

Access times for supraclavicular and infraclavicular approaches of subclavian vein catheterization in pacemaker insertion

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ABSTRACT

Objective: Infraclavicular (IC) approach of subclavian vein (SCV) catheterization is widely used as compared to supraclavicular (SC) approach for pacemaker insertion. The aim of the study was to compare the ease of catheterization of SCV using SC versus IC approach and also record the incidence of complications related to the approach.

Methods: In the prospective and interventional study, 102 patients enrolled were randomly divided into two groups. In one group, the right SCV catheterization was performed using SC approach, and in the other group, catheterization was performed using IC approach. The total number of participants, who fulfilled the requirements, was 92. Access time, success rate of cannulation, number of attempts to cannulate vein, ease of guidewire and catheter insertion, placement of temporary wire as cine time, patient comfort, and associated complications were recorded. The data collected were analyzed on SPSS software version 26.

Results: The SC approach had a lesser access time as compared to IC approach and this was found to be significant. Non-significant parameters included complications, number of attempts, and cine time. Only one patient from the IC group developed pneumothorax.

Conclusions: The SC approach of SCV catheterization is comparable to IC approach in terms of landmark accessibility, success rate, and rate of complications. However, IC approach is less feasible in terms of time constraint and is, therefore, less likely to be successful.

Keywords: Infraclavicular, pacemaker insertion, Pakistan, supraclavicular

Introduction

Pacemakers are electronic devices that stimulate the heart with electrical impulses to maintain or restore a normal heartbeat.^[1-3] There are multiple indications of the procedure: Arrhythmias, ischemia, and other cardiomyopathies to name a few.^[4] For the placement, there are two common approaches used: Supraclavicular (SC) and infraclavicular (IC). The SC approach had low complication rates. Pneumothorax is one major complication of SC approach.^[5] Most of the complications for SC approach included pacemaker infection and atrioventricular (AV) block^[6] that were related to the pacemaker itself and not the technique. The IC approach is now very rare globally, but some hospitals in Pakistan continue to use this technique. IC approach is associated with a success rate of 80% on the first attempt in case of experienced physicians.^[7] The complications with this approach, at the hands of an experienced clinician, are 0.5%.^[8] This approach presents a potential hazard that stability of the

catheter is achieved only by strapping the patient's arm to his side^[9] and it cannot be left in place for longer times if necessary. The approach has proved particularly useful in shocked and anxious patients where the speed of insertion and ease of manipulation in contrast with an approach using visible veins in antecubital fossa. Peripheral vasoconstriction causing difficulty with the location of a vein and painful negotiation through the shoulder area are two other problems with this approach.^[10]

There is another potential approach through either the femoral or internal jugular (IJ) vein. These approaches have been recently reported for patients who require cardiac pacing but are not candidates for immediate cardiac catheterization.^[11]

With this rationale in mind, the objective of our study is to determine the outcomes of these approaches in terms of complications, insertion time, cine time, ease of lead placement, major adverse cardiovascular events, and patient comfort.

Methods

The study was conducted in the Department of Cardiology in Rawalpindi Institute of Cardiology, Rawalpindi, Pakistan, after approval by hospital Ethical Committee. A total of 102 adult patients of either sex, scheduled for the placement of temporary pacemaker under local anesthesia in the emergency department where central venous catheterization (CVC) was indicated, were enrolled in the study. Patients with chronic kidney disease (CKD), peripheral arterial disease, superior vena cava/inferior vena cava thrombosis, vasculitides, and infection at the insertion site were excluded from the study.

A total of 102 patients were randomly assigned into two groups: Group SC included 42 patients where the right SVC was performed using SC approach. Group IC included 50 patients where SVC catheterization was performed using IC approach. In 10 patients of either group, approach needed to be changed to either IJ or femoral due to technical difficulties in cannulating. The patients were assigned using a software and were only switched to another group if severe technical difficulties were present as mentioned earlier. The patients who had undergone a separate approach were not included in the study and the total number of participants was, therefore, 92.

A prior informed consent was taken from all the participants after the goals of the study and consequences of participation were explained. All patients were subjected to detailed clinical history and complete general physical and systemic examination. Routine investigations such as complete hemogram, bleeding time, clotting time, urine examination, coagulation profile, electrocardiogram, and chest X-ray (posteroanterior view) were carried out in all patients.

After the arrival of the patient in the catheterization laboratory, intravenous line was established and routine monitoring was performed comprising electrocardiography, pulse oximetry (SpO₂), non-invasive blood pressure, and respiratory rate. Baseline readings were recorded. Just before administration of local anesthesia, landmarks of either technique were marked with a marker pen. Trendelenburg position was used for both the techniques. For IC approach medial 1/3 and lateral 2/3 of the clavicle, about 1 cm below the clavicle was used as the puncture point. In this technique, bevel was kept inferomedially so that the J-tipped guidewire would not go either toward the opposite vessel or up to the IJ.

In SC approach, the point of needle insertion was 1 cm cephalad and 1 cm lateral to the junction of the lateral margin of clavicular head of sternocleidomastoid (SCM) muscle with the superior margin of clavicle which forms the clavisternomastoid angle. The bevel was kept upward to prevent trapping against the inferior vessel wall, and after successful aspiration of blood, it was turned downward so as to prevent J-tipped guidewire to go upward into internal jugular vein.

Cannulation was performed using modified Seldinger technique. Post-procedure chest X-ray was obtained in all patients to confirm catheter position and to rule out any complication. In all patients, procedure was performed by same trained cardiologist.

Demographic characteristics such as age and gender and comorbid such as diabetes, hypertension, CKD, and smoking were recorded in all patients. Types and cause of the blocks were recorded which included ischemic events such as myocardial infarction, electrolyte imbalance, drugs or degenerative sinus, or AV node. The measured parameters were recorded in terms of access site, number of attempts to cannulate vein (the procedure was abandoned after two attempts and alternate route of CVC was chosen). The tip of catheter, any malpositioning, or kinking of catheter were observed on chest X-ray and repositioning if needed was done. Associated complications such as arterial puncture, pneumothorax, hemothorax, and others were recorded. Patients comfort and ease of limb movement were also observed and recorded. Patients were observed till hospital stay to rule out any complications. The result of the study was compiled, tabulated, and compared statistically. The results within both groups were analyzed using ANOVA, t-test, and Pearson's Chi-square test.

Results

A total of 92 participants were included in the study. Table 1 details the demographic features and comorbid conditions.

Twenty participants (22%) were chronic smokers. The mean access time for the SC group was 4.44 ± 1.07 min and the IC group was 5.82 ± 0.99 min. The difference was found to be statistically significant when a *t*-test was used ($P = 0.00$). $P < 0.05$ was considered statistically significant.

The overall success rate in catheterization of subclavian vein (SCV) using SC approach was better (50 out of 51) as compared with to group using IC approach (42 out of 51). The remaining patients were switched to an alternative emergency approach due to difficulties faced. This difference was statistically non-significant. $P < 0.05$ was considered statistically significant. The first attempt was more successful in the SC group (90%) as compared to the IC group (88%). This is detailed in Table 2.

All successful SCV catheterizations, that is, 50 patients in the SC group and 42 patients in the IC group, were associated with smooth insertion of guidewire following subclavian venipuncture. The catheter tip location was confirmed by post-procedure X-ray in all the patients where successful catheterization was done. No malposition of the catheter was noted in any patient of either group. More cine time was noted with IC as compared with SC approach. Permanent pacemaker was inserted in 69 patients (75%). Restriction of movement

was lesser in the SC group (9 out of 50 patients) as compared to the IC group (4 out of 42 patients) which was statistically non-significant ($P = 0.06$). $P < 0.05$ was considered statistically significant.

Complications related to either of the techniques are shown in Table 3.

The differences in complications were found to be statistically non-significant ($P = 0.33$). $P < 0.05$ was considered statistically significant.

Discussion

This study is the first of its kind in Pakistan which aims at comparing approaches. These approaches have been studied in other parts of the world where they were used not only for cardiac pacing^[12] but also for aortic valve replacement^[13] and

overcoming venous obstruction.^[14] The male-to-female ratio in our study was about 70:30. The allocation of the patients to subgroups for approaches was similar to another study, in which SC approach^[15] was being studied.

Our study shows that the average cine time for pacemaker placement is lesser in case of SC approach when compared to other approaches. This is related more to the ease of access rather than the technique. The SCV has various characteristics that provide this advantage such as its large diameter, absence of valves, and ability to remain patent and in a relatively constant position.^[16,17] There are studies that have reported a similar finding that it is easier to puncture SCVs^[18] provided, no anatomical variation is present.

The same reason can be attributed to how SC approach could be used to place a permanent pacemaker in case of emergency settings or acute indications for placement, especially if lesser access time is considered. SC approach can also be used in cases of an inexperienced operator.^[10] The process is also being adopted as a bedside technique without use of fluoroscopy.^[19]

Our study shows that a single attempt was needed during the procedure when puncture and manipulation were brought to consideration for SC approach (90%) as opposed to IC (88%). The percentages were, therefore, comparatively similar^[14] as mentioned in the literature. Therefore, it should be considered that IC approach is also suitable in cases without obvious venous obstruction, as in our study.

However, IC approach was associated with more complications in patients such as hematoma and pneumothorax. This was an unusual finding of the study as the approach has not had any complications,^[20] local or generalized and is often the approach of choice^[21] in younger patients with an occluded system of SCVs.

It was also seen that patients were more comfortable postoperatively when SC approach was used. This is partly because the procedure itself causes less pain to the patient as the access time^[20] is lesser ($P < 0.05$).

Finally, the comfort level is also dependent on restriction of neck movement. The neck movements are less restricted in case of SC approach. This is partly related to the fact that the SCV is not as closely related to the SCM muscle^[22] as compared to external jugular vein which penetrates the deep fascia close to the muscle.^[23]

There were some limitations to the study. One limitation was that cine time could not be quantified because of unavailability of accurate instruments. Another limitation was that the “other” approach comprising either femoral or jugular access could not be investigated thoroughly.

Table 1: Demographic parameters

Parameter	Supraclavicular approach group (n=50)	Infraclavicular approach group (n=42)
Age in years (mean±S.D)	61.9±20.3	67.1±11.7
Gender, n (%)		
Males	35 (70)	24 (57)
Females	15 (30)	18 (43)
Comorbid conditions, n (%)		
Diabetes mellitus type 2	23(46)	18 (43)
Hypertension	17(34)	18 (43)
Chronic kidney disease	8 (16)	10 (24)

n: Total number of patients in each subgroup

Table 2: Attempts of catheterization using supraclavicular and infraclavicular approach

Attempts	Supraclavicular approach group (n=50)	Infraclavicular approach group (n=42)	P-value
	Frequency (%)	Frequency (%)	
First	45 (90)	37 (88)	0.77
Multiple	5 (10)	5 (12)	

n: Total number of patients in each subgroup

Table 3: Complications

Complications	Supraclavicular approach group (n=50)	Infraclavicular approach group (n=42)
	Frequency (%)	Frequency (%)
Hematoma at puncture site	2 (4)	5 (12)
Pneumothorax	0 (0)	1 (2)
Hemothorax	0 (0)	0 (0)
Infection	0 (0)	0 (0)
Thrombosis	0 (0)	0 (0)

n: Total number of patients in each subgroup

Conclusions

SC approach is relatively safe and feasible for cardiac pacing. There is a dire need to conduct further multicentered studies to compare and contrast the outcomes of the approaches used. In addition, more structured interviews should be conducted with the patients postoperatively to extract themes for further research.

References

1. Carrión-Camacho MR, Marín-León I, Molina-Doñoro JM, González-López JR. Safety of permanent pacemaker implantation: A prospective study. *J Clin Med* 2019;8:E35.
2. Parkash R, Sapp J, Gardner M, Gray C, Abdelwahab A, Cox J. Use of Administrative data to monitor cardiac implantable electronic device complications. *Can J Cardiol* 2019;35:100-3.
3. Polimenakos AC, Mathis L, Shafer B, Kamath MV. Selective use of temporary epicardial pacing leads in early infancy following cardiac surgery: Feasibility and determinants of clinical application. *Pediatr Cardiol* 2019;40:630-7.
4. Bob-Manuel T, Nanda A, Latham S, Pour-Ghaz I, Skelton WP, Khouzam RN. Permanent pacemaker insertion in patients with conduction abnormalities post transcatheter aortic valve replacement: A review and proposed guidelines. *Ann Transl Med* 2018;6:11.
5. Res JC, de Priester JA, van Lier AA, van Engelen CL, Bronzwaer PN, Tan PH, *et al.* Pneumothorax resulting from subclavian puncture: A complication of permanent pacemaker lead implantation. *Neth Heart J* 2004;12:101-5.
6. Kiviniemi MS, Pirmes MA, Eränen HJ, Kettunen RV, Hartikainen JE. Complications related to permanent pacemaker therapy. *Pacing Clin Electrophysiol* 1999;22:711-20.
7. Seneff MG. Central venous catheterization: A comprehensive review, Part 2. *J Intensive Care Med* 1987;2:218-32.
8. Merrer J, De Jonghe B, Golliot F, Lefrant JY, Raffy B, Barre E, *et al.* Complications of femoral and subclavian venous catheterization in critically ill patients: A randomized controlled trial. *JAMA* 2001;286:700-7.
9. Chatterjee K, Harris A, Leatham A. The risk of pacing after infarction, and current recommendations. *Lancet* 1969;2:1061-3.
10. Macaulay MB, Wright JS. Transvenous cardiac pacing. Experience of a percutaneous supraclavicular approach. *Br Med J* 1970;4:207-9.
11. Ferri LA, Farina A, Lenatti L, Ruffa F, Tiberti G, Piatti L, *et al.* Emergent transvenous cardiac pacing using ultrasound guidance: A prospective study versus the standard fluoroscopy-guided procedure. *Eur Heart J Acute Cardiovasc Care* 2016;5:125-9.
12. Liu KS, Liu C, Xia Y, Li YH, Du W, Wei QM, *et al.* Permanent cardiac pacing through the right supraclavicular subclavian vein approach. *Can J Cardiol* 2003;19:1005-8.
13. Dahle TG, Castro NJ, Stegman BM, Dutcher JR, Teskey JM, Schmidt WT, *et al.* Supraclavicular subclavian access for Sapien transcatheter aortic valve replacement-a novel approach. *J Cardiothorac Surg* 2018;13:16.
14. Antonelli D, Freedberg NA, Turgeman Y. Supraclavicular vein approach to overcoming ipsilateral chronic subclavian vein obstruction during pacemaker-ICD lead revision or upgrading. *Europace* 2010;12:1596-9.
15. Guerrero JJ, Castañeda JF, Calatrava MD, Méndez ÁR, Medrano ML, Herrera AM. Transfemoral access when superior venous approach is not feasible equals overall success of permanent pacemaker implantation. Ten-year series. *Pacing Clin Electrophysiol* 2017;40:638-43.
16. Yoffa D. Supraclavicular subclavian venepuncture and catheterization. *Lancet* 1965;2:614-7.
17. Defalque R. Subclavian venipuncture: A review. *Anesth Analg* 1968;47:677-82.
18. Patrick SP, Tjunelis MA, Johnson S, Herbert ME. Supraclavicular subclavian vein catheterization: The forgotten central line. *Western J Emerg Med* 2009;10:110-4.
19. Liu K, Hou D, Li X, Jin F. Rapid bedside temporary pacing by the right supraclavicular subclavian vein approach. *Am J Cardiol* 1993;71:1234-5.
20. Bernstein NE, Aizer A, Chinitz LA. Use of a lateral infraclavicular puncture to obtain proximal venous access with occluded subclavian/axillary venous systems for cardiac rhythm devices. *Pacing Clin Electrophysiol* 2014;37:1017-22.
21. Ovadia M, Cooper RS, Parnell VA, Dicapua D, Vatsia SK, Vlay SC. Transvenous pacemaker insertion ipsilateral to chronic subclavian vein obstruction: An operative technique for children and adults. *Pacing Clin Electrophysiol* 2000;23:1585-93.
22. Dalip D, Iwanaga J, Loukas M, Oskouian RJ, Tubbs RS. Review of the variations of the superficial veins of the neck. *Cureus* 2018;10:e2826.
23. Comert E, Comert A. External jugular vein duplication. *J Craniofac Surg* 2009;20:2173-4.