

## ORIGINAL ARTICLE

# Complications of NA External Fixator in patients who Underwent Tibial Lengthening Surgery

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## ABSTRACT

**Aim:** To determine the spectrum of different complications during tibial lengthening procedure using NA external fixator in our patients at GMC, Gujranwala, and KEMU, Lahore, Pakistan. In addition, this study will also find significant factors associated with occurrence of complications in NA fixator-assisted lengthening surgery.

**Methods:** This was a cross-sectional study. The patients who underwent tibial lengthening procedure using NA external fixator were categorized into two categories: fixator complications group and no complications group. Statistical analysis was done using SPSS version 25. Independent sample T test and Chi-square test for independence were used for quantitative and qualitative variables respectively to determine their significant association with the occurrence of complications during tibial lengthening procedure. The p-values were taken statistically significant if  $< 0.05$ .

**Results:** Out of a total of 100 patients, 26% suffered loosening of pin, 2% breaking of pin, 2% loosening of pin, 2% loosening of clamp, 2% breaking of clamp, while 66% had no complications. 52% got skin reaction to pins. The occurrence of complications of NA external fixator was significantly lower at younger age ( $p=0.022$ ). It has positive association with the number of pins inserted during procedure ( $p=0.037$ ) and negative association with the duration of hospitalization ( $p=0.003$ ). The complications of NA external fixator occurred more after left leg surgery as compared to after right leg surgery ( $p=0.012$ ) and were associated with post healing pain ( $p=0.042$ ).

**Conclusion:** Skin reaction to pins was the commonest complication of NA external fixator in our studied population. The risk of complications of NA fixator had positive correlation with increasing age and number of pins inserted during tibial lengthening procedure. The duration of hospitalization was less while post-healing pain was more among patients in which complications of NA fixator occurred. Complications occurred relatively more after left leg surgery in comparison to right leg surgery. Minimum number of pins should be inserted during lengthening procedure especially in aged people to reduce fixator related complications and post-healing discomfort

**Keywords:** Tibial lengthening surgery, NA external fixator, Complications of fixator, SPSS

## INTRODUCTION

External fixators<sup>1</sup> are used to immobilize the diseased or fractured bones to allow bone healing. Metal pins and clamps are put through skin and muscles into the bones, and then metallic bar is attached to pins and clamps outside of the skin. Naseer Awais (NA) external fixator<sup>2</sup> is a precious invention by well-known Pakistani Orthopaedic Doctor, Muhammad Awais. It is commonly used in our hospitals now a days. The goal of tibial lengthening procedures is to improve the functional mobility of the short-limb patients and prevent long term complications like degenerative joint disease<sup>3</sup> in them. External fixation is associated with risk of a lot of complications like pin-site infection, aseptic loosening of pin, deep vein thrombosis, pulmonary embolism, loss of reduction, and non-union of fractures.<sup>4,5</sup> Meta-analysis<sup>6</sup> suggests 23.6% overall complication rate associated with external fixators, pin-tract infection being the commonest one among all. Yanshi Liu, Maimaiali Yushan, Zhenhui Liu, et al.<sup>7</sup> found pin-tract infection (66%) as the commonest complication and delayed union (13.5%) as the least one in their meta-analysis. Younger age, preoperative hyperglycemia and lengthy tourniquet times are known predictors of complications of external fixator.<sup>8</sup> The detection of modifiable predictors of complications of any modality is a blessing as if found, this helps the performer a lot of guidance to reduce the risk of post-procedural complications. This made the author glade to pick this topic as the study protocol.

Hence, the objective of our study was to determine the spectrum of different complications during tibial lengthening procedure using NA external fixator in our patients at GMC, Gujranwala, Pakistan. In addition, this study will also find significant factors associated with occurrence of complications in NA fixator-assisted lengthening surgery.

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## MATERIAL AND METHODS

This was a cross-sectional study and data of the patients who underwent tibial lengthening procedure using NA external fixator from June 2001 to May 2021 at the Department of Orthopaedics, GMC Teaching hospital, Gujranwala, and KEMU, Lahore after permission from IRB, was collected by purposive sampling. Informed consent was received. The patients having short tibia of all age groups, belonging to both genders, who underwent tibial lengthening procedure using NA external fixator were included. After aseptic measures, NA external fixator was applied with or without fluoroscopy control, then osteotomy / corticotomy was performed through proximal metaphyseal/ middle diaphyseal region and compression was given at osteotomy site. Lengthening was started at day 10, 1mm daily incremental till the required length was achieved. In those cases, in which the lengthened bone was weak, the plaster was applied after removal of external fixator. The plaster was removed after one month. These patients were grouped into two categories: fixator complications group and no complications group. Statistical analysis was performed using SPSS version 25. Age of the patients, number of pins inserted during procedure, duration of hospitalization, duration of external fixation, and time of healing were the quantitative variable, while gender, cause of shortening of leg, side of affected limb, site of tibial osteotomy, bone grafting during procedure, and post-healing discomfort were the qualitative variables. Independent sample T test<sup>11</sup> and Chi-square test for independence<sup>12</sup> were used for quantitative and qualitative variables respectively to determine their significant association with the occurrence of complications during tibial lengthening procedure. The p-values were taken statistically significant if  $< 0.05$ .

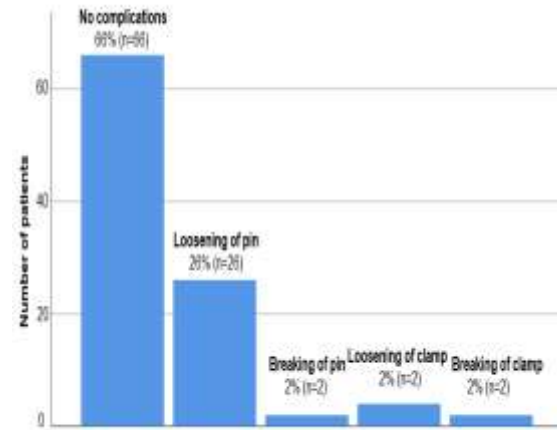
## RESULTS

Out of a total of 100 patients who underwent tibial lengthening procedure using NA external fixator, 66(66%) had no procedure-related complications, 26(26%) suffered loosening of pin, 2(2%)

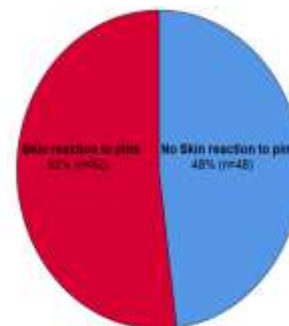
breaking of pin, 2(2%) loosening of pin, 2(2%) loosening of clamp, and 2% (n=2) breaking of clamp (Picture 1). 52% (n=52) got skin reaction to pins (Picture 2). The occurrence of complications of NA external fixator was significantly lower at younger age ( $p=0.022$ ). The mean age of the patients who suffered complications was  $19.65 \pm 9.73$  years while the mean age of the patients who had no complications was  $17.38 \pm 7.48$  years. Similarly, number of pins inserted during procedure had positive association with occurrence of complications of the procedure ( $p=0.037$ ). The mean number of pins inserted during procedure were  $7.06 \pm 1.07$  in patient group who suffered complications while the mean number of pins inserted during procedure were  $6.52 \pm 1.45$  in patient group who had no complications of the procedure. The duration of hospitalization was significantly more among patients who had no complications of the procedure ( $p=0.003$ ). The mean duration of hospitalization was  $4.00 \pm 1.04$  days in patients who had complications while the mean duration of hospitalization was  $5.82 \pm 4.58$  days in patients who had no complications of the procedure. The occurrence of complications of NA external fixator had no association with duration of external fixator ( $p=0.577$ ) and time of healing ( $p=0.194$ ) (Table 1). The complications of NA external fixator occurred proportionally more after left leg surgery as compared to after right leg surgery ( $p=0.076$  when Chi-square test was applied,  $p=0.012$  when Binary logistic regression analysis was applied). After tibial lengthening surgery of left leg, complication rate was 44.4% (in 16 patients out 36) while complication rate after tibial lengthening surgery of right leg was 28.1% (in 18 patients out 64). Off course, post healing pain discomfort occurred significantly more in group of patients who suffered complications of NA external fixator ( $p=0.042$ ). The occurrence of complications of NA external fixator had no association with gender ( $p=0.523$ ), etiology of shortened leg ( $p=0.617$ ), site of osteotomy of tibia ( $p=0.129$ ), and need of bone grafting during lengthening procedure ( $p=0.447$ ) (Table 2).

A binary logistic regression analysis was performed to ascertain the effect of different qualitative and quantitative factors on the likelihood that the patients who underwent tibial lengthening surgery have complications of NA external fixator. The logistic regression model explained 26.3% (Nagelkerke  $R^2$ ) of the variance in the occurrence of complications and correctly classified 78% of cases. Increasing duration of hospitalization was associated with an increased likelihood of complications of NA external fixator in

patients who underwent tibial lengthening surgery. Patients with involvement of left limb shortening were significantly more likely to exhibit complications of NA external fixator when underwent tibial lengthening surgery (Table 3).



Picture 1: Complications of NA external fixator in patients who underwent tibial lengthening surgery (n=100)



Picture 2: Skin reaction to patients who underwent tibial lengthening surgery using NA external fixator (n=100)

Table 1: Associations of Complications of NA external fixator with quantitative variables in patients who underwent tibial lengthening surgery (n = 100) \*

Quantitative variables	Complications of NA external fixator		Mean difference	p-value
	Yes (mean + SD)	No (mean + SD)		
Age (years)	19.65 ± 9.73	16.38 ± 7.48	-3.34	0.022
No. of pins inserted during procedure	7.06 ± 1.07	6.52 ± 1.45	-0.54	0.037
Duration of hospitalization (days)	4.00 ± 1.04	5.82 ± 4.58	1.82	0.003
Duration of external fixation (days)	275.41 ± 92.61	262.30 ± 139.68	-13.11	0.577
Time of healing (days)	339.76 ± 106.90	303.73 ± 166.70	-36.04	0.194

[Independent sample T-test was used

Table 2: Associations of Complications of NA external fixator with qualitative variables in patients who underwent tibial lengthening surgery (n = 100) \*

Predictors / Factors	Complications of NA external fixator		Total	p-value
	Yes	No		
Male	18 (52.9%)	36 (54.5%)	54 (54.0%)	0.523
Female	16 (47.1%)	30 (45.5%)	46 (46.0%)	
<b>Cause of shortening of leg:</b>				0.617
Polio	30 (88.2%)	58 (87.9%)	88 (88.0%)	
Orthopaedic Trauma	04 (11.8%)	08 (12.1%)	12 (12.0%)	
<b>Side of affected limb:</b>				0.076
Right	18 (52.9%)	46 (69.7%)	64 (64.0%)	
Left	16 (47.1%)	20 (30.3%)	36 (36.0%)	
<b>Site of Tibial Osteotomy:</b>				0.129
Proximal metaphysis	28 (0.0%)	46 (0.0%)	74 (0.0%)	
Middle Tibia	06 (0.0%)	20 (0.0%)	26 (0.0%)	
<b>Bone grafting during lengthening procedure:</b>				0.447
Yes	02 (05.9%)	06 (09.1%)	08 (08.0%)	
No	32 (94.1%)	60 (90.9%)	92 (92.0%)	
<b>Post-healing pain /discomfort:</b>				0.042
hurts	28 (82.4%)	42 (63.6%)	70 (70.0%)	
No hurt	06 (17.6%)	24 (36.4%)	30 (30.0%)	

\*Chi-square test for independence was used

Table 3: Binary Logistic Regression Analysis to predict association of various factors with complications of NA external fixator in patients who underwent tibial lengthening surgery (n = 100)

Risk Factors	B	S.E.	Wald-Statistic	p-value	Odds Ratio	95% C.I. for EXP(B)	
						Lower	Upper
Age (years)	.032	.031	1.057	0.304	1.032	.971	1.097
Gender (Male/Female)	.640	.501	1.632	0.201	1.896	.711	5.058
Side of affected limb (Left/Right)	-1.351	.538	6.305	0.012	.259	.090	.743
Post-healing pain (hurts/No hurt)	.873	.570	2.346	0.126	2.393	.784	7.311
Duration of hospitalization (days)	-.276	.121	5.205	0.023	.759	.599	.962
No. of pins inserted during procedure	.286	.199	2.069	0.150	1.332	.901	1.967
Constant	-2.011	1.444	1.941	0.164	.134		

Cox & Snell R Square = 19.0%, Nagelkerke R Square = 26.3%, Percentage correct = 78.0%

## DISCUSSION

The spectrum of complications associated with external fixator is vast.<sup>13</sup> In our study, we observed the overall rate of fixator related complication of 34%, among which loosening of pin was seen in 26% patients. Sanaullah and his colleagues<sup>14</sup> noted 69% complications rate associated with external fixation of tibia, being pin-trak infection (31%) the commonest complication. Lee C Rogers and Nicholas J Bevilacqua<sup>5</sup> found younger age, preoperative hyperglycemia and lengthy tourniquet times as the predictors of complications of external fixator in their study. In November 2020, Chao Zheng, Huanli Han, and Yujiang Cao<sup>15</sup> found older age (p<0.05) and type of external fixator (p<0.05) as the two predictors of complications of lengthening procedure using external fixator. In our study, increasing age (p=0.022) was also noted significantly associated with the occurrence of complications of NA external fixator. Our findings are consistent to the recent research work, however larger studies are needed to ascertain the association in future work. Many researchers took in account the mean duration of external fixation in their study protocol. Recently, Lior Shabtai and his colleagues<sup>16</sup> declared the mean duration of external fixation of 6.7 months (about 200 days). However, in our study, mean duration of external fixator was 275.41±92.61 days for patients who suffered complication of external fixator and 262.30 ± 139.62 days for patients who had no complications. There is lot of literature available on the topic of healing index and healing time.<sup>17,18</sup> Recovery from leg lengthening surgery can be a tedious process as bone distraction and new growth must occur gradually over several weeks or months. The amount of time it takes the bone to heal depends on the amount of lengthening: Each centimetre of lengthening takes 36 days of healing<sup>19</sup>. We also noted the time of healing of the patients who underwent tibial lengthening procedure. We compared and found that the healing time was 36.04 days more in group of patients who had complications of NA external fixator. There are many known different reasons for leg length discrepancy<sup>20</sup>. Anatomic etiologies include congenital scoliosis, hip replacement surgery, normal or abnormal leg length variation, late effects of childhood growth plate injuries/fractures. Functional causes comprise psoas spasticity or IT band tightness, ankle, knee, hip injury, poor running biomechanics, dropped foot arch etc. In our setup, where among one hundred patients with short leg presented to us, 88 had neurological disorder, poliomyelitis leading to leg length discrepancy while othe twelve had history of orthopaedic trauma. Regarding complications of NA fixator both group were comparable (p=0.617). We observed that gender (p=0.523), etiology of shortened leg (p=0.617), site of osteotomy of tibia (p=0.129), and need of bone grafting<sup>21</sup> during lengthening procedure (p=0.447) had no association with complications of NA external fixator. Further studies with large sample size may be required to elboate the significance of the findings in detaile.

## CONCLUSION

Skin reaction to pins was the commonest complication of NA external fixator in our studied population. The risk of complications of NA fixator had positive correlation with increasing age and number of pins inserted during tibial lengthening procedure. The duration of hospitalization was less while post-healing pain was more among patients in which complications of NA fixator occurred. Complications occurred relatively more after left leg surgery in comparison to right leg surgery. Minimum number of pins should be inserted during lengthening procedure especially in aged people to reduce fixator related complications and post-healing discomfort.

Conflict of interest: Nil

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