantly longer than when venography based approach was used.

Our success in landmark guided puncture approximates the result of Belott et al11 who reported success in 165 of 168 patients undergoing blind axillary venous access using the delto-pectoral groove as a surface landmark.

However, we feel that our landmark is scientifically better as it defines the distance from deltopectoral groove in fingerbreadths rather than in centimeters, a more practical approach. We have also specified the surface landmark towards which the needle should be directed, unlike Belott et al—a major lacunae in their study.

Another interesting observation was that the relationship of the axillary vein to the most prominent point of the clavicle was consistently observed in all our patients.

This stands out in sharp contrast to previous studies which reported that the first rib was the only bony landmark which had a consistent relationship with the axillary vein.11,12

There was one failure in a total of 10 attempts in group A. Reanalysis of the venography revealed that the failure was due to tortuosity of the axillary vein which was successfully bypassed by subclavian vein puncture.

Pneumothorax occurred in one patient in Group A which completely resolved on low flow oxygen.

To explain this unexpected occurrence, venographies in group A were reanalyzed and the axillary vein was divided into a medial and lateral segment, as defined by the rib cage margin as shown in the Fig. 5A & B.

On reanalysis it was found that the patient who developed pneumothorax was subjected to axillary vein puncture via the medial approach.

Our findings are consistent with the results of Ramza et al,13 who had studied the relative efficacy and ease of using the venography guided technique to place leads in either the medial or lateral segment of the axillary vein. Results of their study demonstrated that lead placement in the medial aspect of the axillary vein could be accomplished more expeditiously and with a higher success rate than with lateral segment, however the lateral approach could be performed in patients in whom a pneumothorax would represent a catastrophic complication, thus, highlighting the relative safety of lateral approach in preventing pneumothorax.

5.1. Significance of BMI

Another interesting observation made from the study was that increasing BMI had a positive correlation with the time taken for venous access, the fluoroscopic time and the volume of contrast used, all the associations being statistically significant. Thus, the surface landmark guided technique is more safe and expeditious in non obese patients and probably in pediatric patients as well.

5.2. Hazards of fluoroscopy

The mean fluoroscopic time in group A was 53.20 ± 12.5 s.

The new surface landmark guided approach is a significant safety step in terms of reducing the unwanted and avoidable radiation exposure to the hands.

6. Conclusions

The results of this study demonstrate that placement of endocardial permanent pacemaker and ICD leads via the developed surface landmarks is effective and safe and is devoid of the harmful effects of radiation and contrast exposure. It was further seen on sub analysis that the lateral portion of the axillary vein is a safer route than the medial portion. The surface landmark guided technique is more safe and expeditious in non obese patients and probably in pediatric patients as well, and the benefits can be extended to intensive care units and pediatric units for central venous cannulation as well as to emergency units for temporary pacemaker insertion.

Statement

It is stated that the manuscript has been read and approved by all the authors, that the requirements for authorship have
been met, and that each author believes that the manuscript represents honest work.

**Conflicts of interest**

All authors have none to declare.

**REFERENCES**