

Pes Calcanus Leading to Genu Recurvatum: A Distal-to-Proximal Deformity Cascade Treated by Rotating Hinge Arthroplasty: Two Case Reports

Narayan Hulse¹ , Santhosh C Reddy¹, G G Charankumar¹

Learning Point of the Article:

Chronic pes calcaneus deformity may cause severe secondary genu recurvatum and knee osteoarthritis, requiring hinged total knee arthroplasty.

Abstract

Introduction: Chronic pes calcaneus deformity alters sagittal-plane limb mechanics by anteriorly displacing the ground reaction force and may induce a persistent knee hyperextension moment. A possible distal-to-proximal deformity cascade that progressed to severe genu recurvatum and secondary knee osteoarthritis needing hinged total knee arthroplasty is complex and rarely described.

Case Report: The first patient is a 53-year-old woman presenting with a 25° recurvatum, while the second patient is a 73-year-old woman presenting with a 30° genu recurvatum secondary to untreated pes calcaneus. Both patients developed painful osteoarthrosis necessitating a rotating hinge knee arthroplasty. At 5 and 4 years of follow-up, respectively, they reported no pain or recurrence of deformity, and radiographic evaluation showed stable prostheses without evidence of loosening.

Conclusion: We describe a possible distal-to-proximal deformity cascade associated with progressive genu recurvatum and secondary knee osteoarthritis requiring hinged knee arthroplasty. Rotating hinge arthroplasty has been used successfully in our study; however, further investigation is necessary to establish its long-term outcomes.

Keywords: genu recurvatum, hinged total knee arthroplasty, calcaneus deformity

Introduction

Pes calcaneus is a sagittal-plane hindfoot deformity characterized by persistent ankle dorsiflexion, commonly seen in neurological conditions such as cerebral palsy, myelodysplasia, and spina bifida [1,2,3]. While the distal consequences of calcaneus deformity are well described, its long-term influence on proximal joint biomechanics remains insufficiently characterized [4]. In a fixed dorsiflexed hindfoot, premature anterior displacement of the ground reaction force (GRF) vector

occurs, shifting the sagittal mechanical axis anterior to the center of knee rotation, generating an external hyperextension moment [5].

Chronic exposure to an anteriorly directed sagittal load may lead to progressive attenuation of the posterior capsule and structural adaptation of periarticular soft tissues [5,6]. Over time, this can culminate in severe genu recurvatum and secondary tibiofemoral degeneration. Although coronal-plane interactions between foot deformity and knee osteoarthritis have been investigated,

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Dr. Narayan Hulse



Dr. Santhosh C Reddy



Dr. G G Charankumar

¹Department of Bone and Joint Surgery, Fortis Hospital, Bengaluru, Karnataka, India.

Address of Correspondence:

Dr. Narayan Hulse,
Department of Bone and Joint Surgery, Fortis Hospital, Bengaluru - 560076, Karnataka, India.
E-mail: drnhulse@gmail.com

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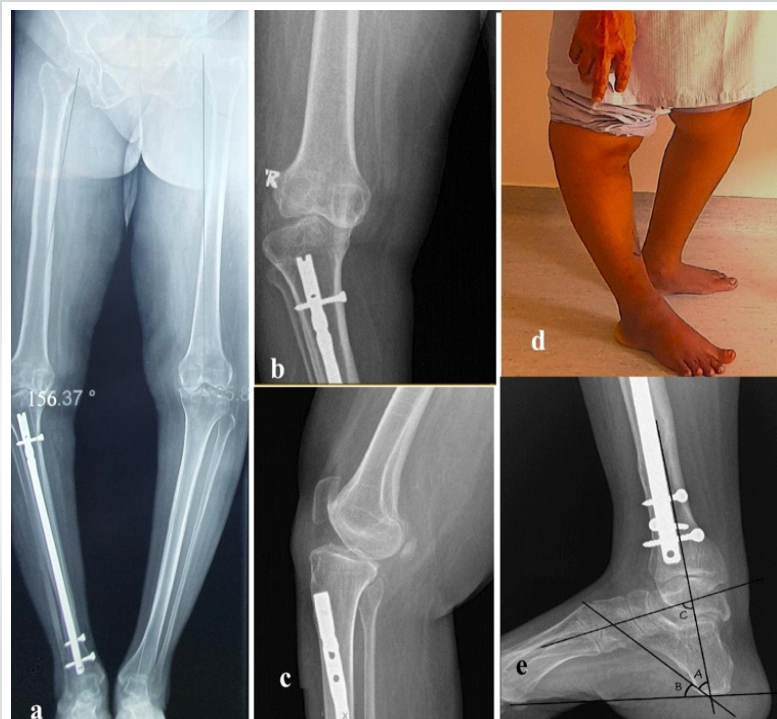


Figure 1: Pre-operative (Case 1) (a) Long-leg composite radiograph, (b) Anteroposterior view (c) Lateral views, (d) Standing photograph showing recurvatum deformity (e) Radiograph of the ankle showing calcaneus deformity (A-Tibiocalcaneal angle - 36°, B - Calcaneal pitch - 44°, C-Talocalcaneal angle - 61°).

particularly in planovalgus alignment [4], the specific relationship between pes calcaneus deformity and progressive sagittal knee instability has received limited attention.

Genu recurvatum in the setting of neuromuscular disease poses unique reconstructive challenges [7]. Unconstrained or semi-constrained knee designs may inadequately control sagittal instability when posterior capsular structures are incompetent, and quadriceps strength is compromised [7,8]. Recurrence of hyperextension has been reported with less constrained implants, particularly in neurologically impaired patients [8,9,10]. Rotating hinge prostheses, by providing intrinsic sagittal stability independent of soft-tissue integrity, therefore represent a logical reconstructive solution in advanced cases [11,12].

The present report describes two cases of long-standing, untreated pes calcaneus deformity secondary to spina bifida that developed progressive genu recurvatum and end-stage knee osteoarthritis. These cases illustrate a potential distal-to-proximal sagittal failure cascade linking hindfoot dorsiflexion to chronic knee hyperextension and degenerative joint collapse. Recognition of this biomechanical relationship may have implications not only for

arthroplasty strategy but also for early deformity correction to prevent secondary proximal joint degeneration.

Case Report

Case 1

A 53-year-old housewife presented with pain in her right knee and difficulty in walking for the past 5 years. She has had bilateral foot deformity since her childhood secondary to a spina bifida at the lower lumbar level. She had not undergone any corrective surgeries in her spine or on her foot in the past. She had undergone an intramedullary nailing for a closed traumatic fracture of the right (ipsilateral) tibia about 8 years ago. She reports progressively increasing hyperextension deformity in her right knee (Fig. 1) for a decade, which was normal in her childhood as far as she remembers.

Clinical examination of the right knee revealed varus alignment of about 10° and hyperextension deformity of 25°, and full flexion. The left knee showed 10° varus and approximately 5° of hyperextension. The quadriceps and hip abductors were normal bilaterally. Examination of the feet revealed callosities on the heel pad, calcaneus-valgus alignment of the hind foot, a high longitudinal arch, and a supinated forefoot. These findings were more pronounced on the right side.

The radiographs showed increased calcaneal pitch (44°), decreased tibiocalcaneal angle (36°), and increased talocalcaneal angle (61°), suggestive of severe pes calcaneus deformity (Fig. 1e). Pre-operative limb alignment was 17° of varus at the knee.

The previous tibial intramedullary nail was buried at the entry point and was inaccessible to the nail-extraction device. A 2-cm

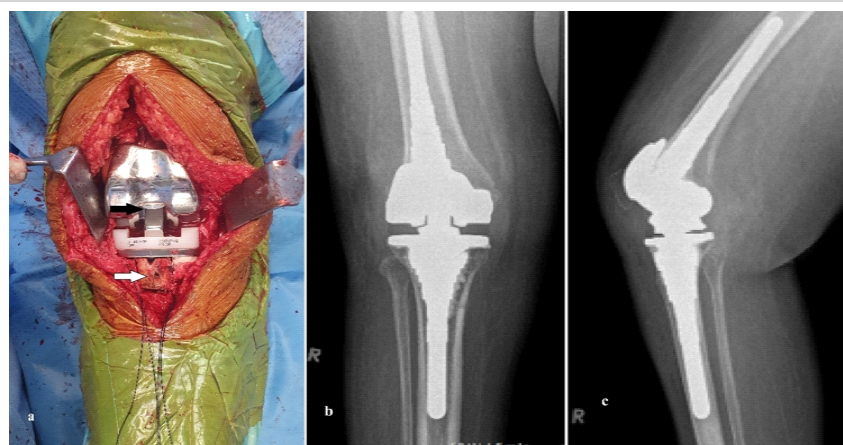


Figure 2: (a) Intraoperative photograph showing cortical window for nail removal (white arrow) and extension-stop mechanism of rotating hinge knee (black arrow), (b and c) post-operative radiographs.



Figure 3: 5-year follow-up: (a) Long-leg composite radiograph, (b) Clinical photograph, (c) Radiographs of contralateral knee.

long cortical window was created medial to the tibial tuberosity to access the nail (Fig. 2a). She underwent right total knee arthroplasty (TKA) using S-ROM NOILES rotating hinge knee (RHK) System (DePuy, USA, Fig. 2b and 2c). She recovered uneventfully in the post-operative period. She returned with pain in her contralateral left knee 4 years after the right TKA. As this knee had no significant deformities, a posterior-stabilized, primary knee prosthesis was used.

At 5 years of follow-up (Fig. 3), she reported no pain, was ambulant without any walking aids, and had a mild limp likely due to her foot deformities. Post-operative limb alignment was 3° of varus at the knee. She declined further corrective surgery for her foot deformities. Her Oxford knee score improved from 5 to 44.

Case 2

A 73-year-old woman presented with right knee pain and difficulty in walking for about 5 years; her quality of life was significantly affected, and she was dependent on a walker frame to walk (Fig. 4a). She had bilateral foot deformities since childhood secondary to spina bifida at the L5 level. She had not undergone any surgical procedures on her spine and feet in the past.

On examination, the right knee exhibited a 10° varus and 30° hyperextension deformity compared to the left knee, which showed a 5° varus and 20° hyperextension deformity. Bilateral feet showed hindfoot calcaneo-valgus deformity and high-arched midfoot. Quadriceps power on the right knee was

3/5, and bilateral plantar flexors were 3/5; all other muscles were 5/5, with no sensory deficits.

Radiographs showed advanced osteoarthritis in the right knee with varus and hyperextension deformity (Fig. 4b). Foot and ankle radiographs demonstrated increased calcaneal pitch (38°), decreased tibiocalcaneal angle (42°), and increased talocalcaneal angle (65°), suggestive of pes calcaneus deformity (Fig. 4c). Preoperatively, limb alignment was 8° of varus at the knee.

She underwent a rotating-hinge TKA using an Endo-Modell rotating-hinge prosthesis (Waldemar LINK GmbH and Co., Hamburg, Germany). She recovered well postoperatively without any surgical complications. Her rehabilitation process was prolonged due to a weak quadriceps mechanism. She had no pain, no recurrence of deformity, and no

loosening of the prosthesis at 4-year follow-up (Fig. 5). Postoperatively, limb alignment was 2° of varus at the knee. At the last follow-up, she could ambulate with a walking stick, partially due to contralateral lower-limb involvement. Oxford knee score improved from 2 to 27 at the latest follow-up.

Discussion

The present cases illustrate a potential distal-to-proximal biomechanical cascade in which untreated chronic pes calcaneus deformity may have contributed to progressive sagittal instability of the knee and secondary osteoarthritis. Both patients required complex knee reconstruction with a RHK prosthesis. While the local effects of pes calcaneus deformity in neuromuscular conditions are well documented, its long-term influence on knee sagittal alignment has received comparatively limited attention. Compensatory mechanisms between joints, especially in response to coronal-plane



Figure 4: Pre-operative (Case 2) (a) Standing photograph showing recurvatum deformity (b) Anteroposterior and (c) Radiograph of the ankle showing calcaneus deformity (A-Tibiocalcaneal angle - 42°, B-Calcaneal pitch - 38°, C-Talocalcaneal angle - 65°).



Figure 5: Post-operative radiographs (a), 4-year follow-up clinical photograph (b), and radiographs (c).

deformities, have been documented in a few studies [1,2]. However, there is limited literature on secondary sagittal-plane deformities of the knee and their surgical management after the development of degenerative arthritis. Unlike primary osteoarthritis associated with coronal malalignment, this pattern represents a predominantly sagittal-plane failure mechanism.

Pes calcaneus deformity is characterized by fixed ankle dorsiflexion resulting from paralysis or weakness of the gastrocnemius–soleus complex, with relative preservation of dorsiflexors and evertors [2,13]. In normal gait, the plantar flexors modulate forward tibial progression during mid-stance and help maintain the GRF vector within a controlled relationship to the knee joint center [13,14]. Loss of plantarflexion power, combined with fixed dorsiflexion, causes premature anterior displacement of the GRF relative to the tibiofemoral axis [6]. This anterior shift creates an external hyperextension moment at the knee [6]. In patients with quadriceps weakness, the knee may adopt hyperextension as an adaptive stabilizing strategy to achieve passive stability during stance [1,6,10].

Chronic exposure to repetitive hyperextension loading may progressively attenuate the posterior capsule and ligamentous stabilizers, leading to fixed sagittal instability [9,10,11]. Altered tibiofemoral mechanics and abnormal contact loading may further accelerate degenerative changes within the knee joint [11,15]. Previous literature has emphasized coronal-plane coupling between foot deformity and knee osteoarthritis, particularly in pes planovalgus alignment and medial compartment loading [4]. However, reports specifically linking fixed calcaneus deformity to progressive genu recurvatum and secondary sagittal degeneration remain sparse [6,16]. The present cases extend this understanding by suggesting persistent hindfoot dorsiflexion may act as a distal contributor to progressive sagittal knee instability.

From a reconstructive perspective, TKA in the presence of fixed

recurvatum presents substantial challenges. Conventional cruciate-retaining or posterior-stabilized implants depend on intact soft tissue tension and extensor mechanism function to maintain sagittal stability [8]. In neuromuscular patients with posterior capsular incompetence and quadriceps weakness, recurrence of hyperextension has been reported with less constrained designs [8,17]. RHK prostheses offer a promising solution by stabilizing the knee without relying on the already compromised bony and soft-tissue structures [17]. The extension-stopper design in rotating-hinge prostheses helps prevent recurrence and correct instability (Fig. 2a).

RHK has been successfully used in neuromuscular conditions, such as poliomyelitis, with excellent pain relief, improved function, and enhanced activities of daily living [8,17]. However, concerns regarding the recurrence of recurvatum and the need for revision in approximately 7% of cases, as early as 6.2 years, have also been reported [12].

Although some literature exists regarding the influence of pes planovalgus deformity on TKA outcomes [4], studies on the pes calcaneus are lacking. The present cases underscore the potential long-term consequences of untreated pes calcaneus deformity. While early correction of hindfoot malalignment in childhood is primarily advocated to prevent ulceration and functional gait dysfunction [1,2], its role in mitigating proximal joint degeneration warrants further study. Early correction of the pes calcaneus deformity in childhood can provide a plantigrade foot, potentially preventing secondary changes in the proximal joints [1,18]. Methods of surgical treatment of pes calcaneus deformity can be divided into two categories. In young and adolescent patients, the standard treatment is surgical correction of soft-tissue deformities and tendon transfer from functionally preserved muscles [1,18]. At an older age, triple arthrodesis, corrective osteotomy of the calcaneus, and wedge-shaped foot resections are performed [1,18].

Conclusion

These cases suggest untreated pes calcaneus may represent an underrecognized distal contributor to progressive sagittal knee failure in selected neuromuscular populations. However, other factors, including intrinsic quadriceps weakness and age-related degeneration, likely contributed to the development of osteoarthritis. Nonetheless, the consistent pattern of a long-standing pes calcaneus deformity, progressive recurvatum, and advanced sagittal instability suggests a plausible mechanical association warranting further investigation.

Clinical Message

Long-term effects of uncorrected pes calcaneus deformity on the proximal joints and axial skeleton are less studied. In this report, a distal-to-proximal deformity cascade leading to severe genu recurvatum needing a rotating hinge knee arthroplasty is described. Long-term studies are needed to evaluate the causative association and the role of early surgical correction of foot deformities in preventing this complex condition.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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