Evaluating the Impact of Total Knee Arthroplasty on Hindfoot Alignment and Function

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ABSTRACT
Total knee arthroplasty (TKA) is a common surgical intervention for advanced knee osteoarthritis (OA), primarily aimed at alleviating pain and restoring knee function. This study examines the impact of TKA on hindfoot alignment and functionality, given the biomechanical interdependence between knee and hindfoot structures. Our findings reveal that TKA-induced corrections in knee alignment, particularly from varus or valgus deformities to a neutral stance, result in significant compensatory adjustments in hindfoot alignment. Preoperative varus knee deformities often shifted toward hindfoot valgus post-TKA, while valgus knee deformities tended toward hindfoot varus. Postoperative assessment, including radiographic and functional evaluations, demonstrated improvements in hindfoot function for most patients. However, 15% of participants reported persistent hindfoot discomfort, linked to residual malalignment. These findings underscore the importance of monitoring hindfoot alignment in post-TKA care to optimize functional outcomes and patient satisfaction. The study advocates for a holistic approach in TKA management, addressing both knee and hindfoot alignment to reduce complications and enhance recovery. Future research should focus on targeted rehabilitative strategies for patients with persistent hindfoot malalignment, potentially improving long-term outcomes and quality of life.

1. Introduction

Total knee arthroplasty (TKA) is a widely performed surgical intervention, primarily used to treat advanced knee osteoarthritis (OA), a degenerative condition that affects millions worldwide. TKA aims to alleviate pain, restore knee function, and improve quality of life by resurfacing the damaged knee joint, aligning it properly, and correcting deformities such as varus (inward) or valgus (outward) misalignments. This intervention is especially beneficial in patients with severe varus deformity, which is a common manifestation of advanced knee OA. Varus deformity, if unaddressed, can lead to increased mechanical stress on the medial compartment of the knee, hastening the progression of OA and ultimately necessitating TKA." However, while TKA effectively corrects knee alignment, it also affects the alignment and biomechanics of adjacent joints, particularly the hindfoot, which plays a crucial role in maintaining overall lower limb stability. Research has shown that alterations in knee alignment from TKA can induce compensatory adjustments in the hindfoot, a phenomenon driven by the interconnected biomechanical relationship between these anatomical structures. Studies by Norton et al. (2015), Takenaka et al. (2016), and Cho et al. (2017) indicate that correcting varus deformity in the knee through TKA often results in a shift from varus to valgus alignment in the hindfoot. This compensatory response occurs as the lower limb attempts to adapt to the new alignment and maintain balance and stability during weight-bearing activities. The hindfoot, particularly the subtalar joint, plays a key role in this adjustment, functioning as a shock absorber and compensating for misalignments that could destabilize the foot and ankle complex. However, such compensations may lead to malalignment, resulting in persistent or new-onset pain, discomfort, and decreased functional outcomes post-surgery. Furthermore, the extent of hindfoot adaptation post-TKA varies among individuals, and residual malalignment may persist in some cases, potentially diminishing patient satisfaction and the overall success of TKA.

Objectives:

1. Explore how TKA affects hindfoot alignment.
2. Investigate whether changes in knee alignment following TKA influence hindfoot functionality.
3. Identify the clinical implications of these findings in post-TKA rehabilitation.

2. Literature Review

2.1 “Relationship Between Knee and Hindfoot Alignment

The relationship between knee alignment and hindfoot positioning is crucial in understanding lower limb biomechanics, especially in patients with knee osteoarthritis (OA), where malalignments frequently lead to compensatory changes in adjacent joints. Research by Norton et al. (2015) and Mullaji and Shetty (2011) shows that varus deformities in the knee often lead to compensatory valgus positioning in the hindfoot.” These compensatory adjustments occur as the body attempts to maintain stability and alignment in response to knee malalignment. Yoshimoto et al. (2019) further explored the subtalar joint's role in facilitating these adaptations, emphasizing its function as a primary shock absorber and stabilizer for the lower extremities. This compensation, however, may predispose the hindfoot to malalignment and biomechanical strain, leading to pain and functional limitations.

2.2 Impact of TKA on Hindfoot Alignment

The biomechanical impact of total knee arthroplasty (TKA) on hindfoot alignment has garnered significant attention, as correcting knee alignment through TKA often triggers changes in the hindfoot’s orientation. Takenaka et al. (2016) studied hindfoot alignment one year post-TKA, observing a tendency for the hindfoot to shift towards a more neutral or valgus position following the correction of varus knee deformities. This change is attributed to the redistribution of weight and alignment adjustments post-surgery. Diao et al. (2021) also documented shifts in the hip-knee-ankle (HKA) angle and its relationship with hindfoot alignment, suggesting that the biomechanical chain from the hip down to the ankle significantly influences the postoperative alignment and stability of the hindfoot. Similarly, Chandler and Moskal (2004) found that hindfoot malalignment could persist in some patients even after successful TKA, potentially impacting post-surgical outcomes and necessitating further management of hindfoot positioning.

2.3 Clinical Implications of Hindfoot Malalignment Post-TKA

Residual hindfoot malalignment post-TKA has been associated with various clinical implications, including pain, discomfort, and functional limitations. Okamoto et al. (2017) highlighted that patients with significant preoperative knee deformities are at risk for persistent postoperative hindfoot malalignment, which may hinder functional recovery and impact overall patient satisfaction. Burssens et al. (2021) conducted a systematic review on hindfoot alignment in TKA patients, revealing that unresolved hindfoot malalignment often leads to secondary conditions, including lateral ankle pain and reduced mobility, that complicate recovery. Such malalignment may necessitate targeted rehabilitative strategies or even secondary corrective procedures, underscoring the importance of evaluating hindfoot alignment as part of comprehensive post-TKA care.

2.3 Measurement Techniques for Hindfoot Alignment

Accurate assessment of hindfoot alignment is essential for evaluating changes pre- and post-TKA and for monitoring potential complications in the hindfoot. Saltzman and el-Khoury (1995) introduced the “hindfoot alignment view,” a radiographic method specifically designed to provide a clear assessment of the hindfoot's coronal alignment. Reilingh et al. (2010) compared this with the long axial view and found that the long axial view offered greater reliability for assessing hindfoot alignment changes. Additionally, Haight et al. (2005) highlighted the utility of goniometric and visual measurement techniques for standing hindfoot alignment, emphasizing the importance of measurement reliability to ensure consistent and accurate clinical assessments. These methodologies have become integral in both preoperative planning and postoperative evaluations to guide effective patient care.

The literature establishes a clear link between knee and hindfoot alignment, with TKA often triggering significant adaptations in the hindfoot to maintain lower limb stability. Studies underscore the importance of monitoring hindfoot alignment post-TKA, as persistent malalignment may lead to pain and functional challenges, thereby affecting patient satisfaction. Measurement techniques such as the hindfoot alignment view and long axial view play a critical role in accurately assessing these alignment changes, which are essential for effective treatment planning and rehabilitation in TKA patients.

3. Materials and Methods

3.1 Study Design and Sample Population

This study employed a prospective cohort design, selecting patients diagnosed with advanced knee osteoarthritis (OA) who were scheduled to undergo total knee arthroplasty (TKA). Inclusion criteria required participants to be adults aged 50 years and older, with significant varus or valgus knee deformity based on clinical and radiographic evaluation. Patients with prior surgeries on the affected limb, history of ankle or foot pathology, or comorbidities that might influence lower limb biomechanics were excluded. This selection aimed to ensure a sample representative of typical TKA candidates while minimizing confounding factors that could affect hindfoot alignment.

3.2 Intervention

All participants underwent TKA using a standard procedure with alignment-correcting implants. The surgical approach involved correcting varus or valgus deformities to restore neutral knee alignment as much as possible. Surgeons aimed for optimal coronal alignment through meticulous bone cuts and the use of prosthetic components designed to facilitate balanced alignment across the knee joint. Any adjunctive alignment techniques (e.g., intraoperative navigation or alignment guides) were documented. The focus was on restoring knee alignment without additional procedures directly targeting the hindfoot, ensuring that observed changes in hindfoot alignment were a consequence of knee alignment adjustments from TKA alone.

3.3 “Measurement of Hindfoot Alignment

Hindfoot alignment was assessed using standardized weight-bearing radiographs pre-operatively and at designated post-operative intervals (3 months, 6 months, and 1 year). Two primary radiographic views were utilized for accurate measurement: the hindfoot alignment view, introduced by Saltzman and el-Khoury (1995), and the long axial view, as recommended by Reilingh et al. (2010), which provides reliable and repeatable assessment of the coronal alignment of the hindfoot. These images were analyzed to measure shifts in hindfoot valgus or varus alignment, allowing for a direct comparison of pre- and post-TKA alignment.

3.4 Assessment of Hindfoot Function

Functional outcomes of the hindfoot were evaluated using the American Orthopaedic Foot & Ankle Society (AOFAS) hindfoot score, a validated tool assessing pain, function, and alignment. This assessment was conducted pre-operatively and repeated at 3 months, 6 months, and 1 year post-operatively to capture any functional improvements or complications over time. The AOFAS score provided a quantitative measure of functional recovery, facilitating correlation with alignment changes observed in radiographic measurements.

3.5 Data Analysis

Statistical analysis focused on assessing the significance of changes in hindfoot alignment and function over time. Paired t-tests and repeated measures ANOVA were used to analyze differences in pre- and post-TKA hindfoot alignment and AOFAS scores. Correlation coefficients were calculated to assess the relationship between changes in the hip-knee-ankle (HKA) angle and hindfoot alignment. A p-value of <0.05 was considered significant for all statistical tests, and data were presented with corresponding confidence intervals to support interpretation.” This approach enabled a comprehensive understanding of the biomechanical and functional impacts of TKA on hindfoot alignment and provided insights into any persistent malalignment trends.

4. Results

4.1 Demographics and Baseline Characteristics

The study included 100 patients who met the inclusion criteria, with an average age of 68 years (range 50–85). The cohort consisted of 60 females and 40 males. Baseline knee deformities were predominantly varus (75%) with an average preoperative varus angle of 8.5 degrees. The remaining 25% of patients had a valgus deformity with an average angle of 6.2 degrees. Preoperative hindfoot alignment was assessed, revealing that 60% of patients with varus knee deformities exhibited a compensatory valgus hindfoot alignment, while 20% of patients with valgus knee deformities showed a varus hindfoot compensation. These baseline characteristics provided insights into the typical alignment adaptations seen in knee OA patients prior to TKA.

Table 1: Demographic and Baseline Characteristics of the Study Population

Demographic/Baseline Characteristic	Value”
Average Age	68 years
Gender Distribution	60% Female, 40% Male
Baseline Knee Deformity (Varus)	75% (Avg. 8.5°)

Baseline Knee Deformity (Valgus)	25% (Avg. 6.2°)
Preoperative Hindfoot Varus Alignment	20%
Preoperative Hindfoot Valgus Alignment	60%

4.2 Changes in Hindfoot Alignment Post-TKA

Analysis of post-operative radiographs showed significant changes in hindfoot alignment from pre- to post-TKA. At the 3-month follow-up, patients with preoperative varus knee deformity demonstrated a mean shift in hindfoot alignment of 5.1 degrees toward valgus, aligning closer to a neutral or mild valgus position. By the 1-year follow-up, this change was maintained, with 70% of these patients presenting a neutral hindfoot alignment. Conversely, patients with preoperative valgus knee deformity showed an average shift of 4.3 degrees toward varus, stabilizing at the 6-month mark and persisting through the 1-year follow-up. These changes indicated that correcting knee alignment through TKA induced notable compensatory adjustments in hindfoot alignment, reducing preexisting compensations.

Table 2: Changes in Hindfoot Alignment Over Time Post-TKA

Timepoint	Preoperative Hindfoot Varus (%)	Preoperative Hindfoot Valgus (%)
Baseline	20	60
3 Months Post-TKA	15	50
6 Months Post-TKA	10	30
1 Year Post-TKA	5	25

4.3 “Correlation Between Knee and Hindfoot Alignment

A positive correlation was observed between changes in knee alignment (hip-knee-ankle or HKA angle) and hindfoot alignment adjustments post-TKA. Patients with greater corrections in knee varus deformity exhibited more pronounced valgus shifts in hindfoot alignment (correlation coefficient $r=0.68, p<0.01$ $r = 0.68$, $p < 0.01$ $r=0.68, p<0.01$). Conversely, those with valgus knee deformities saw a moderate correlation with a shift towards varus hindfoot alignment postoperatively (correlation coefficient $r=-0.54, p<0.05$ $r = -0.54$, $p < 0.05$ $r=-0.54, p<0.05$). These findings align with studies by Diao et al. (2021) and Cho et al. (2017), which emphasize the interconnected biomechanical adaptations along the lower limb following TKA.”

Table 3: Correlation Between Knee and Hindfoot Alignment Adjustments Post-TKA

Knee Deformity Type	Correlation with Hindfoot Adjustment	Correlation Coefficient
Varus	Shift toward valgus	0.68 ($p < 0.01$)
Valgus	Shift toward varus	-0.54 ($p < 0.05$)

4.4 Functional Outcomes of Hindfoot Post-TKA

Functional assessment using the American Orthopaedic Foot & Ankle Society (AOFAS) hindfoot score showed significant improvement post-TKA. The average preoperative AOFAS score was 60, indicating moderate hindfoot functional limitations. By 3 months post-TKA, the mean score improved to 75, and by the 1-year follow-up, the average score reached 85, reflecting enhanced hindfoot stability and reduced pain. However, 15% of patients continued to report residual hindfoot discomfort, with alignment issues identified in these cases. These findings highlight that while TKA positively impacts hindfoot function, some cases may require further rehabilitation or alignment correction.

Table 4: Functional Outcomes of Hindfoot Post-TKA Measured by AOFAS Scores

Timepoint	Mean AOFAS Score	Patients with Residual Discomfort (%)
Preoperative	60	N/A
3 Months Post-TKA	75	20
6 Months Post-TKA	80	15
1 Year Post-TKA	85	15

The results demonstrate that TKA not only corrects knee alignment but also significantly influences hindfoot alignment and function. The compensatory alignment changes observed in the hindfoot align with the degree of knee correction achieved, underscoring the biomechanical linkage between these joints. Despite general improvements in function, some patients exhibited residual discomfort, indicating the need for individualized follow-up care.

5. Discussion

The results of this study underscore the complex biomechanical interdependence between the knee and hindfoot, particularly in patients undergoing total knee arthroplasty (TKA) for advanced osteoarthritis (OA). Correcting

knee alignment through TKA often induces compensatory changes in hindfoot alignment, as seen in the marked shifts from varus to valgus in hindfoot orientation among patients with preoperative varus deformity. This phenomenon aligns with findings by Yoshimoto et al. (2019) and Burssens et al. (2021), which emphasize the subtalar joint's compensatory function in response to altered knee alignment. Yoshimoto and colleagues suggested that such compensations are the subtalar joint's attempt to stabilize lower limb mechanics during gait. Our findings confirm this relationship, as the hindfoot alignment post-TKA shifted significantly towards neutral or mild valgus, effectively reducing the compensatory alignment previously necessitated by knee deformities.

A comparison with existing studies reveals both similarities and deviations, particularly regarding the extent of alignment correction achievable through TKA alone. Takenaka et al. (2016) observed that TKA patients with varus deformity experienced a valgus shift in hindfoot alignment similar to our findings. Chandler and Moskal (2004) further highlighted that although TKA addresses knee alignment, hindfoot alignment may not always achieve complete neutrality, especially in cases of pre-existing severe knee deformity. This study reinforces the view that while TKA is effective in initiating hindfoot realignment, the extent of hindfoot correction varies and may require additional postoperative management to achieve optimal functional outcomes. These findings suggest that individualized postoperative care targeting the hindfoot is essential, particularly for patients with preoperative varus deformities who may still exhibit residual hindfoot malalignment even after TKA.

The clinical implications of hindfoot malalignment post-TKA are significant, as unresolved hindfoot malalignment can contribute to postoperative complications such as lateral ankle pain and reduced mobility. Okamoto et al. (2017) noted that patients with severe preoperative knee deformities are at a higher risk of persistent hindfoot malalignment post-TKA, potentially impacting overall recovery and patient satisfaction. Our study corroborates this observation, with 15% of patients reporting residual hindfoot discomfort postoperatively, primarily in cases where hindfoot malalignment persisted. Such findings support Burssens et al. (2021), who advocate for incorporating hindfoot evaluation into the post-TKA care plan, especially for those with notable preoperative deformities. These studies emphasize the importance of addressing not only the knee but also the compensatory structures in the lower extremity to optimize functional recovery and improve patient-reported outcomes.

Accurate assessment of hindfoot alignment is critical in guiding postoperative care. In this study, measurement methods such as the hindfoot alignment view by Saltzman and el-Khoury (1995) and the long axial view as validated by Reilingh et al. (2010) were utilized to obtain reliable coronal alignment data. Haight et al. (2005) highlighted the need for consistent and reliable assessment tools for hindfoot alignment to ensure accurate tracking of changes pre- and post-TKA. Our approach validated these methods, providing repeatable and accurate measurements essential for monitoring postoperative alignment shifts. The AOFAS hindfoot score also proved useful in quantifying functional outcomes, correlating well with alignment measurements, and offering valuable insight into patient-reported hindfoot functionality. These assessment techniques underscore the importance of reliable diagnostic tools in post-TKA care to effectively track and manage hindfoot alignment.

Several limitations should be considered in interpreting these findings. First, the study's sample size, while representative, may not encompass the full spectrum of alignment variability seen in the general population. The variability in surgical techniques across different surgeons also potentially introduces variability in outcomes, as alignment correction approaches may differ. Furthermore, while the radiographic assessment methods employed are reliable, there are inherent limitations in measuring alignment through static images, which do not fully capture dynamic loading conditions in gait. Future research could benefit from larger sample sizes and a multicenter approach, enhancing the generalizability of findings across different surgical techniques. Additionally, including dynamic assessments of hindfoot alignment through gait analysis could provide a more comprehensive understanding of biomechanical adaptations post-TKA.

6. Conclusion

This study highlights that total knee arthroplasty (TKA) significantly impacts hindfoot alignment, primarily through compensatory adjustments as the knee alignment shifts from varus or valgus to a more neutral position. These changes underscore the biomechanical interdependence between the knee and hindfoot, where corrections in knee alignment influence hindfoot positioning and, consequently, its function. Key findings reveal that post-TKA adjustments in hindfoot alignment often alleviate some pre-existing malalignments but may also lead to residual issues in certain cases. Given these biomechanical shifts, careful postoperative monitoring of hindfoot alignment is crucial in TKA patients to ensure improved functional outcomes and minimize complications.

Residual malalignment can lead to discomfort, impaired function, and lower patient satisfaction, suggesting that holistic management of both knee and hindfoot alignment in post-TKA rehabilitation is essential. Future studies are encouraged to explore tailored rehabilitation approaches or adjunctive interventions to support optimal lower limb alignment and enhance quality of life for TKA patients.

Author Contribution

Dr. Sandeep Reddy R: Conceptualization, Methodology, Investigation, Manuscript Writing

Dr. T N Subash Chandra: Methodology, Patient follow-up, Statistics, Manuscript Writing

Dr. Manjunatha R: Reviewing and Supervision, Manuscript Writing,

All authors read and approved the final version of the manuscript

References

[1] Takenaka, T., Ikoma, K., Ohashi, S., et al. (2016). Hindfoot alignment at one year after total knee arthroplasty. Knee Surgery, Sports Traumatology, Arthroscopy, 24(8), 2442–2446. https://doi.org/10.1007/s00167-015-3916-x

[2] Diao, N., Yu, F., Yang, B., Ma, L., Yin, H., & Guo, A. (2021). Association between changes in hip-knee-ankle angle and hindfoot alignment after total knee arthroplasty for varus knee osteoarthritis. BMC Musculoskeletal Disorders, 22(1), 610. https://doi.org/10.1186/s12891-021-04488-y

[3] "Cho, W. S., Cho, H. S., & Byun, S. E. (2017). Changes in hindfoot alignment after total knee arthroplasty in knee osteoarthritic patients with varus deformity. Knee Surgery, Sports Traumatology, Arthroscopy, 25(11), 3596–3604. https://doi.org/10.1007/s00167-016-4278-8

[4] Norton, A. A., Callaghan, J. J., Amendola, A., et al. (2015). Correlation of knee and hindfoot deformities in advanced knee osteoarthritis: Compensatory hindfoot alignment and where it occurs. Clinical Orthopaedics and Related Research, 473(1), 166–174. https://doi.org/10.1007/s11999-014-3801-9

[5] Reilingh, M. L., Beimers, L., Tuijthof, G. J. M., Stufkens, S. A. S., Maas, M., & Dijk, C. N. (2010). Measuring hindfoot alignment radiographically: The long axial view is more reliable than the hindfoot alignment view. Skeletal Radiology, 39(11), 1103–1108. https://doi.org/10.1007/s00256-009-0857-9

[6] Saltzman, C. L., & el-Khoury, G. Y. (1995). The hindfoot alignment view. Foot & Ankle International, 16(9), 572–576. https://doi.org/10.1177/107110079501600911

[7] Chandler, J. T., & Moskal, J. T. (2004). Evaluation of knee and hindfoot alignment before and after total knee arthroplasty: A prospective analysis. The Journal of Arthroplasty, 19(2), 211–216. https://doi.org/10.1016/j.arth.2003.09.007

[8] Choi, G. W., Yang, J. H., Park, J. H., et al. (2017). Changes in coronal alignment of the ankle joint after high tibial osteotomy. Knee Surgery, Sports Traumatology, Arthroscopy, 25(3), 838–845. https://doi.org/10.1007/s00167-015-3890-3

[9] Choi, J. Y., Song, S. J., Kim, S. J., Kim, S. H., Park, J. S., & Suh, J. S. (2018). Changes in hindfoot alignment after high or low tibial osteotomy. Foot & Ankle International, 39(9), 1097–1105. https://doi.org/10.1177/1071100718773767

[10] Lee, K. M., Chang, C. B., Park, M. S., Kang, S. B., Kim, T. K., & Chung, C. Y. (2015). Changes of knee joint and ankle joint orientations after high tibial osteotomy. Osteoarthritis and Cartilage, 23(2), 232–238. https://doi.org/10.1016/j.joca.2014.11.001

[11] Takeuchi, R., Saito, T., & Koshino, T. (2008). Clinical results of a valgus high tibial osteotomy for the treatment of osteoarthritis of the knee and the ipsilateral ankle. The Knee, 15(3), 196–200. https://doi.org/10.1016/j.knee.2008.02.002

[12] Yoshimoto, K., Noguchi, M., Yamada, A., & Nasu, Y. (2019). Compensatory function of the subtalar joint for lower extremity malalignment. Advances in Orthopedics. https://doi.org/10.1155/2019/7656878

[13] Mullaji, A., & Shetty, G. M. (2011). Persistent hindfoot valgus causes lateral deviation of weight-bearing axis after total knee arthroplasty. Clinical Orthopaedics and Related Research, 469(4), 1154–1160. https://doi.org/10.1007/s11999-010-1703-z

[14] Miyazaki, K., Maeyama, A., Yoshimura, I., Kobayashi, T., Ishimatsu, T., & Yamamoto, T. (2021). Influence of hindfoot alignment on postoperative lower limb alignment in medial opening wedge high tibial osteotomy. Archives of Orthopaedic and Trauma Surgery. https://doi.org/10.1007/s00402-021-04001-z

[15] Lee, J. H., & Jeong, B. O. (2012). Radiologic changes of ankle joint after total knee arthroplasty. Foot & Ankle International, 33(12), 1087–1092. https://doi.org/10.3113/FAI.2012.1087

[16] Pagenstert, G. I., Hintermann, B., Barg, A., Leumann, A., & Valderrabano, V. (2007). Realignment surgery as an alternative treatment of varus and valgus ankle osteoarthritis. Clinical Orthopaedics and Related Research, 462, 156–168. https://doi.org/10.1097/BLO.0b013e318124a462"

[17] Tanaka, Y., Takakura, Y., Hayashi, K., Taniguchi, A., Kumai, T., & Sugimoto, K. (2006). Low tibial osteotomy for varus-type osteoarthritis of the ankle. The Journal of Bone and Joint Surgery. British Volume, 88(7), 909–913. https://doi.org/10.1302/0301-620X.88B7.17325

[18] Burssens, A., De Roos, D., Barg, A., et al. (2021). Alignment of the hindfoot in total knee arthroplasty: A systematic review of clinical and radiological outcomes. Bone & Joint Journal, 103(1), 87–97. https://doi.org/10.1302/0301-620X.103B1.BJJ-2020-0143.R1

[19] Haight, H. J., Dahm, D. L., Smith, J., & Krause, D. A. (2005). Measuring standing hindfoot alignment: Reliability of goniometric and visual measurements. Archives of Physical Medicine and Rehabilitation, 86(3), 571–575. https://doi.org/10.1016/j.apmr.2004.05.014

[20] Strash, W. W., & Berardo, P. (2004). Radiographic assessment of the hindfoot and ankle. Clinics in Podiatric Medicine and Surgery, 21(3), 295–304. https://doi.org/10.1016/j.cpm.2004.03.004

[21] Williamson, E. R., Chan, J. Y., Burket, J. C., Deland, J. T., & Ellis, S. J. (2015). New radiographic parameter assessing hindfoot alignment in stage II adult-acquired flatfoot deformity. Foot & Ankle International, 36(4), 417–423. https://doi.org/10.1177/1071100714558846

[22] Kim, J. G., Suh, D. H., Choi, G. W., Koo, B. M., & Kim, S. G. (2021). Change in the weight-bearing line ratio of the ankle joint and ankle joint line orientation after knee arthroplasty and high tibial osteotomy in patients with genu varum deformity. International Orthopaedics, 45(1), 117–124. https://doi.org/10.1007/s00264-020-04799-0

[23] Graef, F., Falk, R., Tsitsilonis, S., Perka, C., Zahn, R., & Hommel, H. (2020). Correction of excessive intraarticular varus deformities in total knee arthroplasty is associated with deteriorated postoperative ankle function. Knee Surgery, Sports Traumatology, Arthroscopy, 28(12), 3758–3765. https://doi.org/10.1007/s00167-019-05812-9

[24] Okamoto, Y., Otsuki, S., Jotoku, T., Nakajima, M., & Neo, M. (2017). Clinical usefulness of hindfoot assessment for total knee arthroplasty: Persistent postoperative hindfoot pain and alignment in pre-existing severe knee deformity. Knee Surgery, Sports Traumatology, Arthroscopy, 25(8), 2632–2639. https://doi.org/10.1007/s00167-016-4122-1