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A study to estimate the incidence of Schanz pin loosening in LRS and a suggested technique for clinical assessment of pin loosening

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Abstract

Schanz pin loosening affects the outcome of LRS fixators in indications like bone transport and limb lengthening, that need the fixator to be kept in-situ, for periods longer than 6-9 months. The current study, was carried out prospectively, over a period of October 2016-December 2021, over 23 patients on which a Limb Reconstruction System or LRS was applied, in femur or tibia for limb lengthening or bone transport. A total of 196 Shanz pins were assessed over a mean period of 7.2 months. The incidence of loosening was 0.51% of the pins at six months follow up, rising to 6.63 % of total pins at nine months.

Keywords: Pin loosening, LRS, Schanz pin, pin tract infections, rail fixator, limb lengthening, bone transport, half pins.

Introduction

The rising incidence of high velocity trauma arising from motor vehicle accidents has led to greater number of complex, compound fractures of Tibia and Femur, presenting in the Orthopaedic departments. Along with these fractures that present in an acute setting, there is a rising load of infected non-unions, gap non unions, and malunions or otherwise healed fractures with shortening. All these situations call for bone transport or limb-lengthening procedures. Limb lenthening is also needed sometimes, after acute docking of gap nonunions or bone loss with small gaps, or after osteotomy for correction of deformity or malunions. Bone transport may be needed after sequestrectomy or bone loss with gaps larger than 5 cms.

A Limb Reconstruction System or LRS has largely replaced the circular ring fixator or Ilizarov fixator in most of the centres. But the fixator has to be kept in place for long durations, often in excess of 6-9 months, which makes loosening of Schanz pins a worrisome complication, often necessitating change of pins or even changing the configuration of fixator or position of clamps, for better hold of the bone segments, especially if the fixator has to be kept for longer than 9 months. This has lead to the suggestion of using Hydroxyapatite-coated pins for limb lengthening and transport.[(1)] But the cost of hydroxyapatite-coated schanz pins is prohibitively expensive and the regular stainless steel 6.0 mm pins are being used most of the times.

This makes it imperative to periodically assess the pins for signs of loosening, and to replace them as and when it becomes necessary, to preserve the stability of construct, and to ensure that the union, the quality of the regenerate, and the targeted alignment of the limb is not jeopardised. But there are no guidelines to clinically access the stability of the pins. The radiological signs of pin loosening become evident when the pin is already very loose and often it is not possible to slavage the clamp by replacing it by a pin in the adjacent hole of the clamp, making it necessary to change the position of the clamp and the construct. Pommer et al [(2)] have used an electronic torque wrench to access the torque needed to remove the pins at the time of fixator removal, to access for pin loosening, but this technique is applicable only at the time of fixator removal, and cannot be employed during the follow up period, for ensuring a stable LRS construct with well-fixed and secure pins, and to make changes to individual pins if need arises. So the present study aims at estimating the incidence of clinically loose schanz pins, and to suggest a simple test to access impending or probable loose pin.

Materials and Methods

A total of 23 patients which were operated at Raipur Institute of Medical Sciences, Raipur (C.G.), India, from October 2016 to December 2021, in which a Limb Reconstruction System, LRS was applied, were included in the study. The LRS was applied either in the femur or the tibia, for limb lengthening or bone transport. The indications included complex, comminuted compound fractures with bone loss, infected non unions necessitating sequestrectomy leading to bone loss, malunions and shortening. In two cases, acute docking was possible as bone gap was less than 5 cms. In one case, a dome osteotomy of distal femur and lengthening from osteotomy site was done for severe genu varus with shortening.

In 6 patients, two clamps and 6 pins were used with the rail. In the rest, 3 clamps with a total of 9 pins, formed the construct with the rail. 6 mm tapered Stainless Steel Schanz pins was used in all the cases. A prophylactic dose of locally injected antibiotic, cefuroxime 250 mg was given at the pin insertion site as it has been shown to reduce the risk of subsequent pin track infections.[3] The drill bits were introduced with a sleeve passed through a temptlate, and the drill was used to probe the anterior and the posterior cortex, to ensure a central placement. A sharp drill bit was always used, emplying a start and stop technique and slow drilling, accompanied by continuous saline irrigation, which are recommended practices to minimise thermal necrosis and subsequent loosening.[(4,5,6).] Blunt drills were immediately discarded. Schanz pins were inserted manually to second cortex, using the holes 1,3 and 5 for every clamp whenever feasible, for proper spacing. 3 pins per segment were always used.

All patients were given a course of oral prophylactic antibiotics, as suggested by Magyar et al [7]), who had shown in their study of 308 consecutive cases that it brought down the incidence of pin tract infections in their series by half.

Patients with open physis, who had not reached skeletal maturity, having LRS for limb lengthening or any other indication were excluded. Patients which had the LRS for less than 6 months or had a follow up period of less than 6 months were excluded from the study.

Patients were advised to shower once the stitches were out. They were taught pin tract care with saline and water as advocated by ASAMI. They were taught to look for signs of pin tract infection like redness or swelling around pin tracts, discharge whether serous or purulent, pain or fever and report telephonically or in the OPD, for a short course of oral antibiotics as is a standard practice.[8] Pin tract infections not responding to a five day course of oral Cefuroxime or Septran were called in the OPD for admission.

These patients with pin tract infections not responding to short course of oral antibiotics were subjected to pus culture and sensitivity and were started on appropriate culture sensitive antibiotics, preferably by intravenous route.

Apart from these patients with visible pin tract infections, all the operated patients were called for follow up every 4 weeks when an X-ray was done. The X-rays were monitored for radiological signs of loosening, like lysis of the bone around the pin holes. The pin tract sites were inspected the operating team, for visual signs of pin tract infections.

Patients were examined in the Operation theatre under 'C' arm for our proposed clinical test of pin loosening after 6 months or 26 weeks, or even earlier in the presence of intractable pin tract infections, or unexplained pain. Those with radiological signs of loosening were also proposed for an earlier inspection under 'C' arm in the Operation Theatre, but it was not needed in any case as no case showed radiological sign of healing this early. The three pins that were diagnosed as radiologically loose were picked up late in the follow up, when the patients were already planned for fixator removal, cementing our view that radiological sign of loosening comes too late, to be helpful in salvaging the clamp or the construct.

A proper consent was taken for examination of pins, explaining the possible need of pin exchange. Patients were kept nil orally 4 hours prior to the procedure with all pre-operative preparations including peri-operative antibiotics, should the need arise for a pin exchange. Pins were examined under 'C' arm after loosening the top bolt of a clamp. The bottom bolt fixing the clamp to the rail was tightened or checked for being tight before gently loosening the two clamps holding the Schanz pins to the clamp. Each pin was then gently rocked once or twice, in two planes, one parallel to the rail and the other perpendicular to it, under video fluoroscopy or continuous video image on 'C' arm. A tactile perception of toggle and a simultaneous visual appraisal of 'C' arm video of a pin tract motion, if any, was made. A 1 mm toggle in both the planes or a 2 mm or more toggle or abnormal movement in one plane was considered as positive and the said pin was deemed loose. Care was taken not the rotate the pins, especially anticlockwise, as it would render an otherwise secure pin, unstable and loose, considering the fact that the design of pins was always tapering.

Loose pins were immediately replaced by a new pin in the adjacent hole, under local anaesthesia or short G.A., using a sharp drill, by slow drilling accompanied by continuous irrigation. The patients requiring pin exchange were again put on a course of oral antibiotics for two weeks post operatively.

The results of pin tract loosening were tabulated as number of pins found loose in number of weeks rounded off to the nearest week. The pins that were found loose prior to the planned fixator removal were charted separately from those that were found to be loose at the time of fixator removal. A distinction was made between loose cortical pins and those pins that were loose and in the cancellous bone. The presence or absence of infection was noted along with the plane and of toggle, whether it was in one plane or both perpendicular planes.

Results

The results were tabulated regarding the number of Schanz pins found to be loose by 26 week onwards, the number being a cumulative number starting from previous weeks. All in all 47 pins were found to be loose, of which 40 (20.4%) were found loose at the time of final removal of the fixator, only 7 (3.57%) were loose in the course of treatment , that were exchanged. The pins that turn out loose after the planned bone transport or limb lengthening may not affect the final outcome, as by then gradual dynamization of the construct is initiated.

The number of pins that were selectively loose in one plane (> 2mm toggle in one plane) were noted along with those found with loosening in 2 perpendicular planes (>1 mm in both planes). The significance of this distinction is yet to be hypothsized, but this category arose out of the need to be minimally interventionist while observing for pin loosening, as a gentle toggle in two planes would be less damaging to secure pins than a complete wobble. A screwing or unscrewing movement while testing the pins was prohibited as already stated in the methods. In all, only 4 pins (2.04%) were found to be loose in one plane while the majority, 43 pins (20.4%) were loose on 2 planes.

18 cortical pins were found to be loose while 29 were pin the cancellous bone.

A distinction between infected versus aseptic loosening was also tabulated, as it seemed to be a pertinent observation, fit for drawing some conclusions, or a possible hypothesis. So 28 pins were found to be loose and infected while 19 had aseptic loosening.

Discussion

The pin loosening was found to exhibit a gradually rising trend, starting from 0.51% of all 196 pins at 26 weeks, to 8.16% at 40 weeks, 14.28% of at 50 weeks, 17.86% at 60 weeks, and 23.98% at 78 weeks. Statistically this means that at least 1 Schanz pin in a 9 pin, 3 clamp LRS construct, becomes loose by 45 weeks, and is fit for exchange, if the construct needs to be retained. This can suggest that any LRS that is expected to remain in position for longer than 40-45 weeks should employ hydroxyapatite coated pins. If the hydroxyapatite coated pins are not feasible, a proactive approach of pin examination for loosening and exchange should be contemplated.

Some studies suggest use of hydroxyapatite coated pins for at least cancellous bone. Our study also showed more cancellous pins to be loose (29/47 or 61.70% of all loose pins) versus cortical pins (18/47 or 38.29%).

It was also noted that pins that were loose in one plane happened to be cortical pins and they were loose along the long axis of the fixator. We believe they were loosened by the cantilever bending stresses faced by the construct.

Early in the study, most pins had aseptic loosening where the number of loose pins showing signs of infection rose with time. At the median point of study, i.e. 51 weeks, 17 pins had aseptic loosening while 15 were infected and loose. After this median point only 2 pins showed aseptic loosening, the rest had clinical pin tract infection. Some studies have suggested that pin loosening doesn't not necessarily signify infection, and infection comes secondarily due to mechanical instability. Out study cements this view for about half of the pin loosenings, till 51 weeks after which infection takes over. This might be possibly due to longer duration of the pins being in situ, making them more prone to infection after mechanical instability. Or it might suggest infection to be the dominant etiology behind pin loosening after 50 weeks. This again reiterates the inference that hydroxyapatite coated pins are better suited for LRS intended to remain in situ for longer than 50 weeks as hydroxapatite coated pins are found superior with respect to the incidence of pin tract infections as well as they resist bacterial adhesion.[9] It is already established that hudtoxyapatite coated pins have less loosening and higher extraction torque at the time of removal [10], and microscopic bone in growth. [11]

Conclusion

The study concludes that the incidence of pin loosening in LRS rises exponentially with time, and by 45 weeks, statistically every patient with LRS is liable to have at least one loose pin. This would suggest employing hydroxyapatite coated pins in patients needing LRS for durations longer than 40-45 weeks. If it is not feasible, patients with LRS with stainless steel pins, need to be examined for loose pins, by the regimen suggested by the authors, for pin exchange if any pin is found to be loose.

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Legend Figure and Graph

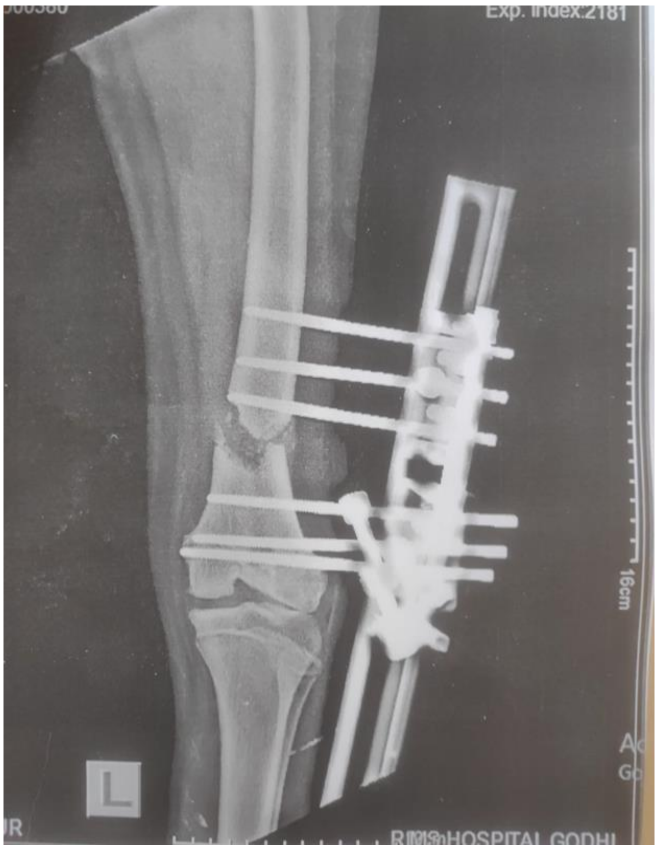

Figure 1: Dome osteotomy distal femur for genu varus, with lengthening at osteotomy site, 18year/Female

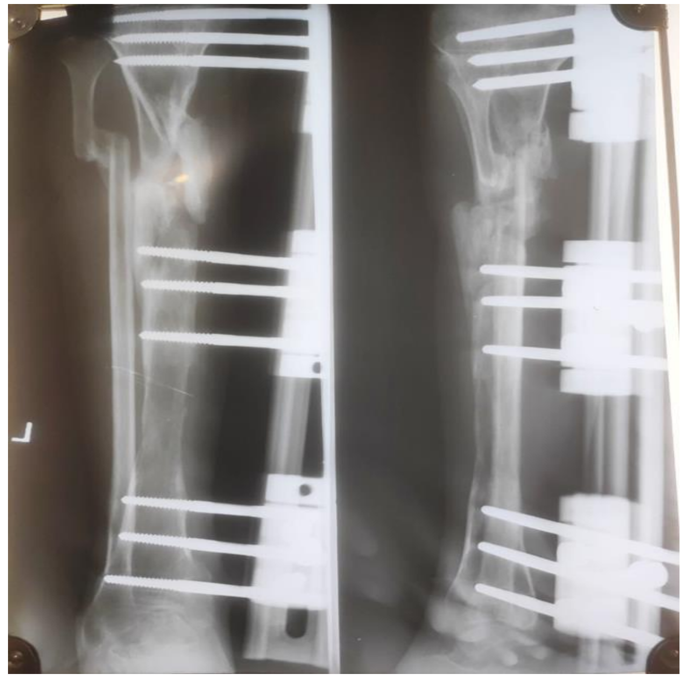

Figure 2: Bone transport with distal tibial cortictomy for compound, comminuted fracture with bone loss of proximal third tibia, 40year/Male

Figure 3: Sub trochanteric limb lengthening for shortening caused by excision of distal femur GCT and knee arthrodesis in 38year/Female

Figure 4: Proximal Tibia corticotomy and bone transport for compound fracture of distal fourth tibia with bone loss.50year/male

Figure 5: Distal femur bone lengthening after acute docking, post sequestrectomy for infected gap nonunion, 29year/Male

Weeks	Cumulative No. of loo se pins		Pins loose at exchange	Pins loose at LRS removal	Pins loose in one plane	Pins loose in two planes	Loose cortical pins	Looose cancellous pins	Infected loose pins	Aseptic loose pins
26	1		1	0	0	1	0	1	0	1
29	3		0	2	0	2	0	2	0	2
30	4		1	0	1	0	1	0	0	1
31	5		0	1	0	1	0	1	0	1
32	5		0	0	0	0	0	0	0	0
33	6		0	1	0	1	0	1	1	0
34	8		2	0	0	2	1	1	1	1
35	9		1	0	1	0	1	0	0	1
36	11		0	2	1	1	1	1	1	1
39	13		0	2	0	2	1	1	1	1
40	16		0	3	0	3	1	2	1	2
43	20		0	4	1	3	1	3	2	2
44	21		1	0	0	1	1	0	1	0
45	23		0	2	0	2	0	2	1	1
46	26		1	2	0	3	1	2	2	1
47	28		0	2	0	2	1	1	2	0
50	28		0	0	0	0	0	0	0	0
51	32		0	4	0	4	2	2	2	2
58	35		0	3	0	3	1	2	2	1
63	37		0	2	0	2	1	1	2	0
65	39		0	2	0	2	1	1	2	0
72	42		0	3	0	3	2	1	3	0
75	44		0	2	0	2	1	1	1	1
78	47		0	3	0	3	0	3	3	0
	47		7	40	4	43	18	29	28	19

Table 1