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Research Article

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Limp After Hip Fracture- Reasons & Prevention: A Prospective Study

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ABSTRACT

Purpose: To study the incidence, etiopathogenesis of limp after hip fracture. Secondary aim was to find out association of limp with patient satisfaction and identify the preventive measures.

Methods: Prospective study in 246 patients treated from January 2019 to December 2025 who underwent fracture reconstruction surgery for proximal femoral fractures. Single center study with minimum follows up of 3 years. Patients between 25 to 65 years with AO/ OTA 31-A and 31-B proximal femur fracture essentially with pre-operative normal gait (limp not reported) and no associated co-morbidities were chosen. Patients with pathological fractures and previous hip surgery were excluded. The patients who developed any post-operative complications were excluded. Harris Hip Score particularly limp sub-score is used. 5-point Likert scale was used to assess satisfaction at 3 years.

Results: Incidence of limp after hip fracture surgery was 30% whereas the incidence of persistent limp was 16%. Common preventable causes of limp are SGN injury, gluteal damage, shortening of neck, varus mal-reduction, implant malposition and limb length discrepancy. Patients dis-satisfaction is directly proportional to the limp after surgery.

Conclusions: Incidence of persistent limp after hip fracture surgery is much higher than we think and the reasons behind it are preventable. Precise anatomical knowledge, careful patient positioning, safe surgical techniques are key factors. Application of these preventive measures warrant further in-depth analysis, to decrease incidence of persistent post-operative limp.

Level of Evidence: Therapeutic Level IV

Keywords: Post-operative Limp, Persistent Limp, Superior Gluteal Nerve, Gluteal Muscle Damage, PFN

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Introduction

Hip fractures, encompassing intra-capsular and extracapsular fractures, are increasingly common due to the profound osteoporosis and high-energy trauma in younger patients [1-3]. With better biomechanical under-standing and recent fixation modalities, overall outcome of these fractures improved than earlier [3]. Despite improvements in pain and function, patients who undergo hip surgery may not always return to desired levels of physical activity. The factors associated with low activity levels are not fully understood. Abductor weakness and fatigue have both been proposed as factors that limit activity. Limp after hip surgery lowers the satisfaction

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level of patient. The notion that fracture surgery is essentially for fracture healing only, so that patients can walk again, does not hold true today. Patients expect pre-injury functional status from hip surgery. Shortening and limp are commonly discussed entities. Some patients tend to accept limp as they attribute it to the initial trauma. The purpose of this study is to find out incidence and common causes of persistent post-operative limp and understand the preventive measures. Patients having persistent painless limp don't complain about it directly but report it indirectly in terms of early fatiguability. Fatiguability is a complex subjective phenomenon influenced by several factors. The patient's expectation to eliminate the preoperative limping to the surgery was linked to satisfaction [4]. Postoperative limping is associated with more unfulfilled expectations and could be a stigma of disability visible to all with an adverse psychological impact affecting patient satisfaction [5,6]. Individual pain threshold, sensitivity, mental state can also influence the limp. Several factors can cause post-operative limp, but our interest is to identify the preventable causes of limp.

Materials and Methods

It's a prospective study of 246 patients treated between January 2019 to December 2025. This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethical Review Boards of KIMS-KINGWAY Hospital (Date – 20/12/2018, No - KIEC/2019/18).

Inclusion & Exclusion Criteria

Patients between 25 to 65 years with AO/ OTA 31-A and 31-B proximal femur fracture essentially with pre-operative normal gait (limp not reported) and no associated co-morbidities were chosen. Patients with pathological fractures and previous hip surgery were excluded. The patients who developed any complication during post-operative period were excluded from the study.

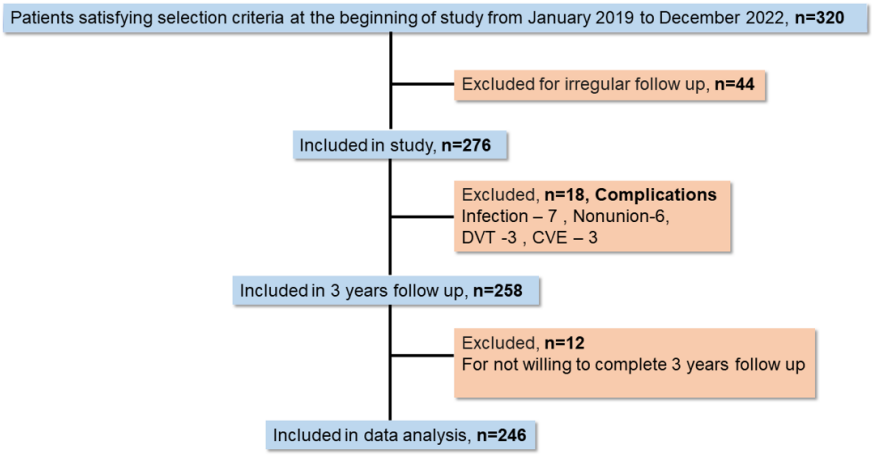

Figure 1: Flowchart for patient enrolment and flow of study population.

246 patients underwent fracture reconstruction surgery divided into three groups, nailing (N-180), plating (P-46), nailing with adjuvant plating (NP-20) (Table-I).

Table I: Basic characteristics of patients in study groups

	N	P	NP
n	180	46	20
Gender			
Male	92	32	14
Female	88	14	6
Side			
Right	102	26	11
Left	78	30	9
Fracture type			
31A	156	32	20
31B	24	12	0

Patient's demographic details and written informed consent obtained. All the surgeries were performed by a team of two senior trauma surgeons. Clinical and radiological assessment were done by two senior orthopaedic consultants independently using standardized forms. Inter-observer reliability was computed using the initial independent ratings prior to consensus resolution. Discrepancies were subsequently resolved by consensus for the final dataset. Patients with any post-operative complication were excluded from the study, to avoid any confounding bias which might influence assessment of post-operative limp. The minimum duration of follow up was 3 years.

At 3 months visit, all patients underwent clinical and radiological evaluation including the Trendelenburg test, abductor strength test and X-ray Pelvis with both hips. Satisfaction response was also recorded. At this stage limpers and non-limpers were identified. Limpers then subject to limp assessment to know the cause. Electromyography (EMG) and MRI were used to assess peripheral nerves with special attention to SGN. EMG was performed using concentric needle electrodes targeting the Gluteus Medius (G.Med) and Minimus (G.Min) under ultrasound guidance to detect fibrillations and positive sharp waves to detect denervation potentials in the G.Med and G.Min

muscles. MRI hip or pelvis done to detect muscle atrophy and exclude structural anomalies. MRI with metal artefact reduction sequences (MARS) incorporated axial and coronal T2- weighted fat-suppressed imaging for assessment of abductor muscle atrophy and fatty change. MRI can detect gluteal tendon injuries and EMG abnormalities or radiological evidence of selective gluteal muscle atrophy suggest SGN injury. Magnetic Resonance Neurography (MRN) can detect peripheral nerve continuity and assess structural integrity after trauma. It is used to identify nerve transection, compression, swelling, or neuromas, that disrupt nerve pathways. Serum level of Creatine kinase (CK), lactate dehydrogenase (LDH) are used as a biomarker for muscle damage. CK & LDH level done on day 2, day 15 and for 3 months visit.

Follow up for all patients done at day 15, 3 months, 6 months, 12 months, 24 months, 36 months from the date of surgery (Table - II).

Table II - Follow up protocol for study population

Day - 0	Enrolment & Demographic data collection	
Day - 1	Surgery	
Day – 2	X ray Pelvis, CK & LDH	
Day - 15	Suture Removal, Wound inspection, CK, LDH	
	No Limp	**Limp**
3 months	C R S	C R S L
6 months	C R	C R L
12 months	C R S	C R S L
24 months	C R	C R L
36 months	C R	C R S L
CK – Creatinine Kinase, LDH – Lactate Dehydrogenase, C - Clinical assessment, R - Radiological assessment, S – Satisfaction response, L - Limp assessment		

Patient showing no signs of limp, undergoes clinical and radiological assessment to identify reasons for no limping. For comparative measure 10% non-limpers from each group (N-16, P-4, NP-1) selected randomly and subjected to EMG/NCV and MRI to found out reasons for non-limping. The primary aim was to note incidence and cause of the limp among the study population. Secondary aim was to know the association of limping with patient satisfaction 3 years after hip surgery. To address this issue, patients' responses were dichotomized into either "satisfied" (including "very satisfied," "satisfied") or "dissatisfied" (including "somewhat satisfied," "somewhat dissatisfied," "dissatisfied"). Proportions of satisfied patients were then compared among groups of limping (none vs. slight vs. moderate to severe) using univariate and multivariate log-binomial regression models.

Operative Protocol

After optimization of patients, all the surgeries were carried out under spinal anaesthesia. Fracture fixation surgeries were performed either on radiolucent table with traction attachment in supine position or on regular radiolucent table without traction attachment in lateral decubitus position with affected side up. Incision for nailing and plating was divided into four zones in relation with tip of the greater trochanter (GT) (Figure-2).

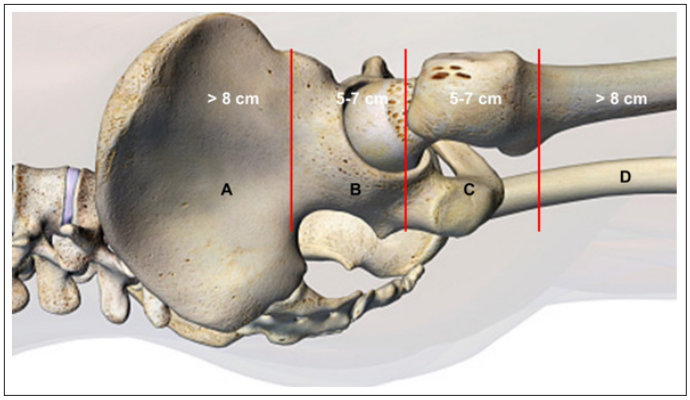

Figure 2: Showing four zones of incision in reference to GT. Zone A – Incision > 8 cm proximal to GT, Zone B – incision 5-7 cm proximal to GT, Zone C – incision 5-7 cm distal to GT, Zone D - incision > 8 cm distal to GT.

Post-operative Protocol

Ankle pumps, quadriceps, hamstring exercises started as soon as anaesthesia weaned off. Bed side sitting and walking non-weight bearing (NWB) for fracture fixation cases and walking full weight bearing for THA patients, commenced from next day. Weight bearing started after 3 months from surgery. During this time the patients monitored for radiological & clinical signs of healing.

Results

In this prospective study of 246 patient's incidence of limp is nearly 30% (n-75). There was marked improvement in limp noted in 6th and 12th months visits. Improvement in limp continues steadily in all group and reached its plateau in 24 months, thereafter no significant improvement in limp noted (Table-III). The difference in the proportion of patients with limp was statistically not significant across groups with time ($p > 0.05$)

Table III: Number of patients with limp according to visits in three groups

Visit	N (n=180)	P (n=46)	NP (n=20)	Overall	
	n (%)				P-value
3 months	58 (32.22)	12 (26.08)	5 (25)	75 (30.48)	**0.618**
6 months	37 (20.55)	7 (15.21)	4 (20)	48 (19.51)	**0.716**
12 months	30 (16.16)	5 (10.86)	3 (15)	38 (15.44)	**0.623**
24 months	28 (15.55)	4 (8.69)	2 (10)	34 (13.82)	**0.424**
36 months	28 (15.55)	4 (8.69)	2 (10)	34 (13.82)	**0.424**
Obtained using Z-test for proportions at each visit					

In this study the common reasons for post-operative limp were pain & discomfort, swelling & stiffness, Gluteal muscle damage (muscle & tendon), Superior Gluteal Nerve (SGN) injuries, loss of neck length, limb length discrepancy, implant malposition. Common reason for persistent limp for each subgroup listed below (Table-IV). Pain, discomfort, swelling, stiffness was patient specific and usually last for initial few days to weeks. The limp persisting at 3 months visit was categorically investigated for its cause.

Table IV: Common causes of limp in study groups

Causes	Study group				
	N (n=58)	P (n=12)	NP (n=5)	Overall (n=75)	P-value
SGN Injuries	43 (74.13)	5 (41.66)	2 (40.0)	50 (66.66)	**0.04**
Muscle damage	10 (17.24)	4 (33.33)	2 (40.0)	16 (21.33)	**0.266**
Malposition of Implant	3 (5.17)	2 (6.66)	1 (20.0)	5 (6.66)	**0.243**
Limb Length Discrepancy	2 (3.44)	1 (8.33)	0 (0.0)	3 (4.0)	**0.657**
Obtained using Z-test for proportions for each cause of injury					

Most common reasons for limp in this study population are SGN injuries, gluteal muscle damage, implant malposition, limb length discrepancy) Figure-3. SGN injuries showed statistically significant difference across three study groups (p=0.04) with higher proportion in N group. Other causes were not significant across groups (p > 0.05).

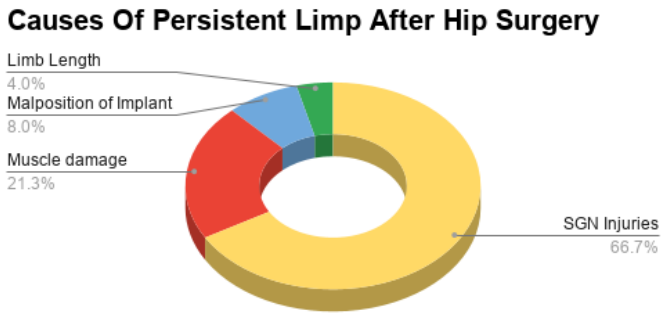

Figure 3: Most common causes of persistent limp after hip surgery.

Table V: Post-surgery dissatisfaction percentage among patients across visits

	N (n=180)	P (n=46)	NP (n=20)	Overall	
		n (%)			P-value
3 months	59 (32.77)	18 (39.13)	7 (35.0)	84 (34.14)	0.717
12 months	32 (17.77)	7 (15.21)	2 (10.0)	41 (16.66)	0.647
36 months	32 (17.77)	2 (10.86)	2 (10.0)	36 (14.63)	0.059
Obtained using Z-test for proportions at each visit					

Patient satisfaction for surgery was recorded at 3, 12 and 36 months from date of surgery. Leading causes of dis-satisfactions were pain and limp during initial visit. After one year the leading cause of dis-satisfaction was limp. Post-surgery dissatisfaction level was not significantly different across study groups (p > 0.05) (Table-V).

Limp and pain are entwined, so evaluation between limping and satisfaction by level of pain was done. In patients without pain, the presence of limping led to substantially greater dissatisfaction, which hints at a direct association (Table-VI). Leading reasons for dis-satisfaction at 3 months visit were pain & limp, whereas at 12- and 36-months limp was the main reason for dis-satisfaction. There is strong and direct association of persistent limp with patient's dis-satisfaction.

Table VI: Limp and Satisfaction analysis among patients across visits

Visit	Limping Pt	Dis-Satisfied Pt	Reasons for Dis-satisfaction	Correlation
3 months	75	92	Pain + Limp	0.9966890462
12 months	38	42	Limp	
36 months	34	31	Limp	
Obtained using Pearson - r correlation test				

Sample size (n-21) form satisfied patient were subjected to MRI and EMG/NCV studies (Table VII). Even in these patients, SGN neuropraxia, grade I-II gluteal muscle damage, partial tears of gluteal tendon were seen but without manifesting into limp. This suggests, every patient undergoing nailing and plating of proximal femur, invariably had these injuries in varying degrees. It's the severity of injuries which determine the outcome in the form of a limp.

Table VII: Results of investigations in non-limpers in sample study groups

Causes	Study group			
	N (n=16)	P (n=4)	NP (n=1)	Overall (n=21)
SGN Injuries	2 (12.5)	1 (25.00)	0 (00.0)	3 (14.28)
Muscle damage	3 (18.75)	4 (100.0)	1 (100.0)	8 (38.09)
Malposition of Implant	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Limb Length Discrepancy	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Discussion

Literature mentions many studies done for incidence of limp after a particular procedure or approach. There was a retrospective study in relation to proximal femoral nailing and SGN injury [7]. Painful limp is far more dis-satisfying than the painless limp. Proposed classification to understand the type of limp and thereby probable cause (Table VIII).

Table VIII: Classification of Post-Operative Limp

Post-Operative Limp	Temporary	Permanent
Painless	L1 – Temporary & Painless	L3 – Permanent & Painless
Painful	L2- Temporary & Painful	L4 – Permanent & Painful

Apart from change in gait the other concern in patient with L3 & L4 type limp is, early fatiguability requiring more energy than earlier for the same set of work. Most patient in this study belongs to rural areas with no rehabilitation facilities, their main concern is early fatiguability than cosmetic limp. This study tried to find out the general incidence of limp after any hip fracture surgery and the possible reasons behind it. Limp with pain is an ideal recipe for medicolegal litigation in recent past. Placement of incision and soft tissue handling throughout the procedure plays important role in future outcome. Incision placed in zone B is associated with SGN injury far graver than neuropraxia, Grade II-III damage to gluteal muscle and partial to complete tear of gluteal tendon. Incision placed in zone A is associated with SGN neuropraxia, Grade I-II damage to gluteal muscle and partial tear of gluteal tendon. Zone C incision associated with gluteal tendon damage but because tendinous portion were already exposed, so repair done and less of these injuries manifest in limp (Figure-4).

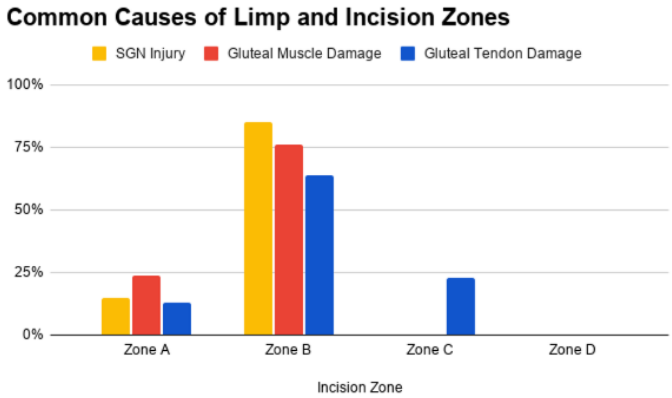

Figure 4: Showing causes of limp in relation to incision zones

Anatomic peculiarities of SGN and abductor muscle explains the reasons for zone B being the most vulnerable zone to result in limp.

Superior Gluteal Nerve: - It originates from the sacral plexus inside pelvis and carries the fibers from L4, L5, S1 nerve root. It exits the pelvis through Greater sciatic foramen superior to the piriformis muscle along with superior gluteal artery and vein. In approximately 75% of cases, it emerges as a single trunk, often in direct contact with the bone at the apex of the greater sciatic notch. In the gluteal region, the SGN travels posteriorly and then curves anterolaterally between the fascial plane of G.Med & G.Min muscles. It divides into a superior branch, which mainly innervates the G.Med, and an inferior branch, which supplies both the G.Med and G.Min, and terminates in the TFL muscle (Figure-5a). It also gives articular branch to hip joint. SGN has approximately 60000 nerve fibers, highest for any peripheral nerve of that length and diameter. Its extensive terminal arborization throughout the muscle fibers for the precise motor control indicates its importance.

Caution must be exercised while coagulating ascending branches of lateral circumflex arteries (ALCFA) during Heuter anterior approach to expose neck femur or head femur. Entry of point SGN and ALCFA are approximately 1 cm from each other (Figure-5b). Most iatrogenic SGN injuries occurs during femur nailing, pelvic surgeries and arthroplasty. SGN typically courses about 60-70 mm superior to the tip of greater trochanter. 5 cm from the tip of greater trochanter superiorly is safe zone. Any further split in G.Med in that direction will catch SGN, as mostly occurs in zone B incisions and lateral hip approaches. Placement of Bone spike around greater sciatic notch and trajectory of screws are risk factors for SGN injury during pelvic surgeries. During femoral nailing the position of adduction and flexion helps in keeping nerve away from nail trajectory. Nailing in lateral decubitus position is safer as it achieves that position automatically. Skin draping must be applied to pelvic brim, and skin incision must be placed along the curved axis of femur irrespective of point of entry (Figure-5c). It will avoid eccentric reaming as well as SGN injury as the trajectory of movement is away from SGN trunk. To minimise SGN injury, the soft tissue deviation should be less than 15 degrees during reaming and nail insertion. Proper position, skin incision and careful soft tissue handling can minimize SGN injuries during femur nailing.

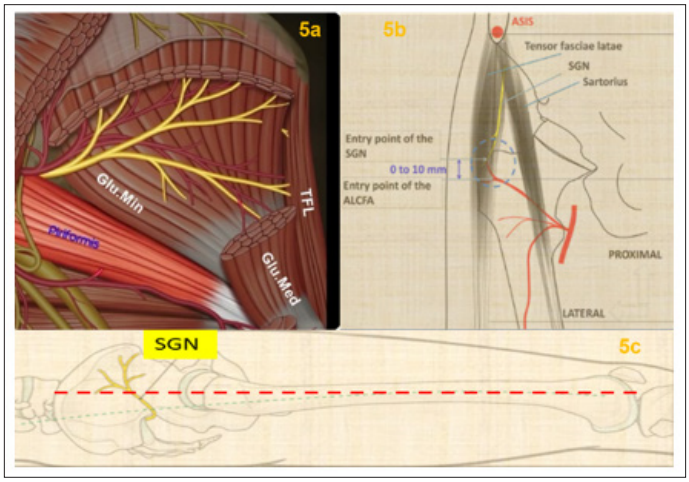

Figure 5: 5a Showing course and branching pattern of SGN. 5b-Showing entry point of SGN & ALCFA. Figure 5c - Red dotted line showing wrong axis and green dotted line showing correct axis of skin incision for femur nailing.

Gluteus Muscle and Tendon: - In this study Injury to Glu. Med muscle and tendon is the second leading cause of persistent limp. Muscle damage usually results from traumatic dissection or retraction. Severity of muscle damage is directly proportional to altered biomechanics which in turn lead to early fatigue. Elevated level of CK & LDH during first 12 – 24 hours is an indicator of muscle damage. Injured muscle lost its original strength is more prone to re-injury with trivial trauma. Weakness of the hip muscles can result in abnormal gait patterns and functional disability with lateral bending of the trunk. Injuries extending across the entire cross-section of the muscle, results in virtually complete loss of muscle function and intense pain. Such

patients may continue to have some degree of pain for months after the occurrence and treatment of the injury. G.Med tendon injury is the commonest cause of lateral hip pain. It is inevitable during reaming and nail insertion [8]. Tendon disruption occurs in 14.8% to 52.5% patients with average of 27%. Geriatric patients and earlier surgery are the commonest risk factors [8]. G.Med tear could be acute or degenerative. Partial tears can be managed conservatively but complete tears need either open or endoscopic repair.

Table IX: Preventive measures for SGN injuries

Procedure or Approach	Preventive Measures	
Femur Nailing	Position	Adduction and flexion of hip
	Draping	Up to pelvic brim
	Incision	As proximal as possible along the curved axis of femur
	Soft Tissue	Less than 15 degrees deviation during reaming and nail insertion
Heuter- Anterior Approach	Coagulation	Coagulation of ALCFA away from TFL
	Retraction	Avoid too much retraction of TFL
Posterior Approach	Bone Lever	Avoid bone lever near greater sciatic notch
Lateral Approach	Safe Zone	Safe Zone 5 cm from greater trochanter
	Muscle Damage	Minimize damage to Glu.Med tendon

Limb length discrepancy and implant malposition are the other reasons for persistent limp in this study. Persistent limp leads to increased energy requirements per step which in turn lead to reduced activity levels and activation of compensatory mechanisms to minimize force requirement from weak abductors [9,10]. Early fatigue occurs rapidly in weakened muscles, which is associated with decreased walking efficiency and increased energy cost. Decreased abductor function may be associated with energetically costly gait adaptations. Both experimental and simulation studies demonstrate that hip abductor function is critical for frontal plane stability during walking. In this study the incidence of SGN injuries Limp after hip surgery and patient dissatisfaction has direct association. The strength of the association varies by severity of limping and absence or presence of concomitant pain. In this study 30.48% patient presented with various degree of limp during initial period and 13.82% of them had it even after 3 years of the surgery. The most common causes of persistent limp in this study are SGN injuries (66.66%), Gluteus muscle and tendon damage (21.33%), implant malposition (6.66%), limb length discrepancy (4%).

Conclusions

This study notices the factors responsible for limp after hip surgery and possible preventive measures. Precise anatomical knowledge, careful patient positioning, safe surgical techniques are key factors. Application of these preventive measures warrant further in-depth analysis, to decrease incidence of persistent post-operative limp.

Limitation of Study

Single-centre study, no other comparative study

Declarations

Ethics Approval and Consent to Participate

Consent to Publication

The authors affirm that human research participants provided informed consent for publication of the images in figures.

Availability of Data and Material

The authors affirm that data and material used in this manuscript are created during this study only.

Competing Interests

The authors declare no competing interests.

Funding Statement

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Potential Conflicts of Interest and Funding Sources

There are no financial conflicts of interest to disclose

Author Contributions

Dr Amol Patil: Conceptualization, Formal analysis, Investigation, Visualization, Writing – original draft.
Dr D D Tanna: Conceptualization, Visualization, Methodology
Dr Sushrut Babhulkar: Conceptualization, Project administration
Dr Nitin Kimmatkar: Investigation, Supervision,
Dr Ashutosh Apte: Project administration, Supervision
Dr Amol Kadu: Methodology, Formal analysis
Dr Aniruddha Sonegaonkar: Formal analysis, Data Curation

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