SVOA Orthopaedics

e-ISSN 2752-9576

ScienceVolks Open Access

Technical Paper

Functional Alignment Total Knee Arthroplasty Using the 5C® MEDic Medial Pivot Knee System

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https://doi.org/10.58624/SVOAOR.2026.06.022

Received: July 27, 2026

Published: August 13, 2026

Citation: Kosmas V, Mousa C, Papadimitriou G, Papaskarlatos I, Sakellariou V. Functional Alignment Total Knee Arthroplasty Using the 5C® MEDic Medial Pivot Knee System. *SVOA Orthopaedics 2026*, 6:4, 151-164. doi: 10.58624/SVOAOR.2026.06.022

Abstract

Background: Despite the excellent survivorship of modern total knee arthroplasty (TKA), up to one in five patients remains dissatisfied following surgery, often because the reconstructed knee fails to reproduce physiological kinematics and soft-tissue behaviour. Functional alignment has emerged as a patient-specific alignment philosophy that aims to restore constitutional anatomy while minimizing ligament releases [6–13]. When combined with a medial pivot implant, this approach seeks to reproduce native knee biomechanics and improve functional recovery.

Technique: This Technical Note describes the standardized surgical technique using the 5C® MEDic Medial Pivot Knee System. Preoperative planning is based on constitutional alignment analysis using long-leg radiographs, arithmetic hip–knee–ankle angle (aHKA), lateral distal femoral angle (LDFA), medial proximal tibial angle (MPTA), joint-line obliquity (JLO), and CPAK classification. A computer-navigated medial parapatellar approach is employed without robotic assistance or patient-specific instrumentation. Bone resections and implant positioning are individualized using computer-assisted navigation to restore physiological alignment while preserving native ligament balance.

Clinical Experience: The described technique has been applied in a consecutive series of 419 primary total knee arthroplasties. Early clinical assessment demonstrated substantial improvement in patient-reported outcome measures, restoration of knee motion, low complication rates, and excellent short-term implant survivorship.

Conclusions: Functional alignment using the 5C® MEDic Medial Pivot Knee System represents a reproducible patient-specific technique that combines individualized alignment with implant characteristics designed to reproduce native knee kinematics. Early clinical experience supports the safety and reproducibility of this surgical strategy, although longer-term comparative studies remain necessary.

Keywords: *Functional alignment, Total knee arthroplasty, Medial pivot, CPAK, 5C® MEDic*

1. Introduction

Total knee arthroplasty (TKA) is among the most successful procedures in modern orthopaedic surgery, providing reliable pain relief and functional restoration for patients with end-stage degenerative knee disease. Although implant survivorship now exceeds 90–95% at long-term follow-up in many national registries, patient satisfaction has not improved to the same extent, with approximately 15–20% of patients reporting persistent pain, instability, stiffness, or the sensation of an artificial knee despite technically successful surgery [17–20]. These observations have prompted increasing interest in surgical strategies that more closely reproduce physiological knee biomechanics rather than simply restoring neutral mechanical alignment [3–7].

Historically, mechanical alignment has represented the gold standard in TKA, positioning both femoral and tibial components perpendicular to their respective mechanical axes to create an overall neutral limb alignment. While this approach has demonstrated excellent implant longevity, it does not account for the wide variability in constitutional limb alignment observed in the native population. Restoration of neutral alignment often requires extensive collateral ligament releases and alteration of the patient's natural joint-line orientation, potentially contributing to abnormal knee kinematics and reduced patient satisfaction [10,21–23].

Growing understanding of native knee biomechanics has fundamentally changed contemporary alignment philosophy. Fluoroscopic and biomechanical investigations have demonstrated that the normal knee does not function according to the traditional "four-bar linkage" model previously adopted in prosthetic design. Instead, the medial compartment behaves as a relatively stable centre of rotation while the lateral femoral condyle translates posteriorly during flexion, producing the characteristic medial pivot motion [1,2]. This physiological movement pattern contributes to knee stability, efficient quadriceps function, and coordinated femoral rollback [1,2,14].

These observations have stimulated the development of medial pivot prostheses specifically designed to reproduce native knee kinematics. By combining a highly congruent medial compartment with controlled lateral compartment motion, medial pivot implants seek to reduce paradoxical anterior femoral translation, improve anteroposterior stability, and restore more physiological knee motion during functional activities [14–16].

Concurrently, alignment philosophies have evolved toward individualized approaches that respect constitutional anatomy rather than imposing universal neutral alignment. Functional alignment integrates detailed preoperative anatomical assessment with intraoperative soft-tissue balancing to restore each patient's native coronal alignment within safe boundaries. Instead of balancing the knee through extensive ligament releases, component positioning is adjusted to accommodate the patient's physiological ligament envelope [6–13].

The 5C® MEDic Medial Pivot Knee System was developed to complement this philosophy. The implant incorporates posterior-referencing instrumentation, a single-radius femoral component, an anatomical tibial baseplate, highly congruent medial articulation, vitamin E–stabilized highly cross-linked polyethylene, and modular fixation options designed to facilitate physiological knee mechanics while allowing accurate patient-specific reconstruction [15,24,25].

2. Implant Philosophy

Successful total knee arthroplasty requires not only accurate implant positioning but also restoration of physiological knee mechanics. Increasing evidence suggests that reproducing native knee kinematics may improve joint stability, quadriceps efficiency, functional performance, and ultimately patient satisfaction following TKA [1–3,14–16]. The design philosophy of the 5C® MEDic Medial Pivot Knee System was developed with this objective in mind by combining a medial pivot articulation with implant characteristics that facilitate individualized functional alignment.

Native Knee Kinematics

The traditional concept of knee motion described the femur as rolling and gliding uniformly over the tibia through a "four-bar linkage" mechanism controlled by the cruciate ligaments. Modern fluoroscopic and in vivo kinematic studies, however, have demonstrated that normal knee motion differs substantially from this simplified model [1,2].

During flexion, the medial compartment remains relatively stable, functioning as the centre of rotation, whereas the lateral femoral condyle translates posteriorly while simultaneously rotating around the medial side. This asymmetric behaviour creates the characteristic medial pivot motion that has become the target of contemporary implant design. Preservation of this physiological movement pattern improves femoral rollback, maintains quadriceps efficiency, and minimizes paradoxical anterior femoral translation [1,2,14].

Rationale for a Medial Pivot Design

Conventional posterior-stabilized and cruciate-retaining prostheses frequently reproduce symmetrical tibiofemoral motion rather than the asymmetric kinematics of the native knee. As a consequence, paradoxical anterior femoral translation may occur during flexion, reducing the quadriceps moment arm and altering functional knee mechanics [2,14].

Medial pivot prostheses were specifically developed to address these limitations. Their design incorporates a highly congruent medial compartment that behaves as a ball-and-socket articulation while allowing controlled motion within the lateral compartment. This configuration improves anteroposterior stability without relying exclusively on a cam-post mechanism and more closely reproduces physiological knee motion [14–16].

Design Characteristics of the 5C® MEDic Knee System

The 5C® MEDic Knee System incorporates several design features intended to support both functional alignment and physiological knee kinematics.

The femoral component uses a single-radius geometry, maintaining a nearly constant flexion-extension axis throughout the arc of motion. This configuration contributes to more uniform collateral ligament tension and may improve quadriceps efficiency, particularly during early flexion [24].

A posterior-referencing instrumentation system allows controlled femoral rotation and facilitates preservation of posterior condylar anatomy while minimizing unnecessary bone resection. This characteristic is particularly advantageous when individualized component positioning is performed using functional alignment principles [6–13].

The tibial component incorporates an anatomical baseplate designed to maximize cortical coverage while reducing component overhang. Broad compatibility between femoral and tibial component sizes allows more accurate anatomical reconstruction across different patient morphologies.

Polyethylene inserts are manufactured from vitamin E–stabilized highly cross-linked polyethylene (XLPE) and are available in 1-mm thickness increments, permitting fine adjustment of flexion and extension balance without additional bone resection. The implant system also provides optional tibial stem extensions and augments for selected situations requiring additional fixation or management of compromised bone stock [25].

Functional Alignment and Implant Synergy

Functional alignment and medial pivot implant design should not be viewed as independent concepts but rather as complementary strategies.

Functional alignment aims to restore constitutional anatomy while preserving the patient's native ligament envelope. This philosophy minimizes collateral ligament releases by adjusting implant position instead of forcing every knee toward neutral mechanical alignment [6–13].

The medial pivot design complements this strategy by providing intrinsic stability through the highly congruent medial compartment while allowing physiological lateral femoral rollback. Together, these concepts seek to restore native knee biomechanics more closely than conventional alignment philosophies combined with symmetrical implant designs [6,11–16].

In our practice, functional alignment is therefore considered an ideal partner for the 5C® MEDic system, enabling individualized reconstruction while maintaining reproducible soft-tissue balance using computer-assisted navigation without robotic assistance or patient-specific instrumentation.

3. Surgical Indications

Appropriate patient selection remains fundamental for successful implementation of functional alignment.

Indications

Indications

Functional alignment using the 5C® MEDic Medial Pivot Knee System is primarily indicated for patients undergoing primary total knee arthroplasty because of:

- Primary osteoarthritis
- Post-traumatic osteoarthritis
- Constitutional varus alignment
- Neutral constitutional alignment
- Symptomatic end-stage degenerative joint disease refractory to non-operative treatment
- Correctable valgus deformity

Patients presenting with preserved collateral ligament competence and deformities that can be corrected within acceptable alignment boundaries are considered ideal candidates for this technique [6–13].

Contraindications

The authors avoid routine use of this technique in patients presenting with:

- Severe valgus deformity associated with incompetent collateral ligaments
- Generalized ligamentous laxity
- Advanced inflammatory arthritis
- Fixed knee recurvatum
- Major instability requiring constrained reconstruction
- Severe extra-articular deformities requiring complex corrective procedures

In these situations, more constrained implant designs or alternative alignment philosophies may provide more predictable stability and long-term fixation [6,21,23].

4. Preoperative Planning

Preoperative planning is performed using standardized standing long-leg radiographs extending from the hip to the ankle. Every patient undergoes a detailed constitutional alignment analysis before surgery.

The following parameters are routinely measured:

- Hip–Knee–Ankle Angle (HKA)
- Arithmetic Hip–Knee–Ankle Angle (aHKA)
- Lateral Distal Femoral Angle (LDFA)
- Medial Proximal Tibial Angle (MPTA)
- Joint Line Obliquity (JLO)

These measurements allow reconstruction of the patient's constitutional alignment while defining safe limits for femoral and tibial component positioning [8–12].

The Coronal Plane Alignment of the Knee (CPAK) classification is used as an adjunctive planning tool to characterize both limb alignment and joint-line orientation. Rather than aiming for universal mechanical neutrality, component positioning is individualized to restore physiological alignment while preserving the native soft-tissue envelope.

Bone resections are planned preoperatively but remain adjustable according to intraoperative assessment of ligament balance and gap symmetry. Throughout the procedure, the objective is to restore constitutional anatomy within reproducible and biomechanically safe alignment limits while avoiding unnecessary collateral ligament release.

5. Surgical Technique

Surgical Planning

All procedures were undertaken using computer-assisted navigation with conventional instrumentation through a medial parapatellar approach, without robotic assistance or patient-specific instrumentation. Implant positioning follows a functional alignment philosophy, aiming to restore each patient's constitutional anatomy while maintaining physiological soft-tissue tension.

Following preoperative radiographic analysis, individualized femoral and tibial resections are planned according to the patient's native alignment. The final decision regarding component position is confirmed intraoperatively based on ligament balance and gap assessment.

Step 1. Patient Positioning

The patient is positioned supine on a radiolucent operating table. A pneumatic tourniquet is applied to the proximal thigh according to surgeon preference. The operative limb is prepared and draped in a standard sterile fashion, allowing unrestricted knee flexion beyond 120°.

Intravenous prophylactic antibiotics are administered before skin incision. A multimodal analgesic protocol, including local infiltration analgesia and peripheral nerve blocks when appropriate, is used to facilitate early mobilisation. Rapid recovery protocols are routinely implemented, with mobilisation on the day of surgery and discharge usually within 24 hours [17,18].

Step 2. Surgical Exposure

A straight midline skin incision is performed, followed by a standard medial parapatellar arthrotomy.

The patella is gently everted or subluxated laterally according to intraoperative soft-tissue tension.

Care is taken to preserve the extensor mechanism and minimise unnecessary soft-tissue dissection.

Before any bone resection is undertaken, all accessible osteophytes are removed from the distal femur, proximal tibia and posterior femoral condyles. Removal of osteophytes restores physiological ligament tension and frequently reduces the need for subsequent collateral ligament releases.

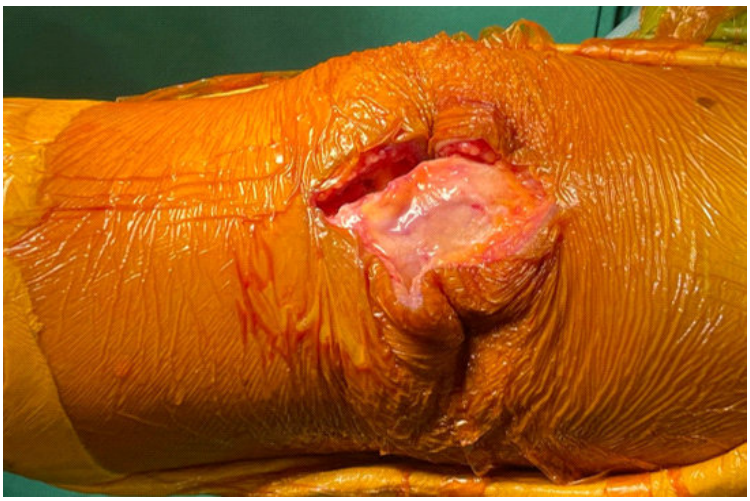

Figure 1. Straight midline skin incision.

Step 3. Femoral Preparation

The distal femoral cut is performed according to the preoperative functional alignment plan rather than aiming for universal mechanical neutrality.

The 5C® MEDic system uses a posterior-referencing technique, allowing preservation of posterior condylar anatomy while facilitating controlled femoral rotation [24].

Femoral component rotation is determined using multiple anatomical references, including:

- posterior condylar axis,
- transepicondylar axis,
- Whiteside's line,
- intraoperative flexion-gap assessment.

Reliance on several anatomical landmarks improves rotational accuracy and reduces the risk of femoral malrotation, particularly in knees presenting with advanced osteoarthritis and asymmetric cartilage wear [21,23,24].

In our technique, the femoral component is intentionally implanted in slight internal rotation. Although this may increase the Q angle and potentially compromise patellar tracking, it further reinforces the medial pivot philosophy by promoting a more stable medial compartment and producing a knee that feels more natural. To mitigate the potential effects on the patellofemoral joint, we routinely perform a partial lateral patellar facetectomy (PLPF), while a lateral patellar release is reserved for cases in which intraoperative assessment demonstrates unsatisfactory patellar tracking. In addition, PLPF may help prevent anterior knee pain by reducing lateral patellofemoral retinacular (LPFR) tension and patellofemoral contact pressure.

The single-radius femoral component maintains a relatively constant flexion-extension axis, promoting uniform collateral ligament tension throughout knee motion.

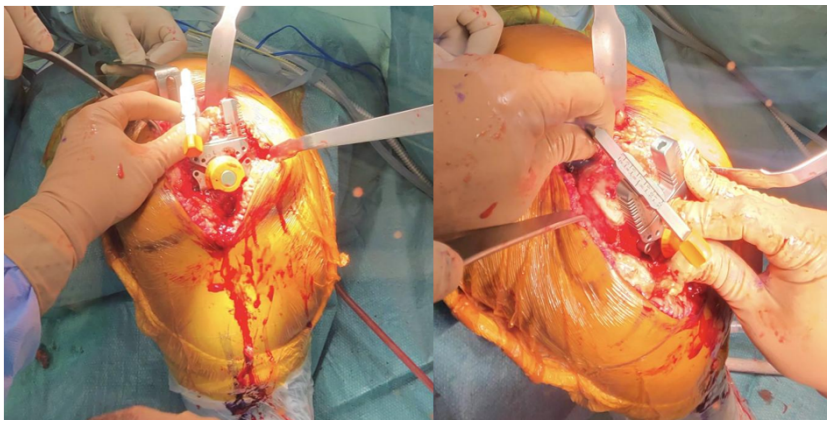

Figure 2. Femoral preparation using posterior-referencing instrumentation.

Step 4. Tibial Preparation

The proximal tibial resection is performed after careful verification of constitutional alignment.

Rather than forcing a neutral mechanical tibial cut, the resection is individualised within predefined safe limits to preserve physiological joint-line orientation.

Posterior tibial slope is reproduced according to the patient's native anatomy while remaining compatible with implant design recommendations.

The anatomical tibial baseplate is selected to maximise cortical coverage while avoiding mediolateral overhang. Correct rotational alignment is verified using the medial one-third of the tibial tubercle together with overall tibial morphology.

Because tibial component malrotation remains an important cause of postoperative pain and patellofemoral complications, meticulous rotational positioning is considered essential [21,23].

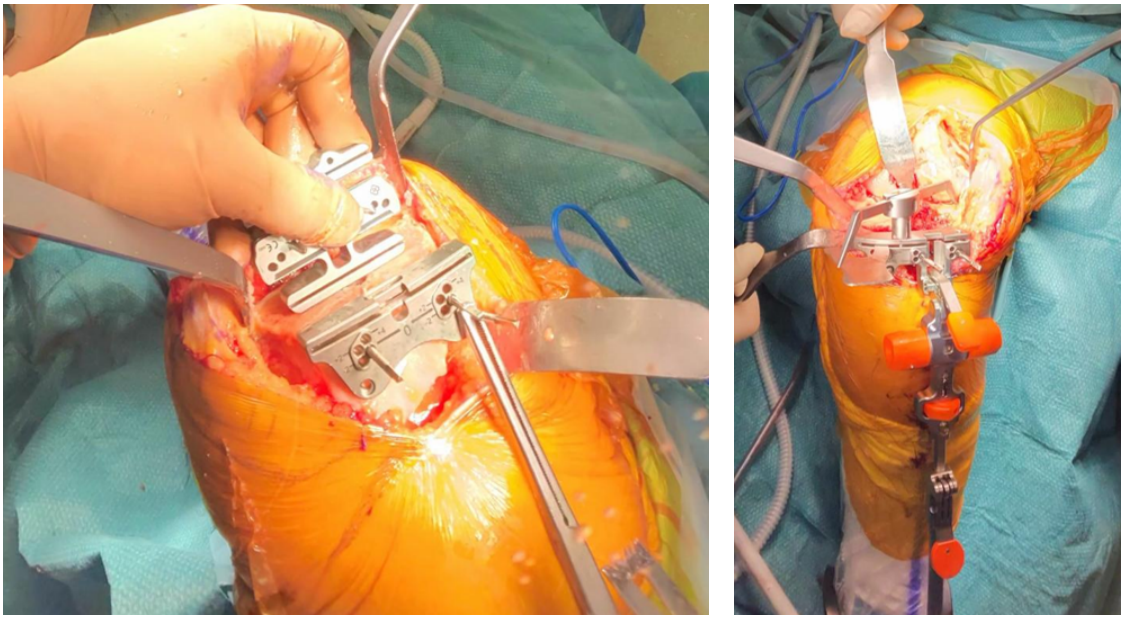

Figure 3. Proximal tibial preparation.

Step 5. Functional Gap Balancing

Gap balancing represents the cornerstone of functional alignment.

Instead of sequential collateral ligament releases, bone resections and component positioning are adjusted to restore the patient's physiological ligament tension.

Extension and flexion gaps are assessed repeatedly using trial spacers and laminar spreaders throughout the procedure.

The desired endpoint includes:

- symmetrical extension balance,
- physiological flexion balance,
- stable medial compartment,
- controlled physiological lateral laxity,
- normal patellar tracking.

Collateral ligament release is reserved for exceptional circumstances and is performed only when component positioning alone cannot restore balanced knee mechanics.

This strategy preserves the native ligament envelope and complements the medial pivot philosophy of the implant [6,11–16].

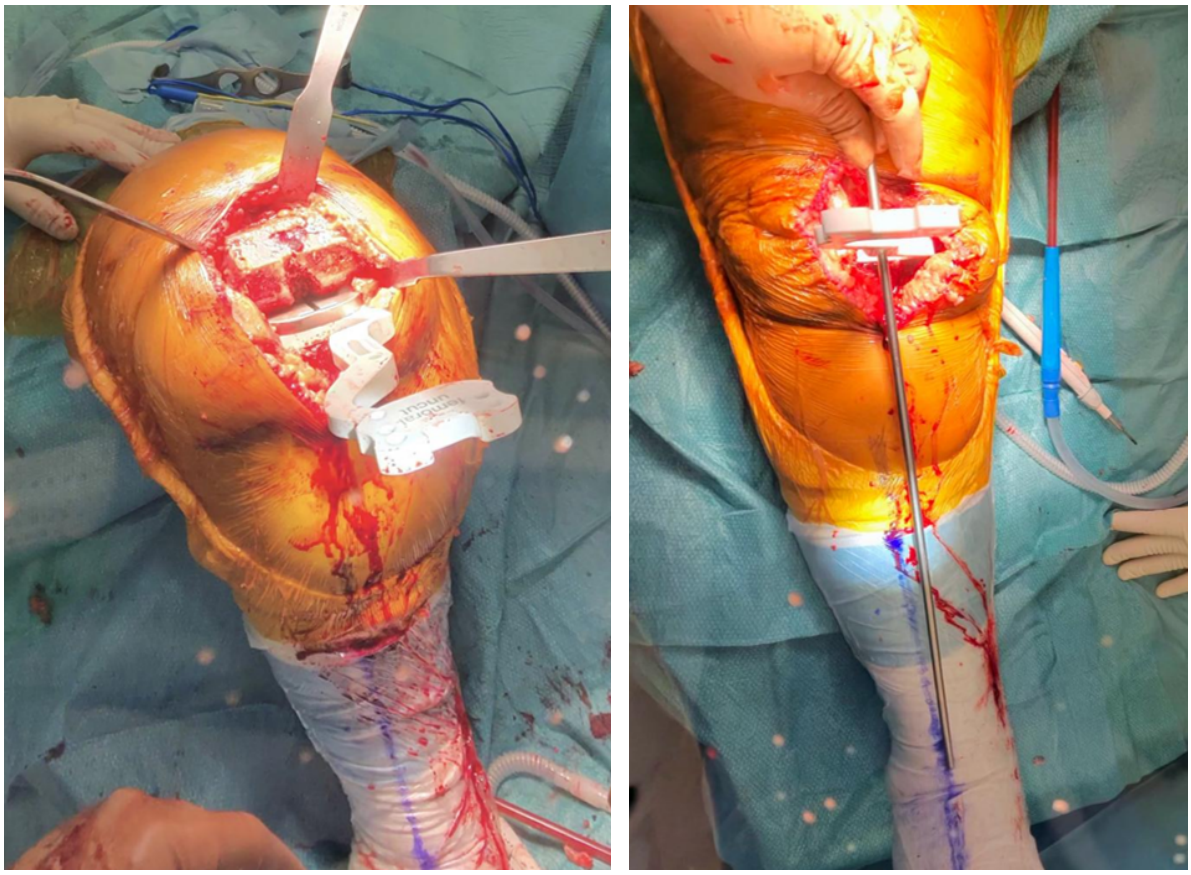

Figure 4. Assessment of extension and flexion gaps.

Step 6. Trial Reduction

Trial femoral and tibial components are inserted together with the appropriate trial polyethylene insert.

The knee is cycled repeatedly through the full range of motion.

The following parameters are evaluated:

- full extension,
- maximum flexion,
- mediolateral stability,
- anteroposterior stability,
- patellar tracking,
- overall limb alignment.

Availability of polyethylene inserts in 1-mm thickness increments allows precise intraoperative balancing while avoiding unnecessary additional bone resection [25].

If required, minor adjustments in component rotation or polyethylene thickness are performed before definitive implantation.

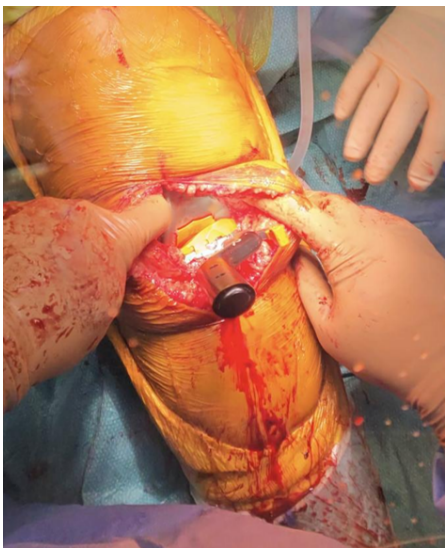

Figure 5. Trial reduction demonstrating balanced medial stability.

Step 7. Final Implantation

After pulsatile lavage and meticulous bone preparation, polymethylmethacrylate cement is applied to both femoral and tibial bone surfaces.

The definitive femoral and tibial components are implanted sequentially.

Following complete cement polymerisation, the definitive vitamin E–stabilised highly cross-linked polyethylene insert is inserted.

Final assessment confirms:

- restoration of full extension,
- satisfactory flexion,
- physiological ligament balance,
- stable medial compartment,
- unrestricted patellar tracking,
- satisfactory overall alignment.

In selected patients presenting with compromised metaphyseal bone quality or increased mechanical demands, optional tibial stem extensions are used to enhance fixation.

Figure 6. Final implantation of the 5C® MEDic Medial Pivot Knee System.

Step 8. Postoperative Rehabilitation

Patients begin full weight-bearing as tolerated on the day of surgery under the supervision of a physiotherapist.

Rehabilitation focuses on:

- restoration of full extension,
- progressive knee flexion,
- quadriceps activation,
- gait training,
- proprioceptive exercises.

Rapid recovery protocols facilitate discharge within one postoperative day for most patients [17,18]. Clinical and radiographic follow-up is performed according to institutional protocols using standardized patient-reported outcome measures and long-leg standing radiographs.

6. Early Clinical Experience

Between September 2022 and March 2025, a consecutive series of 419 primary total knee arthroplasties was performed following the standardized functional alignment protocol described in this Technical Note. All procedures were undertaken using computer-assisted navigation with conventional instrumentation through a medial parapatellar approach, without robotic assistance or patient-specific instrumentation.

Clinical assessment demonstrated substantial improvement across all evaluated patient-reported outcome measures, including KOOS-12, Oxford Knee Score, Forgotten Joint Score, and patient satisfaction. Progressive improvement in knee range of motion was observed throughout follow-up, with restoration of full extension and flexion.

Radiographic analysis demonstrated restoration of constitutional limb alignment while maintaining physiological joint-line orientation according to the principles of functional alignment. Classification according to the CPAK system confirmed reproducible correction within patient-specific alignment boundaries [8–13].

Complications were uncommon. One patient developed an acute periprosthetic joint infection that was successfully treated with debridement, antibiotics, and polyethylene insert exchange while retaining the implant. One additional patient experienced postoperative deep venous thrombosis that resolved following anticoagulant therapy. No cases of aseptic loosening, instability requiring revision, mechanical failure, or periprosthetic fracture were encountered during the available follow-up period. Kaplan–Meier analysis demonstrated a cumulative implant survivorship of 99.8% at one year.

Although longer follow-up remains necessary, these findings support the safety and reproducibility of the described technique and are encouraging for continued clinical use. The favorable short-term outcomes observed in this consecutive series are consistent with the published literature on medial pivot and functional alignment TKA, although direct comparisons should be interpreted cautiously because of differences in study design and follow-up duration [11–18].

7. Discussion

The evolution of total knee arthroplasty has progressively shifted from implant survivorship alone toward restoration of physiological knee function. While conventional mechanical alignment has produced excellent long-term durability, patient dissatisfaction remains a significant challenge despite technically successful procedures [17–23]. Functional alignment has therefore emerged as an individualized alignment philosophy intended to restore constitutional anatomy while preserving the patient's native soft-tissue envelope [6–13].

The present Technical Note describes a reproducible surgical technique combining functional alignment with the 5C® MEDic Medial Pivot Knee System. Rather than considering implant design and alignment philosophy separately, this approach integrates both concepts to recreate native knee biomechanics.

The medial pivot concept has become increasingly supported by biomechanical, fluoroscopic, and clinical investigations. Native knees demonstrate minimal translation within the medial compartment while the lateral femoral condyle undergoes posterior rollback during flexion [1,2]. Reproducing this movement pattern may reduce paradoxical anterior femoral translation, improve quadriceps efficiency, increase anteroposterior stability, and reduce prosthetic joint awareness [2,14–16]. The highly congruent medial articulation incorporated into the 5C® MEDic system was specifically developed to reproduce these physiological characteristics.

An equally important aspect of this technique is the use of functional alignment. Instead of pursuing a universal neutral mechanical axis, individualized component positioning allows restoration of constitutional anatomy within predefined safe limits. This reduces the need for extensive collateral ligament release and preserves native soft-tissue balance. In our experience, this strategy has simplified intraoperative balancing while maintaining excellent postoperative stability.

Computer-assisted navigation complements the functional alignment philosophy by increasing the accuracy and consistency of patient-specific component positioning, thereby supporting restoration of constitutional alignment and reducing variability in implant placement.

Several implant-specific characteristics further support this philosophy. Posterior-referencing instrumentation facilitates controlled femoral rotation and preservation of posterior condylar anatomy [24]. The single-radius femoral design maintains consistent collateral ligament tension throughout knee flexion, whereas the anatomical tibial component and highly cross-linked vitamin E polyethylene insert contribute to stable articulation and precise intraoperative balancing. Availability of polyethylene inserts in 1-mm increments provides additional flexibility during gap balancing without requiring unnecessary bone resection [25].

The early clinical experience presented in this Technical Note demonstrates excellent functional recovery, high patient satisfaction, low complication rates, and excellent short-term survivorship. Although these observations originate from a single-centre experience and should therefore be interpreted with appropriate caution, they are consistent with previously published reports describing favourable outcomes following medial pivot total knee arthroplasty [11–16].

The present article has several limitations. It reflects the experience of a single high-volume arthroplasty centre without a comparative control group. Furthermore, the available follow-up remains relatively short and therefore does not permit conclusions regarding long-term implant durability. Nevertheless, the large consecutive clinical experience and standardized surgical protocol provide valuable practical guidance for surgeons adopting functional alignment with the 5C® MEDic system.

Future multicentre prospective studies with longer follow-up should compare this technique with contemporary mechanical, kinematic, and restricted kinematic alignment philosophies while evaluating patient-reported outcomes, gait analysis, implant survivorship, and radiographic restoration of native knee mechanics [3–13,17,18].

8. Conclusion

Functional alignment total knee arthroplasty using the 5C® MEDic Medial Pivot Knee System combines patient-specific component positioning with implant characteristics designed to reproduce native knee biomechanics.

Application of a standardized functional alignment protocol through a conventional medial parapatellar approach allows restoration of constitutional alignment while preserving physiological ligament balance and minimizing soft-tissue releases.

The authors' early clinical experience demonstrates encouraging functional recovery, excellent patient satisfaction, low complication rates, and excellent short-term implant survivorship. Although longer follow-up and comparative prospective investigations remain necessary, this technique represents a reproducible and practical strategy for surgeons seeking to restore physiological knee function using conventional instrumentation.

9. Clinical Message

The combination of patient-specific functional alignment and a medial pivot implant represents a contemporary approach to primary total knee arthroplasty. Restoration of constitutional alignment, preservation of native ligament balance, and reproduction of physiological knee kinematics may improve functional recovery while maintaining excellent implant stability [1–16]. The described technique provides a reproducible workflow using computer-assisted navigation without robotic assistance or patient-specific instrumentation, allowing accurate patient-specific reconstruction while preserving physiological ligament balance.

Acknowledgements

The authors acknowledge the contribution of the surgical, anaesthetic, nursing, physiotherapy, and research staff of the Orthopedic Clinic OSTEON, Athens Medical Center, whose commitment to standardized perioperative care contributed to the successful implementation of the described surgical protocol.

Ethics Statement

All surgical procedures were performed in accordance with the ethical principles of the Declaration of Helsinki and institutional clinical practice standards.

All patients provided written informed consent for surgery and anonymous use of their clinical and radiographic data for research and educational purposes.

Conflict of Interest

Dr. Sakellariou serves as a Consultant and Trainer for Implantcast GmbH. The remaining authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding

No external funding was received for this study.

References

1. Freeman MA, Pinskerova V. The movement of the normal tibio-femoral joint. J Biomech. 2005 Feb;38(2):197-208. doi: 10.1016/j.jbiomech.2004.02.006. PMID: 15598446.

2. Dennis DA, Komistek RD, Mahfouz MR, Haas BD, Stiehl JB. Multicenter determination of in vivo kinematics after total knee arthroplasty. Clin Orthop Relat Res. 2003 Nov;(416):37-57. doi: 10.1097/01.blo.0000092986.12414.b5. PMID: 14646738.

3. Howell SM, Papadopoulos S, Kuznik KT, Hull ML. Accurate alignment and high function after kinematically aligned TKA performed with generic instruments. Knee Surg Sports Traumatol Arthrosc. 2013 Oct;21(10):2271-80. doi: 10.1007/s00167-013-2621-x. Epub 2013 Aug 15. PMID: 23948721.

4. Dossett HG, Swartz GJ, Estrada NA, LeFevre GW, Kwasman BG. Kinematically versus mechanically aligned total knee arthroplasty. Orthopedics. 2012 Feb 17;35(2):e160-9. doi: 10.3928/01477447-20120123-04. PMID: 22310400.

5. Howell SM. Calipered kinematic alignment in total knee arthroplasty. *JBJS Essential Surgical Techniques*.

6. Risitano S, Cacciola G, Sabatini L, Capella M, Bosco F, Giustra F, Massè A, Vaishya R. Restricted kinematic alignment in primary total knee arthroplasty: A systematic review of radiographic and clinical data. J Orthop. 2022 Jul 2;33:37-43. doi: 10.1016/j.jor.2022.06.014. PMID: 35812351; PMCID: PMC9263746.

7. Shatrov J, Foissey C, Kafelov M, Batailler C, Gunst S, Servien E, Lustig S. Functional Alignment Philosophy in Total Knee Arthroplasty-Rationale and Technique for the Valgus Morphotype Using an Image Based Robotic Platform and Individualized Planning. J Pers Med. 2023 Jan 26;13(2):212. doi: 10.3390/jpm13020212. PMID: 36836446; PMCID: PMC9961945.

8. MacDessi SJ, Griffiths-Jones W, Harris IA, Bellemans J, Chen DB. Coronal Plane Alignment of the Knee (CPAK) classification. Bone Joint J. 2021 Feb;103-B(2):329-337. doi: 10.1302/0301-620X.103B2.BJJ-2020-1050.R1. Erratum in: Bone Joint J. 2026 Jan 1;108-B(1):141. doi: 10.1302/0301-620X.108B1.BJJ-2025-00062. PMID: 33517740; PMCID: PMC7954147.

9. MacDessi SJ, Griffiths-Jones W, Harris IA, Bellemans J, Chen DB. The arithmetic HKA (aHKA) predicts the constitutional alignment of the arthritic knee compared to the normal contralateral knee: a matched-pairs radiographic study. Bone Jt Open. 2020 Nov 2;1(7):339-345. doi: 10.1302/2633-1462.17.BJO-2020-0037.R1. PMID: 33215122; PMCID: PMC7659698.

10. Victor JM, Bassens D, Bellemans J, Gürsu S, Dhollander AA, Verdonk PC. Constitutional varus does not affect joint line orientation in the coronal plane. Clin Orthop Relat Res. 2014 Jan;472(1):98-104. doi: 10.1007/s11999-013-2898-6. PMID: 23733590; PMCID: PMC3889437.

11. Clark G, Steer R, Wood D. Functional alignment achieves a more balanced total knee arthroplasty than either mechanical alignment or kinematic alignment prior to soft tissue releases. Knee Surg Sports Traumatol Arthrosc. 2023 Apr;31(4):1420-1426. doi: 10.1007/s00167-022-07156-3. Epub 2022 Sep 18. PMID: 36116071; PMCID: PMC10050049.

12. Van de Graaf VA, Chen DB, Allom RJ, Wood JA, MacDessi SJ. Functional alignment in total knee arthroplasty best achieves balanced gaps and minimal bone resections: an analysis comparing mechanical, kinematic and functional alignment strategies. Knee Surg Sports Traumatol Arthrosc. 2023 Nov;31(11):5118-5127. doi: 10.1007/s00167-023-07567-w. Epub 2023 Oct 4. PMID: 37789215.

13. Manara JR, Steer R, Whitehouse SL, Collopy D, Clark GW. Functional alignment restores native kinematics more consistently than mechanical axis alignment in total knee arthroplasty. Bone Joint J. 2025 Apr 1;107-B(4):423-431. doi: 10.1302/0301-620X.107B4.BJJ-2024-0956.R1. PMID: 40164174.

14. Sabatini L, Risitano S, Parisi G, Tosto F, Indelli PF, Atzori F, Massè A. Medial Pivot in Total Knee Arthroplasty: Literature Review and Our First Experience. Clin Med Insights Arthritis Musculoskelet Disord. 2018 Jan 4;11:1179544117751431. doi: 10.1177/1179544117751431. PMID: 29326531; PMCID: PMC5758963.

15. Schmidt R, Ogden S, Blaha JD, Alexander A, Fitch DA, Barnes CL. Midterm clinical and radiographic results of the medial pivot total knee system. Int Orthop. 2014 Dec;38(12):2495-8. doi: 10.1007/s00264-014-2444-5. Epub 2014 Jul 11. PMID: 25011412.

16. Iida T, Minoda Y, Kadoya Y, Matsui Y, Kobayashi A, Iwaki H, Ikebuchi M, Yoshida T, Nakamura H. Mid-term clinical results of alumina medial pivot total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2012 Aug;20(8):1514-9. doi: 10.1007/s00167-011-1734-3. Epub 2011 Nov 5. PMID: 22057351.

17. National Joint Registry. Annual Report (latest edition).

18. Australian Orthopaedic Association National Joint Replacement Registry. Annual Report (latest edition).

19. Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? Clin Orthop Relat Res. 2010 Jan;468(1):57-63. doi: 10.1007/s11999-009-1119-9. PMID: 19844772; PMCID: PMC2795819.

20. Behrend H, Giesinger K, Giesinger JM, Kuster MS. The "forgotten joint" as the ultimate goal in joint arthroplasty: validation of a new patient-reported outcome measure. J Arthroplasty. 2012 Mar;27(3):430-436.e1. doi: 10.1016/j.arth.2011.06.035. Epub 2011 Oct 13. PMID: 22000572.

21. Abdel MP, Ollivier M, Parratte S, Trousdale RT, Berry DJ, Pagnano MW. Effect of Postoperative Mechanical Axis Alignment on Survival and Functional Outcomes of Modern Total Knee Arthroplasties with Cement: A Concise Follow-up at 20 Years. J Bone Joint Surg Am. 2018 Mar 21;100(6):472-478. doi: 10.2106/JBJS.16.01587. PMID: 29557863.

22. Victor J, Bellemans J. Constitutional alignment and individualized TKA.

23. Parratte S, Pagnano MW, Trousdale RT, Berry DJ. Effect of postoperative mechanical axis alignment on the fifteen-year survival of modern, cemented total knee replacements. J Bone Joint Surg Am. 2010 Sep 15;92(12):2143-9. doi: 10.2106/JBJS.I.01398. PMID: 20844155.

24. Gómez-Barrena E, Fernandez-García C, Fernandez-Bravo A, Cutillas-Ruiz R, Bermejo-Fernandez G. Functional performance with a single-radius femoral design total knee arthroplasty. Clin Orthop Relat Res. 2010 May;468(5):1214-20. doi: 10.1007/s11999-009-1190-2. PMID: 20012237; PMCID: PMC2853642.

25. Bistolfi A, Spezia M, Cipolla A, Bonera M, Mellano D, Banci L, Colombo M, Massè A. Vitamin E-stabilized polyethylene shows similar survival rates at minimum 7-year follow-up compared to conventional polyethylene in primary total knee arthroplasty. J Exp Orthop. 2024 Sep 5;11(3):e12106. doi: 10.1002/jeo2.12106. PMID: 39239569; PMCID: PMC11375329.