

# To Study the Preoperative and Post Operative Incidence of Axillary Nerve Injuries in Patients with Three Part or Four Part Proximal Humerus Fractures

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**Abstract:-** Proximal humerus fractures are common injuries occurring both in younger and older population. They have a close association with injuries to the axillary nerve injuries which can occur due to both traumatic and iatrogenic causes. Our study was an attempt to determine the incidence of axillary nerve injuries in three and four-part proximal humerus fractures using pre-operative and post-operative nerve conduction studies. A total of 30 patients were included in the study. The patients on admission underwent a pre-operative EMG and NCV study to detect presence or absence of post traumatic axillar nerve injury. The patient then underwent a surgical procedure and fixation type was decided according to the fracture pattern. Post operatively the patient underwent another EMG and NCV study to detect presence of any iatrogenic axillary nerve injury. The patient was then followed up at regular intervals to detect the time taken and degree of nerve recovery achieved. The youngest patient involved in this study was 18 years old and the oldest was 84 years old. The commonest age group that got affected was 55-64 years. Maximum number of patients were above the age of 50 years. There was no single gender preponderance in this study, with 50% involvement of each gender. The most common mode of injury was fall from height followed by a road traffic accident. The most common type of fracture seen was a three-part proximal humerus fracture and the least common was a 4-part fracture dislocation. In our study the incidence of traumatic axillary nerve injury was 16.7% and the incidence of iatrogenic axillary nerve injury was 26.7%. Out of the 13 patients who developed axillary nerve injury all the patients had partial or complete recovery of nerve function with a good shoulder strength and range of motion. The importance of nerve conduction studies and electromyography as tools for the precise diagnosis of nerve lesions cannot be undermined in such instances. The presence of axillary nerve injuries affects the functional outcome of the shoulder and hampers the return of normal range of joint movements. Even though nerve injuries are present majority of them are neuropraxia or axonotmesis which recover over a period of time with adequate rehabilitation and rigorous physiotherapy programs.

## I. INTRODUCTION

Fractures of the proximal humerus are extremely common injuries accounting for 4-8%<sup>1</sup> of total injuries to the appendicular skeleton with an increased incidence and increased morbidity in elderly population. Above 60 years of age after hip and distal end radius fractures, they are the third most commonly occurring fractures as a result of osteoporosis. In younger population these fractures are a result of high velocity injuries like road traffic accidents, natural disasters assault and industrial accidents.

Proximal humerus fractures are usually low velocity injuries resulting from fall on outstretched hand from standing position. Three- and four-part fractures are more common in the osteoporotic related age group and more in women than in men.

An injury to the proximal humerus is associated with damage to the brachial plexus among which the axillary nerve was reported to be the most commonly injured nerve. An “unhappy triad” of the shoulder comprises of proximal humerus fracture, rotator cuff tear and axillary nerve injury

Low velocity injuries to shoulder result in dislocation or proximal humerus fractures that are often associated with surrounding nerve injuries. 3 and 4 part proximal humerus fracture have an even higher association of axillary nerve injuries if concomitant dislocation is present.

Axillary nerve injury during operative procedure of the shoulder is a common occurrence and importance of protecting it cannot be over emphasized. Iatrogenic axillary nerve injuries are also common in surgical procedures in the treatment of 3 and 4 part proximal humerus fractures, whether its primary plate fixation and hemiarthroplasty.

These nerve injuries are difficult to detect clinically due to severe pain, swelling and restricted ROM. EMG is a highly sensitive test that can detect ANI and its relatively simple to do as it detects deltoid muscle paralysis and its recovery and its easily documented.

Till now only six prospective studies have been conducted of nerve lesions in fractures or dislocations of the shoulder after low-velocity trauma, of which five are electromyography (EMG) based studies. The incidence of

traumatic nerve injuries in these five studies varies between 19% and 55%<sup>2,3,4</sup>. All of them in their own ways being incomplete and not representing the real incidence.

Not many prospective studies are available in literature which evaluate axillary nerve injuries as a probable cause of poor functional outcome in treatment of three or four part fractures. Hence a prospective study of axillary nerve injuries in three or four part humeral fractures with pre and post-operative EMG studies of deltoid and NCV studies of axillary nerve is undertaken.

## II. AIMS

To evaluate the preoperative and postoperative incidence of axillary nerve injuries in patients with three part and four-part proximal humerus fractures.

## III. OBJECTIVES

- To detect axillary nerve injury that occurs in 3 part proximal humerus fractures with or without fracture dislocation
- To detect axillary nerve injury that occurs in 4 part proximal humerus fractures with or without fracture dislocations
- Correlate axillary nerve injuries and its recovery to functional recovery of the shoulder regarding pain, movement and restriction of function
- Detect axillary nerve injuries that occur iatrogenically during surgical interventions for 3 and 4 part proximal humerus fractures
- Follow up cases of axillary nerve injuries by comparing severity of injury preoperatively and at 3 weeks post operation to detect recovery of nerve injuries
- To study in the time taken for nerve recovery in postoperative period

## IV. MATERIAL AND METHODS

The study was conducted in MGM hospital Aurangabad with the subjects being the patients admitted the orthopedics ward with a recent history of shoulder trauma and pain in shoulder with clinical and radiological examination suggestive of proximal humerus fracture. A total sample size of 30 patients was taken which were followed up at regular intervals for a period of 2 years.

Once the patients were admitted they were stabilized vitally and injured shoulder was immobilized in a sling or arm pouch. Clinical evaluation was performed by measurement of active and passive motion of the shoulder from neutral position and by testing muscle strength. Other associated injuries were also examined and appropriately treated. X rays of the injured shoulder were done in antero-posterior view and lateral view and a 45° cranio-caudal view. Additional CT scans were ordered in some cases for better understanding of the fracture anatomy. In addition to these investigations a preoperative NCV study was done of the injured shoulder in order to obtain knowledge about the status of axillary nerve post injury.

The test was conducted by electrically stimulating the nerve and measuring the electrical impulse 'down stream' from the stimulus. This was done using surface patch electrodes that are placed on the skin over the nerve at various locations. Very mild electrical impulse was used by one electrode to stimulate the nerve and the resulting electrical activity is recorded by the other electrodes. The distance between electrodes and the time it takes for electrical impulses to travel between electrodes help in measuring the speed of impulse transmission. A decrease in speed of transmission indicates nerve disease or abnormal pressure on the nerve.

According to the type of fracture the decision was taken on the implant to be inserted and the type of fracture fixation. The fracture was treated using either percutaneous pinning, intra medullary nailing, open reduction and plating or a shoulder hemiarthroplasty. Patient was followed up at 3 weeks post operation where sutures were removed and wound was assessed. The functional range of motion regained by the patient as well as the pain and swelling experienced by the patient was noted in the patient form. At the same time patient was asked to undergo a repeat nerve conduction test to check presence of recovery of the axillary nerve injury or occurrence of iatrogenic nerve injury in a patient whose nerve conduction study was normal before the operation. These patients were followed up at 6 weeks post operatively, 3 months post operatively, and 6 months post operatively for regular assessment and clinical improvement in functional outcome. The functional recovery of the shoulder was assessed using Neer's score and neurological recovery was assessed using nerve conduction tests.

## V. OBSERVATIONS AND RESULTS

We studied a total of 30 adult patients of proximal humeral fracture which were followed up regularly and the following observations were made

### 1. AGE DISTRIBUTION

The youngest patient is 18 years and oldest is 84 years, the average age being 53 years.

### 2. SEX DISTRIBUTION

In our study 14(46.7%) are male patients and 16(53.3%) are female patients. The ratio of Male to Female is M: F=1:0.87. The incidence is slightly more in females is due to most cases in our study being old patients with fractures due to trivial fall.

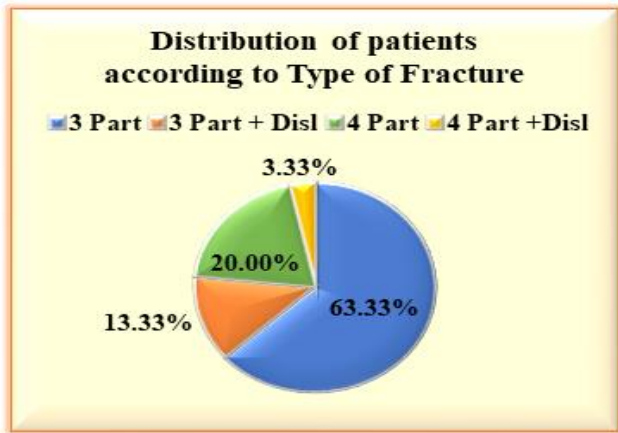
### 3. MODE OF INJURY

The most common mode of injury observed in our series was fall at home. It accounted for 13 patients (43.3%). The next common cause was history of road traffic accidents accounting for 12 patients (40%) and five patients had a history of injury while working in farm (16.7%).

### 5. TYPE OF FRACTURE

In our study series the most common type of fracture observed was 3-part humerus fracture accounting for 19 of 30 patients (63.3%), the next common being 3-part humerus

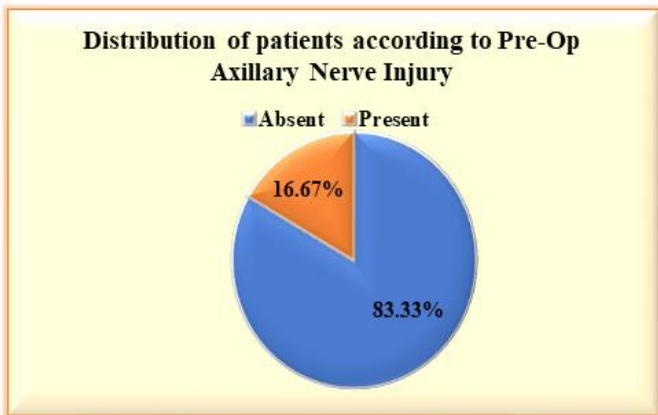
fracture dislocation accounting for 4 out of 30 patients (13.3%). Six patients suffered a 4-part proximal humerus fracture (20%) and one patient (3.3%) had a 4-part fracture dislocation of humerus.



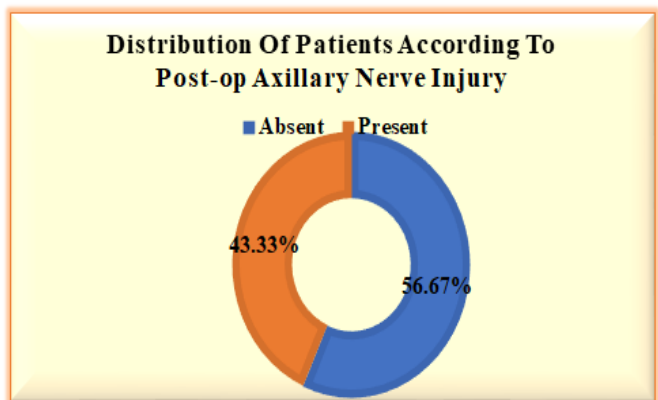
GRAPH 1: TYPE OF FRACTURE

6. INCIDENCE OF AXILLARY NERVE INJURIES

In our study of 30 patients an axillary nerve injury was observed post traumatically in 5(16.7%) patients. After surgery when post-op EMG study was carried an axillary nerve injury was detected in 13(43.3%) patients. Hence an iatrogenic nerve injury occurred in 8 out of 30 patients (26.7%).



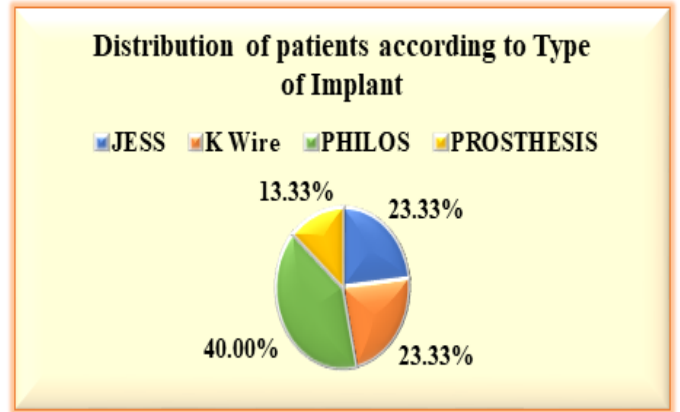
GRAPH 2: PRE-OP AXILLARY NERVE INJURY



GRAPH 3: POST OP AXILLARY NERVE INJURY

7. TYPE OF IMPLANT USED

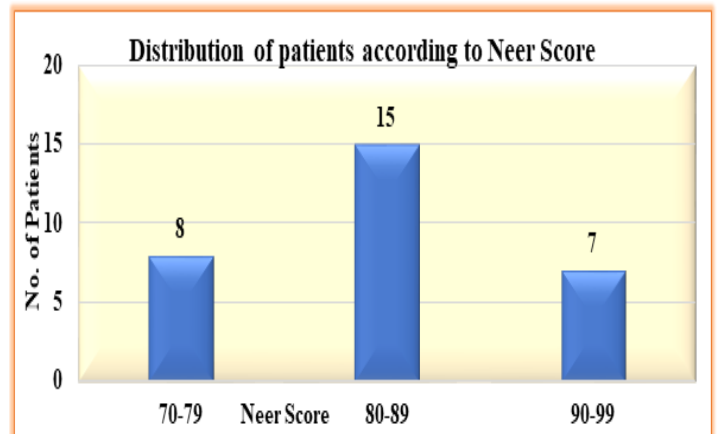
The 30 patients who underwent surgery had different implants used in them according to the type of fracture. The fractures were stabilized with JESS fixators in 7(23.3%) patients and threaded K wires in 7(23.3%) patients. Maximum number of fractures (12-40%) were fixed using PHILOS plates and 4(13.3%) patients underwent shoulder hemiarthroplasty procedure using prosthesis.



GRAPH 4: TYPE OF IMPLANTS

8. NEER'S SCORE

In our study the functional outcome after surgery was calculated using Neer's score. 7(23.3%) patients had a score of above 90 with excellent results, 15(50%) patients had satisfactory results with a score between 80-89 and 8(26.7%) patients had unsatisfactory results with a score between 70-79. None of the fractures went into failure. The minimum score obtained was 70 and the maximum Neer's score was 94.



GRAPH 5: NEER'S SCORE

VI. DISCUSSION

Proximal humeral fractures make up 4-5% of all fractures of long bones. Recently, its incidence is increasing because of increase in geriatric population with osteoporosis and increased RTA in young population. 80-85% of these fractures can be treated by conservative methods, remaining 15-20% that are grossly comminuted or displaced require some type of internal fixation.

These fractures have a 21-36% incidence of neurovascular injuries with the axillary nerve being the most commonly injured nerve. As the axillary nerve runs anterior and inferior to the glenohumeral joint it is vulnerable to both traumatic and iatrogenic nerve injury.

**CORELATION BETWEEN AXILLARY NERVE INJURY AND FUNCTIONAL OUTCOME**

In our study there were 5 patients who were diagnosed to have a post traumatic axillary nerve injury on nerve conduction studies and 8 patients who initially had intact axillary nerve function suffered from an intra operative nerve trauma and had an iatrogenic axillary nerve injury. Among the 5 patients who had post traumatic ANI, satisfactory results were noted in 3 patients and unsatisfactory results were seen in 2 patients which after statistically evaluating by chi square test was found to be

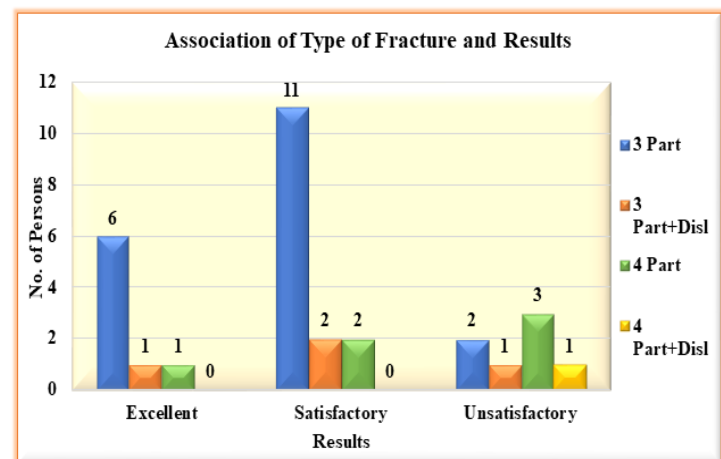
non-significant. Among the 8 patients who had iatrogenic ANI, 1 patient had an excellent result 4 patients had a satisfactory result and 3 patients had unsatisfactory results on follow up which was also found to be statistically non-significant. When these patients had come on 3 monthly and 6 monthly follow-ups they had clinically good functional outcomes with reinnervation potentials seen on NCS, thus concluding that the type of nerve injury was mostly neuropraxia which recovered over time and did not affect the overall functional outcome of the fracture. De Laat et al. found nerve injury in 45% of cases on electrophysiological tests. Visser et al. reported that nerve injuries in proximal humeral fractures are a much more common occurrence than has been reported in the literature: on EMG study, axonal denervation was seen in 67% (96 of 143) of the patients and isolated nerve injury was seen in 21 of 143 cases

STUDY	NUMBER OF PATIENTS	TEMPORARY ANI	PERMANENT ANI
GAVASKAR et al	50	3 (06%)	1 (2%)
WESTPHAL et al	40	3 (7.5%)	4 (10%)
KHAN et al	14	1(07%)	NONE
WU et al	28	7(25%)	NONE
OUR STUDY	30	8 (26.7%)	NONE

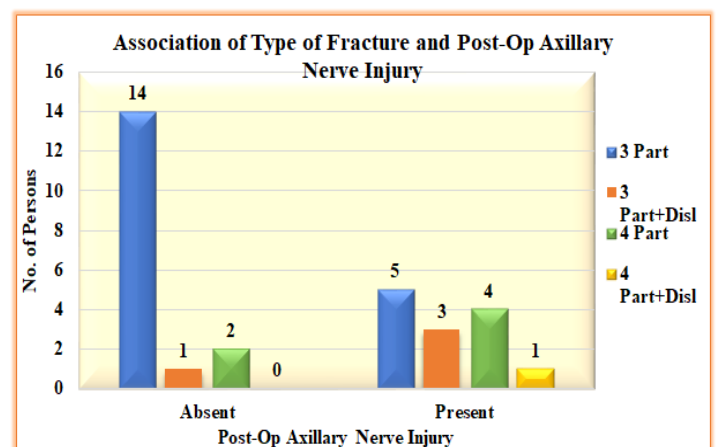
TABLE 1: STUDY COMPARISON OF INCIDENCE OF AXILLARY NERVE INJURY

**CORELATION BETWEEN TYPE OF FRACTURE AND FUNCTIONAL OUTCOME**

From the 30 patients in our study, 19 patients had a 3-part proximal humerus fracture from which 6 (31.6%) patients had excellent results, 11(57.9%) patients had satisfactory results and 2 (10.5%) patients had unsatisfactory results. A 3-part fracture dislocation was seen in 4 patients with 1(25%) patient having excellent results, 2 (50%) patients having satisfactory results and 1 (25%) patient having an unsatisfactory result. 6 patients suffered from a four part proximal humerus fracture in which 1 (16.7%) patient had an excellent result, 2 (33.3%) patients had a satisfactory result and 3 (50%) patients had an unsatisfactory result on follow up. A 4-part fracture dislocation was seen in only 1 patient who had an unsatisfactory result on follow up. These association were statistically tested using chi square test and it was found that the type of fracture had a significant correlation with the overall functional outcome and as the fracture became more complex the functional outcome of the patient reduced significantly. When the association between type of fracture and the incidence of ANI was calculated it was noted that among the 14 patients who had a 3-part proximal humerus fracture 5 (26.3%) patients had post-operative ANI. Four patients had 3-part fracture dislocation out of which 3 (75%) patients developed ANI. 6 patients had a four-part proximal humerus fracture from which 4 (66.7%) patients developed ANI. A four-part fracture dislocation was seen in only 1 (100%) patient and he developed ANI on NCV study. This association was found to be statistically significant and it was seen that more comminuted the fracture higher was the incidence of ANI and this incidence increased significantly when the fracture was associated with a dislocation of the proximal humerus.



GRAPH 6: ASSOCIATION BETWEEN FRACTURE TYPE AND RESULTS



GRAPH 7: ASSOCIATION BETWEEN FRACTURE TYPE AND POST OP ANI

**CORRELATION BETWEEN TYPE OF IMPLANT USED AND FUNCTIONAL OUTCOME**

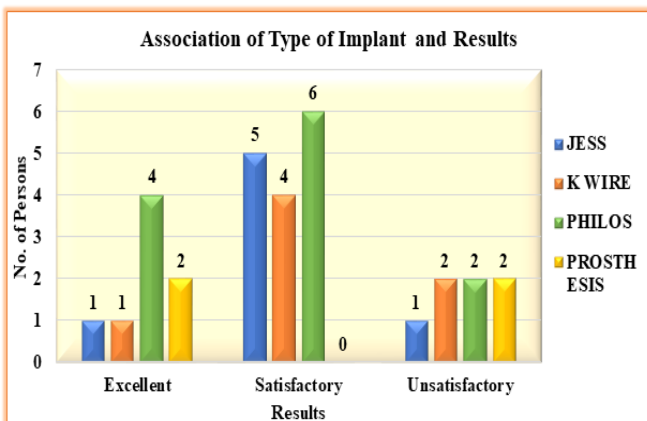
From the 30 patients operated, 7 patients were operated using JESS fixator in which 1 (14.3%) patient had an excellent result, 5 (71.4%) patients had satisfactory results and 1(14.3%) patient had an unsatisfactory result. K wire fixation was done in 7 patients from which 1 (14.3%) patient had an excellent result, 4 (57.1%) patients had satisfactory results and 2 (28.6%) patients had unsatisfactory results. 12 patients were operated using PHILOS plate from which 4 (33.3%) patients had excellent results, 6 (50%) patients had satisfactory results and 2(16.7%) patients had unsatisfactory results. A shoulder replacement was done using prosthesis in 4 patients with 2 (50%) patients had excellent results and 2 (50%) patients had unsatisfactory results. This correlation was tested statistically using chi square test and it was seen that there was no significant correlation between the type of implant used and the functional outcome of the fracture. The incidence of iatrogenic axillary nerve injury was also calculated for every implant used and it was seen that 3 patients had ANI in which JESS fixator was used. 2 patients operated using PHILOS plate developed ANI and 3 patients operated using prosthesis developed iatrogenic ANI. None of the patients operated using K wires had an iatrogenic ANI. This association between the type of implant used and incidence of iatrogenic axillary nerve injury was found to be non-significant.

**VII. CONCLUSION**

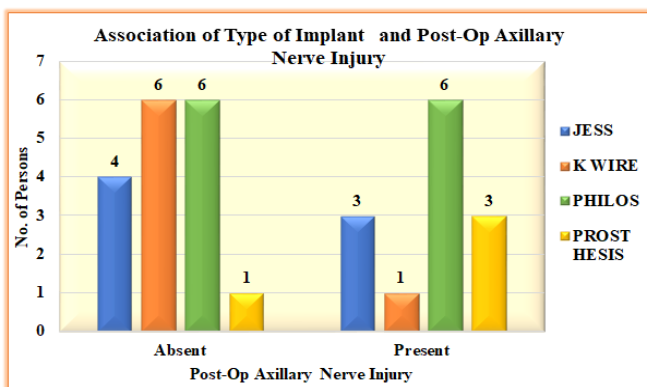
This study was aimed to calculate the incidence of axillary nerve injuries in proximal humerus fractures. At the end of the study it has been observed that the association of proximal humerus fractures with axillary nerve injuries is grossly overlooked while addressing such fractures. It also emphasizes the fact that during surgery adequate care has to be taken so as to prevent iatrogenic axillary nerve injuries. Even though the sample size of our study was small and it was not a randomized control trial, the results are comparable with other published studies. In our study of 30 cases an incidence of 16.7% of traumatic axillary nerve injury and 26.7% of iatrogenic axillary nerve injury gives alarming evidence to the fact that the axillary nerve is at risk both pre operatively and intra operatively. Clinically diagnosing such nerve injuries can be challenging especially in the setting of a fracture where sensory and motor tests cannot be conducted accurately. The importance of nerve conduction studies and electromyography as tools for the precise diagnosis of nerve lesions cannot be undermined in such instances. The presence of axillary nerve injuries affects the functional outcome of the shoulder and hampers the return of normal range of joint movements. Even though nerve injuries are present majority of them are neuropraxia or axonotmesis which recover over a period of time with adequate rehabilitation and rigorous physiotherapy programs.

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**GRAPH 8: ASSOCIATION BETWEEN IMPLANT TYPE AND RESULTS**



**GRAPH 9: ASSOCIATION BETWEEN IMPLANT TYPE AND POST OP ANI**

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