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Complications - Other

Compatibility of Retrograde Intramedullary Nails With Knee Prostheses: A Comprehensive Analysis

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A B S T R A C T

Background: Periprosthetic distal femoral fractures pose major challenges in orthopaedic surgery, particularly among aging populations with total knee arthroplasties. Retrograde intramedullary nailing has emerged as a viable fixation option due to its biomechanical stability, less invasive nature, and facilitation of early weight-bearing. However, the compatibility between retrograde nails and various knee prostheses remains a critical determinant of surgical success. This review consolidated existing knowledge and evaluated current nail-prosthesis compatibility and options for lateral femoral periprosthetic plating and provided a compatibility matrix for fixation options for these complex fractures.
Methods: An evidence-based review was conducted to evaluate the compatibility of retrograde intramedullary nails with total knee arthroplasty prostheses. Additionally, currently available lateral distal femoral plates were evaluated. Data were synthesized from key studies, technical specifications from major manufacturers, and recent advancements in nail and prosthesis design. Technical parameters such as intercondylar dimensions, posterior notch geometry, nail diameter, and proximal sagittal nail bend angles were analyzed. The findings were summarized in comprehensive tables, cross-referencing nail systems with prosthesis models to identify optimal combinations and highlight potential challenges.
Results: The analysis identified critical factors influencing nail-prosthesis compatibility, including nail diameter, intercondylar width, and posterior notch geometry. These findings were synthesized into detailed tables categorizing prosthesis compatibility by manufacturer, model, and technical specifications.
Conclusions: This paper provides a comprehensive resource for optimizing retrograde nail selection based on prosthesis-specific geometries, addressing a critical aspect of managing periprosthetic distal femoral fractures. Although advancements in nail and prosthesis designs have improved compatibility, variations in posterior notch placement and intercondylar dimensions highlight the importance of preoperative planning.

Periprosthetic distal femoral fractures represent a growing challenge in orthopaedic surgery, particularly in the aging population with total knee arthroplasties (TKAs) [1–9]. As the frequency of TKA continues to rise globally, so too does the incidence of these complex fractures [10,11]. The overarching decision whether to fix or replace is dictated by the stability of the implant and remaining bone stock. In the setting of a well-fixed implant with sufficient bone stock, the type of internal fixation can be dictated by implant design and fracture pattern [12,13]. Patient age and comorbid conditions are also critical factors in decision-making in fracture management and implant selection [14].

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Retrograde intramedullary nailing has emerged as one of the preferred techniques for treating periprosthetic supracondylar femoral fractures with well-fixed implants due to its biomechanical stability, minimally invasive approach, and ability to enable early weight-bearing through load-sharing principles [15]. However, the compatibility of retrograde nails with various knee prostheses is a critical factor in determining surgical plausibility. Factors such as intercondylar notch width, nail diameter, and the positioning of the prosthesis can ultimately influence the ease of nail insertion and postoperative outcomes [16,17].

Several studies have explored the challenges of matching retrograde nails to knee prostheses, with earlier work by Thompson et al. providing guidelines for selecting nails based on the intercondylar distances of specific prostheses [16]. More recent work by Gerow et al. has expanded upon this by incorporating new designs and technologies in both prostheses and nails [17]. With advancements in nail systems, such as variable distal locking mechanisms, increased nail diameter ranges, and improved reaming techniques, surgeons now have a broader selection of devices to address these fractures. Moreover, updated knee prosthesis designs, such as those with increased intercondylar distances, modifications to posterior notch geometry, and modified nail features like increased distal bend angle and narrower medial-to-lateral distal nail width, offer expanded indications for retrograde intramedullary nail fixation of these fractures. There seems to be greater utility in achieving fit with the use of blocking screws, though this is not a replacement for preplanning compatibility [18].

In addition to retrograde femoral nailing for distal femoral periprosthetic fractures, nail-plate combinations and dual plating have also been described in the literature with promising results [19,20]. A number of different options exist on the market for lateral plates designed for the complex anatomy of the distal femoral-prosthesis interface that enhance the ability to stably fix periprosthetic distal femoral fractures [21].

The purpose of this paper was to consolidate and update current knowledge on the compatibility of retrograde intramedullary nails with knee prostheses. By reviewing available nail systems on the market and correlating them with modern prosthesis designs, this manuscript aimed to provide a comprehensive guide for orthopaedic surgeons. Additionally, currently available lateral femoral locking plates were reviewed, as they are a common alternative or addition to intramedullary nail constructs. This paper incorporates data from previous research alongside detailed product specifications for nails, ensuring that surgeons can make informed decisions based on both current and prior generations of implants. Furthermore, this addresses the clinical implications of selecting the appropriate fixation strategy, offering insight into the biomechanical advantages of various nail-prosthesis combinations.

Methods

To collect relevant data, a comprehensive review of prior studies was conducted on retrograde nail compatibility with knee prostheses, emphasizing two foundational sources while incorporating more recent publications [16,17,22]. Additionally, lateral distal femoral plates currently available on the market were included for completeness. In addition to a review of the literature, the technical specifications of each implant which were collected directly from manufacturers, including product manuals, online catalogs, and clinical technique guides from Aesculap (Center Valley, Pennsylvania, United States), Arthrex (Naples, Florida, United States), CarboFix (Collierville, Tennessee, United States) Corentec (Chungcheongnam-do, S. Korea), Corin (Cirencester, United Kingdon), Enovis (Wilmington, Delaware, United States), Exactech (Gainesville, Florida, United States), Globus Medical (Audubon, Pennsylvania, United States), Johnson & Johnson Link (Hamburg, Germany), Maxx (Norristown, Pennsylvania, United States), DePuy Synthes (Warsaw, Indiana, United States), Medacta (Castel San Pietro, Switzerland), Microport (Arlington, Tennessee, United States), Ortho Development (Draper, Utah, United States), Orthofix (Lewisville, Texas, United States), Restor3d (Durham, North Carolina, United States), Shalby (El Dorado Hills, California, United States) Smith and Nephew (Memphis, Tennessee, United States), Stryker (Kalamazoo, Michigan, United States), Total Joint Orthopedics (Salt Lake City, Utah, United States), United Orthopedic Corporation (Taichung, Taiwan), and Zimmer Biomet (Warsaw, Indiana, United States) [23–47]. The primary objective was to address compatibility issues related to retrograde nails and knee prostheses, including measurements of intercondylar dimensions, posterior notch positioning, and other geometric factors influencing nail insertion. These data were supplemented with data from newer studies published after the initial research to capture advancements such as variable distal locking mechanisms, larger nail diameters, increased distal bend angles designed for periprosthetic fractures, and improved reaming techniques that accommodate a wider range of prosthesis designs.

Extracted data points included each nail system's characteristics—such as nail diameter, distal bend angle, driving end size, and opening reamer requirements—as well as special features like variable locking mechanisms designed for diverse prosthesis compatibility. Knee prosthesis data focused on models commonly used in TKA, with details on intercondylar width, posterior notch geometry, and design aspects that could affect nail compatibility.

Finally, based on the synthesized data, a clinical guide was developed to guide surgeons in the selection of the appropriate retrograde nail for their specific periprosthetic distal femoral fracture. This guide includes compatibility recommendations for common TKA models, suggested nail specifications tailored to specific prosthesis designs, and practical insights on surgical technique adjustments to optimize fixation outcomes.

Results

This review identified key compatibility patterns between retrograde intramedullary nails and knee prostheses, summarized in Tables 1 and 2. Intercondylar distances were recorded as minimum values, as most prostheses increase in clearance with implant size. Outlier prostheses include narrow cruciate-retaining (CR) femurs, such as Zimmer Biomet NexGen CR and DePuy Synthes LCS CR, which present compatibility challenges in small-statured individuals. Additionally, posterior-stabilized (PS) femora with small or excessively posterior notches—including DePuy Synthes Sigma PS RPF Hi-Flex—may further limit retrograde nail insertion.

The most universally compatible retrograde nails share common design features, including small opening reamers/distal diameters, multiple distal screw options, and unique fixation elements (locking washers, locking side plates) (Figure 1). The DePuy Synthes Retrograde Femoral Nail-Advanced, Zimmer Biomet Phoenix Retrograde, and Stryker T2 Alpha Femur Retrograde are among the most versatile, demonstrating broad prosthesis compatibility. In contrast, the Smith & Nephew TRIGEN Meta-Nail Retrograde, Orthofix Centronail, and Stryker T2 Femur A/R are least compatible due to larger proximal body diameters and higher opening reamer requirements, making them unsuitable for prostheses with narrow minimum intercondylar distances. Notably, prostheses with the largest intercondylar diameters, such as Zimmer Biomet Vanguard CR/PS, Wright Evolution Medial Pivot, and DePuy Synthes PFC Sigma PS, allow flexibility in nail selection, making them less dependent on specialty designs. In these cases,

Table 1
Retrograde Intramedullary Nail Specifications.

Manufacturer	Nail Model	Nail Diameters (mm)	Driving End Diameter (mm)	Opening Reamer (mm)	Nail Lengths (mm)	Distance From Distal End of Nail to First Interlock (mm)	Distal Bend (°)	Notes
Arthrex [a]	Retrograde Femoral Nail	10, 11, 12, 13	13	13.5	220, 260-460 (20 mm inc.)	10	Not specified	Condyle fixation nuts
CARBOFIX	Piccolo	10, 11, 12	10-11: 11.5 12: 12	13	300-420 (20 mm inc.)	17	1.5-meter RoC	Carbon fiber nail
DePuy Synthes	Retrograde Femoral Nail (RFN)-Advanced	9, 10, 11, 12, 14	9-12: 12 14: 14	9-12: 11.2 14: 12.8	160-480 (20 mm inc.)	9.5	5° and 10°	Periprosthetic locking washer
Globus Medical	AUTOBAHN EVO Retrograde	10, 11, 12	12	11.2 or 12.8	320-440 (20 mm inc.)	n/a	5° and 10° 70 mm from tip	Locking washer
ORTHOFIX	Centronail	9, 10, 11, 12	13	13	130-375 (25 mm inc.)	7.5	10°	Condylar compression screws
Smith + Nephew	TRIGEN META-NAIL Retrograde	10, 11.5, 13	10, 11.5: 12 13 = 13	12.5	180-500 (20 mm inc.)	15	Not specified	No specific periprosthetic options
Stryker	T2 Femur A/R	9, 10, 11, 12, 13, 14, 15	9-11: 11.5 12-15: Constant	12	140-480 (20 mm inc.)	15	Not specified	Condylar compression screws
Stryker	T2 Alpha Femur Retrograde	9, 10, 11, 12, 13, 14	9-11: 11.5 12-14: Constant	12.5	170, 200, 220-480 (20 mm inc.)	6	1-5° 4° on 170 and 200 mm nails	Condylar compression screws
Zimmer Biomet	Phoenix Retrograde	9, 10.5, 12, 13.5	9-12: 12 13.5 = 13.5	12.2	240-460 (20 mm inc.)	14	5°	Distal screws lock into nail
Zimmer Biomet	Natural Nail Retrograde	10, 11.5, 13	13	13.5	160, 200, 240, 280-440 (20 mm inc.)	9-14	5°	Compatible with narrow geometries

mm, millimeters; inc., increments; n/a, not available; RoC, radius of curvature.
[a] Formerly AOS Magellan.

Table 2
Total Knee Prosthesis and Retrograde Nail Compatibility Guide. Smallest Diameter Nail Fits Between the Smallest intercondylar Width of Total Knee Arthroplasty.

Manufacturer	Prosthesis Model	Arthrex Retrograde Nail	CARBOFIX Piccolo	*DePuy Synthes RFNA*	Globus AUTOBAHN	ORTHOFIX Centronail	S&N TRIGEN META-NAIL	Stryker T2 Femur A/R	Stryker T2 Alpha Retrograde	ZB Phoenix Retrograde	ZB Natural Nail Retrograde
Aesculap	Columbus										
	Vega										
Arthrex	iBalance CR										
	iBalance PS										
Corentec	Exult CR										
	Exult PS										
	LOSPA										
Corin	Unity										
	Apex	Smaller knees → nail with caution if > 14 mm									
DePuy Synthes	Attune CR										
	Attune PS	Smaller knees → nail with caution if > 14 mm									
	LCS CR										
	LCS PS										
	Sigma CR										
	Sigma PS	Opening 11.7 × 12.7 mm for all sizes – metal cutting bur may be required									
	PFC (Press Fit Condylar)										
	Total Condylar 1	Posterior notch, nail with caution									
	Total Condylar 2										
	AMK										
Enovis	EMPOWR CR										
	EMPOWR PS	Nail with caution if > 14 mm									
	Foundation	Nail with caution if > 12 mm									
	(Lima) Physica										
Exactech	Optetrak Logic CR										
	Optetrak Logic PS										
	Truliant CR										
	Truliant PS										
Link	Gemini SL CR										
	Gemini SL PS										
	SymphoKnee CR	Nail with caution if > 14.5 mm									
	SymphoKnee PS										
Maxx	Freedom CR										
	Freedom PS										

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Table 2 (*continued*)

Manufacturer	Prosthesis Model	Arthrex Retrograde Nail	CARBOFIX Piccolo	*DePuy Synthes RFNA*	Globus AUTOBAHN	ORTHOFIX Centronail	S&N TRIGEN META-NAIL	Stryker T2 Femur A/R	Stryker T2 Alpha Retrograde	ZB Phoenix Retrograde	ZB Natural Nail Retrograde
Medacta	GMK Sphere										
	GMK PS										
MicroPort	Advance Medial Pivot										
	Evolution Medial Pivot										
	ADVANTIM CR										
	ADVANTIM PS Open			if > 15 mm				if > 15 mm			
	ADVANTIM Medial Pivot										
Ortho development	BKS										
Smith + Nephew	Genesis I CR										
	Genesis I PS										
	Genesis II CR										
	Genesis II PS										
	Journey II BCS	Nail with caution if > 14.5 mm in sizes 1 and 2									
	Journey II CR/XR										
	Legion CR										
	Legion PS										
	Profix CR	Intercondylar distance is 22 mm, but a smaller IM nail may be required due to the posterior extension of the notch									
	Profix PS	Nail with caution if > 14.5 mm									
Restor3d[a]	iTotal CR	Custom implants, will vary patient to patient									
	iTotal PS										
Stryker	DURACON										
	Triathlon CR										
	Triathlon PS										
	Scorpio NRG										
	PCA										
	Kinemax CR										
	Kinemax PS										
	Omnifit										
	Series 7000										
Total Joint Orthopedics	Klassic CR										
	Klassic PS										

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Table 2 (*continued*)

Manufacturer	Prosthesis Model	Arthrex Retrograde Nail	CARBOFIX Piccolo	*DePuy Synthes RFNA*	Globus AUTOBAHN	ORTHOFIX Centronail	S&N TRIGEN META-NAIL	Stryker T2 Femur A/R	Stryker T2 Alpha Retrograde	ZB Phoenix Retrograde	ZB Natural Nail Retrograde
United Orthopedics	U2										
Zimmer-Biomet	Persona CR	Nail with caution if > 14 mm in smaller sizes									
	Persona PS										
	Vanguard CR										
	Vanguard PS										
	AGC CR										
	AGC PS										
	Maxim CR										
	Maxim PS										
	Natural Knee II										
	NexGen CR										
	NexGen PS										
	Insall-Burstein I										
	IBII CR										
	IBII PS										
	Miller-Galante I										
	Miller-Galante II	Nail with caution if > 12.5 mm									

Light grey: Nail fits (intercondylar distance > nail diameter) and the notch is not too far posterior. Gray: Either the intercondylar distance or the notch data could prevent nailing of certain diameter nails, and caution is warranted. Black: Nail Does not fit (nail diameter > intercondylar distance), the notch is too far posterior or has a closed box.
AGC, anatomic graduated component; CR, cruciate retaining; IB, Insall-Burstein; GMK, Global Medacta Knee; LCS, low contact stress; LSK, LinkSymphoKnee; IM, intramedullary; N/a, not available; NRG, nonrestrictive geometry; PS, posterior stability; Reg, regular; ZB, Zimmer-Biomet.
J&J Sigma CR and PS have a 11.94 × 12 mm polyethylene plug that can be removed and safely nailed [48].
[a] Restor3d are custom and semicustom implants, sizes vary.

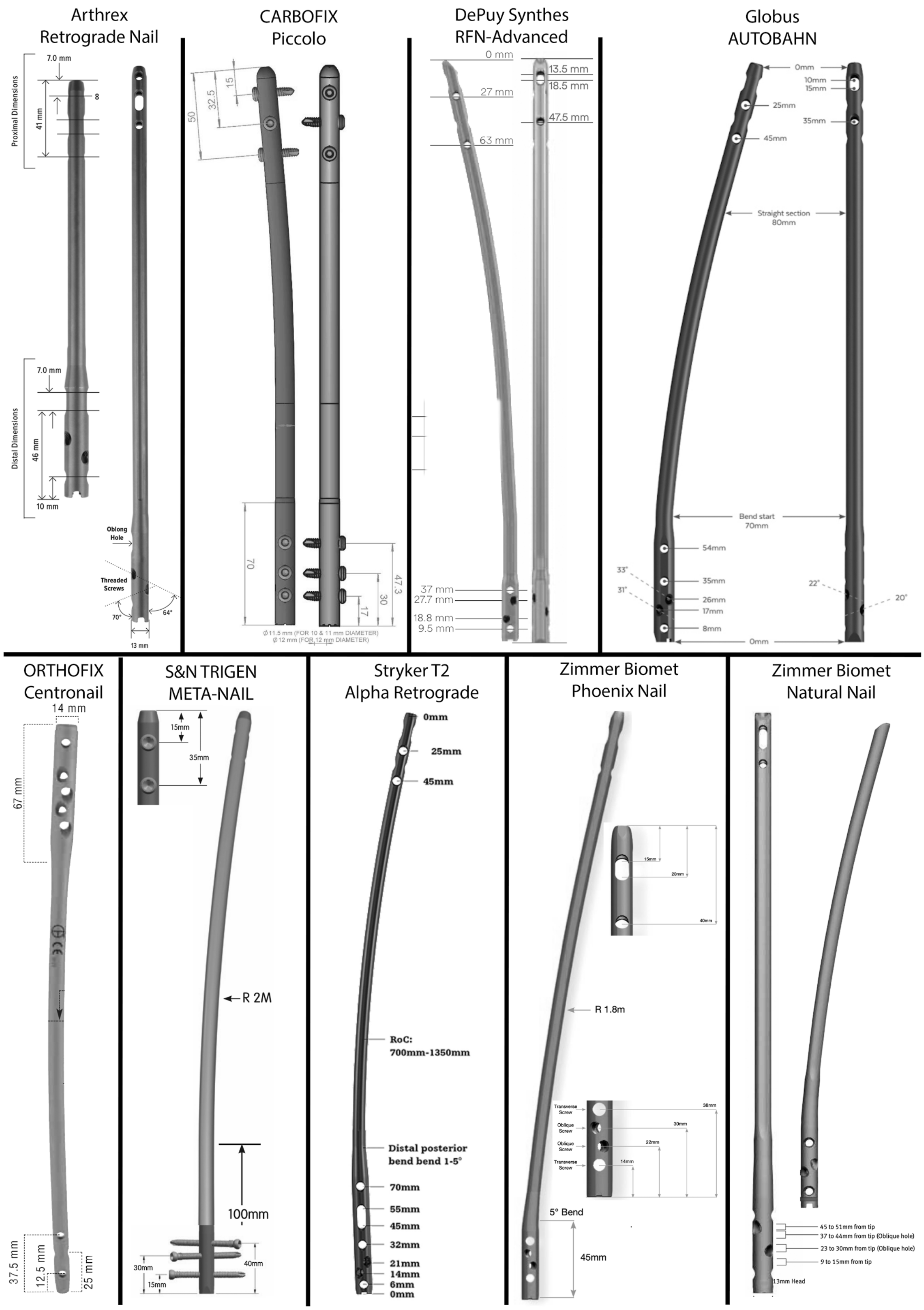

Figure 1. Currently available retrograde femoral nails examined in this review.

surgeon preference or hospital implant contracts can dictate nail choice without major technical limitations.

Additionally, Table 3 highlights the role of lateral locking plates as a valuable adjunct in cases where intramedullary nails may be limited by prosthesis design or fracture morphology (Figure 2). These plates can enhance fixation stability, particularly in periprosthetic distal femoral fractures with compromised bone stock or challenging prosthesis geometries. Their integration with retrograde nails provides an alternative fixation strategy when compatibility constraints arise.

Table 3
Details on Currently Available Lateral Distal Femoral Locking Plates on the Market and their Sizing.

Manufacturer	Plate	Holes (Lengths, mm)	Periarticular Screw Block	Features
DePuy Synthes	LCP Distal Femur Plate	5 (156) 7 (196) 9 (236) 11 (276) 13 (316) 15 (356) 17 (396) 19 (436)	7	- Dynamic compression unit holes—locking, cortical, or combination of the two - Proprietary screw targeting arm (5-, 9-, and 13-hole plates)
Globus Medical	ANTHEM Distal Femur System	5 (137) 8 (169) 11 (202) 14 (234) 17 (267) 20 (299) 23 (331) 26 (363) 29 (395) 32 (427) 35 (458)	8	- Screw targeting arm - Narrow and broad lateral plates and a medial plate available in same set - Dual kickstand holes - Stainless steel and titanium options
Smith + Nephew	EVOS Periprosthetic Plate	14 (296.9) 16 (333.2) 18 (369.4) 20 (405.5) 22 (441.6)	7	- 3.5 mm variable angle screws peripherally - Compatible with proprietary cabling system
Stryker	AxSOS 3	4 (126) 6 (162) 8 (197) 10 (245) 12 (271) 14 (305) 16 (342) 18 (380) 20 (415)	8	- Titanium plate with screw targeting instrumentation - Optional cable attachment - 5.0 mm variable angle extension arms for 4.0 mm screws to expand screw trajectory options
Stryker	Pangea Plates	6 (173) 10 (241) 13 (280) 16 (318) 19 (355) 23 (396)	7	- Have both distal femur and intra-prosthetic plate options - Screw targeting arm - Cable fixation attachment - 5.0 mm variable angle extension arms for 4.0 mm screws to expand screw trajectory options
Zimmer Biomet	NCB Periprosthetic Distal Femur	9 (238) 12 (278) 15 (317) 18 (355) 21 (393)	7	- Variable angle screws with locking caps - Screw targeting arm - Cable fixation attachment - Unicortical locking screws and bone spacer screws available

Discussion

This comprehensive analysis of retrograde intramedullary nail compatibility with knee prostheses highlights major considerations for managing periprosthetic supracondylar femoral fractures. Compatibility between nail systems and knee prostheses depends on multiple factors, including nail diameter, driving end size, opening reamer requirements, and prosthesis-specific geometries like intercondylar distance and posterior notch placement [49]. This review synthesizes these findings to provide practical recommendations that can aid orthopaedic surgeons in choosing the optimal nail-prosthesis combination for various patient needs.

As expected, the minimum intercondylar distance is a primary constraint in determining nail compatibility. Prostheses with wider minimum intercondylar spaces demonstrated consistent compatibility with a range of nail diameters, while narrower prostheses were compatible only with specialized narrow-diameter nails. This underscores the importance of preoperative planning, as nail-prosthesis mismatches could lead to insertion aperture conflict. Femoral component geometry is critical, and prior compatibility studies show that intercondylar box position and posterior notch depth strongly influence whether a retrograde nail can be passed in line with the canal. Notch position (more posterior) is often more limiting than absolute width.

Driving end diameter and reamer size emerged as additional key factors affecting nail selection. Nails with larger driving ends and reamer requirements, such as those requiring reamers exceeding 12.5 mm, were incompatible with narrower prostheses. This finding is clinically relevant, as surgeons may need to opt for nails with reduced driving end diameters in cases involving prostheses with limited intercondylar distances. Additionally, using nails with appropriate reamer sizes helps to minimize bone removal and maintain the structural integrity of the prosthesis.

Lateral femoral locking plates also play a pivotal role in managing periprosthetic distal femoral fractures and can be used in isolation or in conjunction with retrograde nails. The utilization of nail-plate constructs provides additional stability with dual-philosophy fixation, particularly in cases with complex fracture patterns or suboptimal bone stock [50]. The combination of locking plates with retrograde nails may increase fracture stability [12]. Incorporating lateral femoral locking plates into the surgical strategy offers a valuable adjunct to retrograde nailing, enabling a more comprehensive approach to fixation [51].

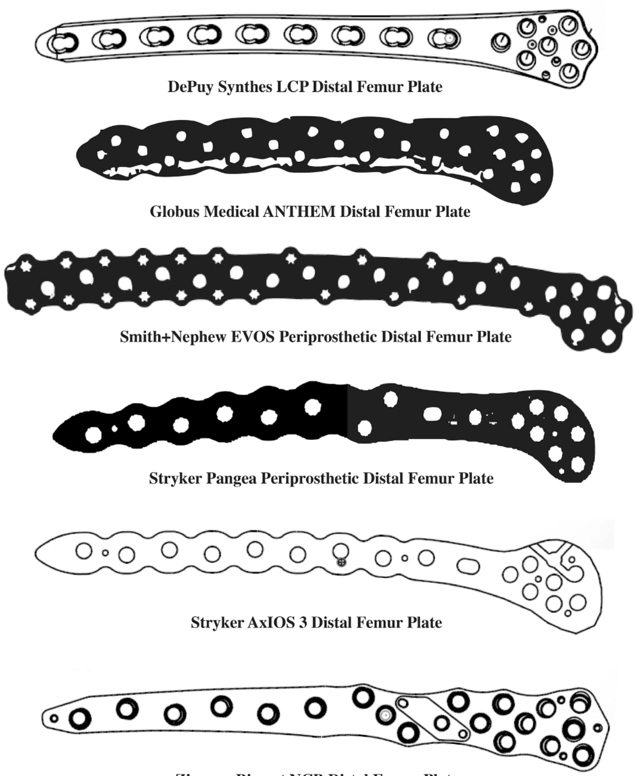

Figure 2. Examples of currently available lateral distal femoral locking plates.

Nails with variable distal locking configurations offer distinct advantages in addressing periprosthetic fractures due to their design features. Specifically, these nails allow for tight clustering of distal screw holes, enabling fixation points to be placed closer to the prosthesis—critical for achieving stable fixation in periprosthetic scenarios. One example includes distal locking holes positioned to maximize screw placement options within the confined space of the distal femur. Additionally, the proximal features of these nails differ importantly; one accommodates auxiliary constructs like a mini side plate, while the another offers compatibility with screw washers, providing added versatility for proximal fixation.

When evaluating nails for periprosthetic fractures, three key considerations emerge: the distance of the distal-most screw hole from the prosthesis stem, the number and planes of screws that can be passed through the proximal body, and any advanced locking features in the proximal configuration. These design elements collectively influence the nail's adaptability to specific fracture geometries and prosthesis designs, making certain nails more suitable for challenging cases. These nails provide increased stability in cases with complex fracture geometries and diverse prosthesis dimensions. Their design, particularly the array and distal placement of screw holes, allows surgeons to achieve fixation even in excessively distal fractures. For example, the placement of tightly clustered distal locking screws ensures that, even if a very distal screw hole is missed, adequate fixation can still be achieved using the remaining options within the construct. Although most surgeons aim to utilize all available distal screws for optimal stability, the overall configuration of screw holes in these nails supports robust fixation even in challenging anatomical or fracture scenarios.

The positioning of the posterior notch also markedly impacts compatibility, as nails must pass through the intercondylar space without anterior obstruction or excessively posterior start points that can culminate in an extension deformity of the fracture with resulting malreduction and malunion of the fracture [52]. Certain prostheses, with posterior notches closer to the anterior edge, facilitated straightforward nail insertion and allowed compatibility with various nail models. Conversely, prostheses with posterior notches positioned further back presented challenges, often requiring nails with specialized entry configurations to avoid impingement. This further underscores the importance of preoperative planning to mitigate these risks and ensure optimal alignment and prosthesis geometry [16]. Furthermore, nails designed to accommodate the posteriorized entry inherent to many TKAs yield much better sagittal alignment and fewer extension (recurvatum) deformities than conventional nails, which is an effect plausibly mediated by improved geometric compatibility [53].

This paper provides practical recommendations based on observed compatibility trends. Some prostheses offer high compatibility with multiple nails due to larger intercondylar spaces and accommodating notch placements, making them flexible options for patients who need various fixation methods. In contrast, prostheses with more restrictive geometries require a more targeted approach, often necessitating nails with smaller diameters and reduced driving ends. By following these compatibility guidelines, surgeons can enhance fixation stability, optimize surgical outcomes, and potentially reduce complications associated with improper nail-prosthesis alignment.

Potential Limitations

Although this review synthesizes a broad array of data, it is limited by the availability of standardized measurements across all prosthesis and nail models. In addition, this paper is a technical review rather than a presentation of new clinical data. Variations in prosthesis design over time may also influence compatibility outcomes. Furthermore, this analysis relied on manufacturer specifications and literature, which may not always account for clinical variability or the nuanced challenges encountered in real-world settings. Additionally, not all data may be publicly available. In cases where compatibility is questionable, surgeons can still use a metal cutting burr to create a custom hole in the prosthesis to facilitate nail insertion. Moreover, this review does not include direct clinical validation, and as implant designs evolve, ongoing updates will be necessary to ensure the accuracy and relevance of the compatibility data presented.

Conclusions

Future papers should consider evaluating these nail-prosthesis combinations in clinical settings to validate compatibility recommendations. Comparative studies focusing on clinical outcomes, such as fixation stability and rates of reoperation, could provide valuable insights into the long-term effectiveness of recommended nail-prosthesis pairs. Additionally, as new prosthesis designs and nail technologies emerge, periodic updates to this guide are essential to maintain its relevance as a practical resource for surgeons. Continued research into the biomechanical outcomes of nail-plate combinations will further refine surgical approaches and improve patient outcomes.

CRediT authorship contribution statement

Alexandra E. Richards: Writing – review & editing, Writing – original draft, Investigation, Data curation. **David G. Deckey:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Matthew K. Stein:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Sean P. Ryan:** Writing – review & editing, Writing – original draft, Supervision, Methodology. **Andrew M. Schwartz:** Writing –

review & editing, Writing – original draft, Supervision, Methodology, Data curation. **Thorsten M. Seyler:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Conceptualization.

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Appendix

Table S1
Expanded Knee Prosthesis Compatibility Details.

Manufacturer	Prosthesis Model	Sizes	Smallest Intercondylar Distance (mm)	Compatible with Retrograde Nail?
Aesculap	Columbus CR/PS	Sizes 1–8	18	Yes
	Vega	Sizes 1–8	20.25	Yes
Arthrex	iBalance CR	Sizes 1–10	18	Yes
	iBalance PS	Sizes 1–10	18	Yes
Restor3d (ConforMIS)	iTotal CR	Custom to patient anatomy	N/A	Varies
	iTotal PS	Custom to patient anatomy	N/A	Varies
Corentec	Exult CR	Sizes 1–13	18	Yes
	Exult PS	Sizes 1–13	16	Yes
	LOSPA	Sizes 3–16	15	Yes
Corin	Apex	Sizes 1–6	14.5	Yes
	Unity	Sizes 1–9	17	Yes
DePuy Synthes	AMK (Anatomic Modular Knee)	Not specified	20	Yes
	Attune CR	Sizes 1–10	14.1	Yes
	Attune PS	Sizes 1–10	14.1	Yes
	LCS	Small to Large+	13.7	Yes
	LCS Complete	Small to Large+	13.7	Yes
	PFC (Press Fit Condylar)	Not specified	20	Yes
	Sigma CR	Sizes 1.5–6	17.4	Yes
	Sigma PS	Sizes 1.5–6, and 4N	11.7	Yes[a]
	Total Condylar 1	Not specified	15	No
	Total Condylar 2	Not specified	18	No
Enovis	Empowr CR/3D	Sizes 2–11	16	Yes
	Empowr PS	Sizes 2–11	14.5	Yes
	Foundation	Sizes 2–12	12	Yes
	(Lima) Physica	Sizes 1–10	17	Yes
Exactech	Optetrak	Sizes 0–6	15.3	Yes
	Optetrak Logic	Sizes 0–6	15.3	Yes
	Truliant CR	Sizes 0–6	15.3	Yes
	Truliant PS	Sizes 0-6	15.3	Yes
Link	Gemini SL CR	X-Small-X-Large	15	Yes
	Gemini SL PS	X-Small-X-Large	15	Yes
	LSK CR	Sizes 0-10	14.5	Yes
	LSK PS	Sizes 0-10	17.5	Yes
Maxx	Freedom CR	Sizes 1-8	19.5	Yes
	Freedom PS	Sizes 1-8	17.8	Yes
Medacta	GMK Sphere	Sizes 1–7	20	Yes
	GMK PS	Sizes 1–7	20	Yes
MicroPort	Advance	Sizes 1–6	18	Yes
	ADVANTIM CR	Not specified	20	Yes
	ADVANTIM PS Open	Not specified	15.9	Yes
	Evolution Medial Pivot	Sizes 1–8	16	Yes
Ortho development	Balanced Knee System (BKS)	Sizes 1–7	16	Yes
Smith + Nephew	Genesis I CR	Sizes 1-8	20	Yes
	Genesis I PS	Sizes 1-8	17.8	Yes
	Genesis II CR	Sizes 1–9	16.5	Yes
	Genesis II PS	Sizes 1–9	16.5	Yes
	Journey II BCS	Sizes 1–10	14.5	Yes
	Journey II CR/XR	Sizes 1–10	19	Yes
	Legion CR	Sizes 1–8	16.5	Yes
	Legion PS	Sizes 1–8	16.5	Yes
	Profix CR	Sizes 1-7	22	Yes
	Profix PS	Sizes 1-7	14.6	Yes[b]
Stryker	DURACON	X-Small-X-Large	18.5	Yes
	Kinemax CR	Small-Large	14	Yes
	Kinemax PS	Small-Large	Closed box	No
	Omnifit	Not specified	25	Yes
	PCA	Not specified	18.5	Yes
	Scorpio	Not specified	16.5	Yes
	Scorpio NRG	Not specified	16.5	Yes
	Triathlon CR	Sizes 1–8	16.15	Yes
	Triathlon PS	Sizes 1–8	16.15	Yes
Total Joint Orthopedics	Klassic CR	Sizes 1–7	22.5	Yes
	Klassic PS	Sizes 1–7	17.9	Yes
United Orthopedics	U2	Sizes 1–7	18	Yes
Zimmer Biomet	AGC CR	Sizes 55–80	18	Yes
	AGC PS	Sizes 55–80	18	Yes
	Insall-Burstein I	Sizes 54-74	16	Yes

(*continued on next page*)

Table S1 (*continued*)

Manufacturer	Prosthesis Model	Sizes	Smallest Intercondylar Distance (mm)	Compatible with Retrograde Nail?
	IBII CR	Sizes 54-74	15.3	Yes
	IBII PS	Sizes 54-74	Closed Box	No
	Maxim CR	Sizes 55–80	21	Yes
	Maxim PS	Sizes 55–80	21	Yes
	Miller-Galante I	N/a	Closed Box	No
	Miller-Galante II	Reg-large++	12.5	Yes
	Natural Knee II	Size 00–5	14	Yes
	NexGen CR	Sizes A–H	11.9	Yes
	NexGen PS	Sizes A–H	13.7	Yes
	Persona CR	Sizes 1–12	14.1	Yes
	Persona PS	Sizes 1–12	14.1	Yes
	Vanguard CR	Sizes 55–80	16.26	Yes
	Vanguard PS	Sizes 55–80	16.26	Yes

AGC, anatomic graduated component; CR, cruciate retaining; IB, Insall-Burstein; GMK, Global Medacta Knee; LCS, low contact stress; LSK, LinkSymphoKnee; N/a, not available; IM, intramedullary; NRG, nonrestrictive geometry; PS, posterior stability; Reg, regular.

[a] DePuy Synthes Sigma PS have a 11.7 × 12.7 mm polyethylene plug that can be removed and safely nailed, but actual intercondylar width is 17.8 mm—metal cutting burr can be used to enlarge the opening.

[b] Although the intercondylar distance is 22 mm, a smaller IM nail may be required due to the posterior extension of the notch.