

Lead Fracture in Permanent Pacemakers: Evaluation from the Anatomical and Technical Perspective

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ABSTRACT

Objective: To determine the Lead Fracture in Permanent Pacemakers: Evaluation from the Anatomical and Technical Perspective.

Study Design: Retrospective study.

Place and Duration of Study: This study was conducted at the Department of Electrophysiology at Hayat Abad Medical Complex Peshawar from 2008 to 2018.

Materials and Methods: We conducted this study in the Pace Maker suite of the Medical Complex Peshawar, Pakistan. We retrospectively examined our pacemaker's implantation records for any complication during the procedure and soon after the device implantation during the hospital stay. Apart from this, all those patients who came for pacemakers follow up with and without symptoms, were critically examined for any mal function of devices based on clinical examination, twelve lead ECG and pacemakers programming. X-ray chest and fluoroscopy examination were advised based on initial assessment if needed. The data so obtained was analyzed for complication of pacemaker's implantation.

Results: Total 670 patients' data were analyzed in the study period. Five cases (0.3%) of lead fracture were identified from the record. One was during the procedure due to excessive force on the knot over the sleeve. There was one patient with subclavian crush syndrome and the cause remains unidentified in other two patients. Two patients were symptomatic at presentation and two were caught incidentally in follow up clinic.

Conclusion: Lead fracture is not an uncommon complication which can be best prevented, if the procedure is done in way keeping in view the possible causes of the complication.

Key Words: Permanent pacemakers, Lead fracture, subclavian crush syndrome, pacemaker's implantation

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INTRODUCTION

Lead fracture in permanent pacemakers can rightly be called "the mother of complication in device implantation."¹ The incidence of pacemaker lead fracture is about 2.6–3.6% in literature.² The complication is mostly appreciated after the mal function of the device.³ If it diagnosed at the time of implantation, then only the lead needs to be changed and all most all the time a new venous access may be needed. The complications may be horrible at time if the patient is out of the hospital.

The threshold will jump high and the previously set parameter may fail to work properly threatening the patient's life.³ There will be change in the sensing quality of the device and inappropriate pacing due to undersensing.⁴ This will not only make the patient symptomatic⁵ due to inappropriate rhythm but can also lead to R on T phenomena and possibly can induce ventricular fibrillation.⁶ Thus needs to be address on emergency basis. Since the problem is in the lead so need to be replaced. The difficulty of explanation will depend on the post implantation duration.⁷ Device explanation is not only a tedious process but also can lead to complications.⁸ Lead extraction and separation from the surrounding fibrous tissue can damage the vein through the lead was implanted.⁹ It can also leads to perforation of right ventricle during forceful pulling.¹⁰ After lead extraction, if venous access is not possible on the ipsilateral side, contralateral access may be needed. Right atrial lead extraction will be as difficult as the right ventricular lead and leaving the lead in situ will be a nidus for infection and erosion.¹¹ performing the procedure on the contralateral side in the same sitting is very uncomfortable for the patient, as these procedures are done under local anesthesia. Cost is another issue which cannot be under

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estimated in these cases for patient who are not insured.¹² Patient stay in the hospital will be very prolonged as compare to the hospital stay after routine implantation even in the absence of any infection or any other complication before or after explantation.¹³

The lead fracture is mostly caused by friction or blunt trauma.^{14,15} Friction lead mostly occurs at the site of insertion or at the tricuspid valve area.¹⁶ If the venous access is too close to the clavicle or first rib then movements of the upper limb may lead to costoclavicular friction causing insulation break and lead fracture.³ The frictional injury at tricuspid area is also a documented entity, although very rare.¹⁶ Traumatic fracture occurs mostly under the pulse generator where the lead is rolled and kept during procedure. The site of sleeve, where lead is stabilized with body tissue, may be another cite for fracture due to excessive use of force while putting the knots.¹⁵ Lead fracture may be a chance finding during follow up, or at time, patient may present with symptoms to in the emergency room.

MATERIALS AND METHODS

This study was conducted at Hayat Abad Medical Complex Peshawar Khyber Pakhtunkhwa. The study duration was from January 2008 to December 2018 also included patients referred from CMH Rawalakot Azad Jammu and Kashmir who have been implanted PPM and required follow up programming. We a retrospective collected the data of all those patient records who were implanted pacemakers during the study period. The study also included patients whose devices were implanted before the study period and came for device programming with and without symptoms. Patient related information including history, diagnosis at time of implantation, place of implantation record, implantation interventionist, stay in hospital after initial implantation, any complication during the procedure and during the hospital stay and regular follow up information were collected. All patients' data with permanent pacemakers, analyzed for lead fracture. Previous patient chest X-rays if any and lab data was included in the study.

We routinely examined our patients on the 2nd post-operative day and get X ray chest change dressing and do telemetry programming of the device. Mostly our patients stay in the hospital for 4-5 days. After discharge from the hospital all patients are regularly followed in pacemakers' clinic after a month, then six months and then yearly interval or on the commencement of symptoms. At each visit brief history of any symptoms is recorded. Pacemaker's implantation site is examined. Twelve lead ECG performed. Patients' device is analyzed on programmer for battery life, Impedance, threshold and sensing. Atrio-ventricular (AV) delay adjusted for maximum ventricular intrinsic rhythm sensing. All this data is

maintained in a booklet that is kept by the patient in his custody and also the information is recorded in hospital register.

All patients whose telemetry programming was point to any mal function of the device or who were symptomatic are further subjected to X-Ray chest postero-anterior and lateral view and if in need are examined under fluoroscopy. The possible cause of leads fracture was identified from history of any trauma and on examination of chest X-ray and fluoroscopy. Such patients are routinely admitted on emergency basis to the cardiology unit and are investigated. All the data so collected was analyzed on SPSS version 22 for frequency and percentages.

RESULTS

The patient's record of complication is tabulated in table 1. There was total 1670 patient's record available in the study period. Male patients were 9629 (57.6%) and female patients were 708 (42.4). Mean age of the patients were 60.47 ± 16.35 in the study group. Only 2.6% patients were below the age of 20 years and 0.1% below the age of 10 years. Minimum age in the study was 10 years and maximum 100 years. There were 92.2% patient from Pakistan and 7.8% from Afghanistan. About 1592 (95.3%) were having screwing leads, 28 (1.7%) were having tine leads, 49 (2.9%) with mix tine and screwing leads in different chambers. One patient had reveal device. We sort out 5 (0.3%) cases of lead fracture in our study. One patient's lead fracture was identified during the procedure. During the procedure when lead was implanted and stabilized with silk 1/0 with muscles and the threshold was checked, it was very high. So the impedance of the lead was checked which was also very high. So the lead was removed and when examine outside the body there was blood inside the insulation figure 2.

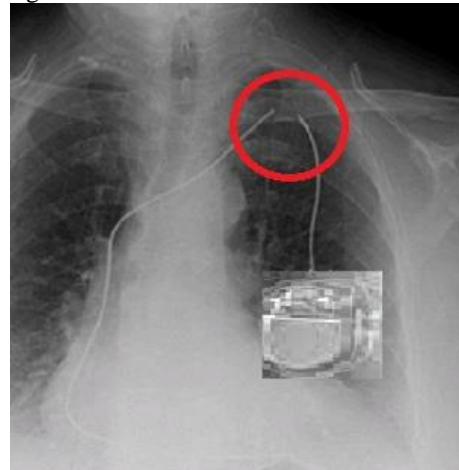


Figure No.1: Subclavian crush syndrome

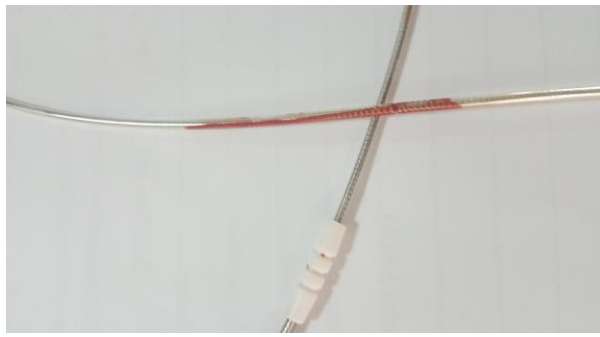


Figure No.2: Insulation break due to suture piercing through the sleeve.

Table No.1: Complication of permanent pacemakers

	Frequency	Percent
Total pacemakers	1670	100.0
Lead displacement	6	.4
Failed	3	.2
Svc dissection	2	.1
Mild pericardial effusion	1	.1
Haematoma	3	.2
Infection	3	.2
Pneumothorax	16	1.0
Lead fractured	5	.3

The site of lead where it was stabilized got damaged by excessive force on the knot and so the blood trickled inside the insulation. One patient presented subclavian crush syndrome figure 1. The cause could not be defined in other two cases. Two patients came to the emergency room after having symptoms after the lead fracture. Two patients were incidentally caught in the follow up clinics.

DISCUSSION

Pacemaker implantation is the art of science. A successful implantation is a life saving procedure. Complications of pacemaker’s implantation not only increase the misery of the patient but also can endanger patient’s life. Complications may occur during the procedure or after the discharge from the hospital. Complications of any procedure, by and large, are part and parcel of procedures. But all complications related to pacemakers are not unavoidable. If the procedure is planned properly the ratio of complication can be minimized.

The lead fracture though a very dreaded complication but a sound knowledge of implantation will minimize the rate of complication. There are two main causes of pacemaker lead fracture:

- 1) Trauma¹⁴
- 2) Friction¹⁵

The site of lead fracture is also very well recognized, but it is overlooked by most operators while implanting devices.^{14, 16.}

The first site which is the most vulnerable site for lead fracture is the pocket.¹⁴ This is the most exposed site of

the lead. The lead after implantation in rolled and put behind the pulse generator. Lead which by itself is a very delicate structure if accommodated in very loose space, then it gets folded on itself and around the device making the lead vulnerable to trauma.¹⁷ As the device mostly lying subcutaneously and expose to external pressure, so any pressure on chest at the pocket site can damage the lead.¹⁸

The second most common site is the lead sleeve site, where the lead is stabilized with the chest muscles.^{16,20}

The sleeve is mostly stabilized with non-absorbable sutures. If the knot over the lead sleeve is put with more than adequate force, then it can break the insulation or even fracture the lead. The same happened in our case when the lead was screwed, and threshold was checked, the minimum threshold was 3 millivolts. The lead was unscrewed and repositioned, the threshold was still high. When the impedance was checked, it was In2500 Ω. The lead was pulled out and new lead was implanted. When the lead was examined outside, clearly blood was there inside the insulation of the lead. Silk 1/0 is very notorious which can transmit the force without any resistance. Mostly a new operator use excessive force to prevent the dislodgment.

The 3rd most common cause of the lead fracture is subclavian crush syndrome.³ Mostly it happens when the lead is implanted through the subclavian vein very close to the clavicle medial end or at the first rib near the costoclavicular region. Then, with the upper limb movement on the side of the device, constant friction of lead with the bone, leads to the fracture of lead. One of our patients presented with subclavian crush syndrome. On X-ray it can be clearly appreciated that the lead is very closed to the clavicle medial end and the rib is very closed to it. The lead got crushed between the clavicle and rib. Over all the ratio of fracture of lead is less than the ratio in the literature. One of the reasons is that we mostly use the axillary veins for implantation. The friction forces are less in these veins.¹⁴ So the overall frequency of fracture due to friction is less than the other studies. Friction is also more in active people like children as compared to the adults and as we had mostly adult patient about 97.4%, so the ration of friction and fracture of leads is less in our study.¹⁴

The fourth site is due to the friction forces of the tricuspid valve¹⁶ or rarely intracardiac masses.²¹ Though, this is very rare cause of the lead fracture but still it is a documented entity. We do not come across to such patients.

Apart from this the lead design also affect the future of the lead.^{22.} Screwing mechanism of leads are also blamed for lead fracture but today mostly screwing leads are used and the frequency of lead fracture reduced as compare to the previous version of lead which were mostly tine leads.^{23.} in our study we were having 95.3% screwing leads. However, in the data so

collected there was no identification of damage leads that is whether tine or screwing.

Now keeping in view all the mechanism and sites which prone the lead to fracture, they are avoidable except in very rare cases. If we use axillary vein, then it is a site which is less prone to frictional forces. Even subclavian vein, if the puncture is made away from the hinge area then the possibility of the vein being crushed, is minimal. The lead can also be saved from fracture by putting it in a reasonable space in the device pocket so there should be no undo forces to twist the lead with acute angles which expose it to damages.^{24,25}

The last thing is to stabilize the lead with chest muscle using adequate forces. So that the leads neither slip nor it is too tight to be damaged. The only area where we are helpless in avoiding the lead fracture is the tricuspid valve. But luckily this site fracture is very rare. Beside these, there are other some rare cases²⁶ reported in the literature but all those causes in most cases can be prevented by proper planning of implantation.

CONCLUSION

Lead fracture is one of the complications in pacemaker's implantation procedure. Though the frequency rate of this complication keep on decreasing, but still it pup up in the implantation of pacemakers. It has well recognized and identifiable causes which can best be further reduce if not totally prevented by careful implantation and selecting correct vein.

Author's Contribution:

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Final Approval of version:	Bakhtawar Shah

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