Aesculap® Columbus® Rationale

Aesculap Orthopaedics

B|BRAUN
SHARING EXPERTISE

Contents

List of key words

List of abbreviations

A	Anterior
AS	Advanced Surface
CR	Cruciate Retaining
CRA	Cruciate Retaining Augmentation
PSA	Posterior Stabilized Augmentation
DD	Deep Dish
F	Fix
HC	High Constraint
HXLPE	Highly Cross-Linked Polyethylene
PCL	Posterior Cruciate Ligament
KSS-F	Knee Society Score – Function
KSS-K	Knee Society Score – Clinical
L	Lateral
M	Medial
MC	Medium Constraint
MIOS®	Minimally Invasive Orthopedic Solutions
N	Narrow
OXF	Oxford-Score
P	Posterior
PE	Polyethylene
PS	Posterior Stabilized
RP	Rotating Platform
UC	Ultra Congruent
UCR	Ultra Congruent Rotating
UHMWPE	Ultra High Molecular Weight Polyethylene

One world – One knee

1. Introduction

Although revision rates in knee replacement procedures have been continuously decreasing over recent years, there has been little improvement in patient satisfaction, with the number of dissatisfied patients following knee arthroplasty remaining at around 14 %.[1] The main complications following knee replacement surgery include unnatural tibiofemoral kinematics, an abnormal patellar motion, polyethylene abrasion and a limited degree of flexion.[2, 3, 4] The Columbus® knee prosthesis was developed to resolve exactly these problems with its advanced implant design and versatile options in the selection of implants and instruments, and to provide a good surgical outcome for both the patient and surgeon.

Columbus® knee prosthesis

Superior design features of the Columbus®:

- Natural kinematics
- Excellent abrasion rate
- High bending capability
- Outstanding patellar motion

2. The Columbus® Portfolio

Variety – Discover individuality

2.1 Overview

The Columbus® Knee System offers a suitable solution for nearly all patient needs. The choice is yours: The combinability of Columbus® allows an intraoperative change from a PCL-retaining (CR DD, RP) treatment to a PCL-sacrificing (UC, UCR, PS) treatment. The implant options vary with regard to the degree of guidance and stabilization, and they therefore enable the appropriate treatment of nearly all conditions of the ligaments. Minor defects can be treated in the primary region with tibial plates, tibial extension stems and gliding surfaces up to 20 mm in height. For severe bone defects and unstable ligament conditions, the Columbus® Revision System provides extensive treatment options.

Discover Compatibility

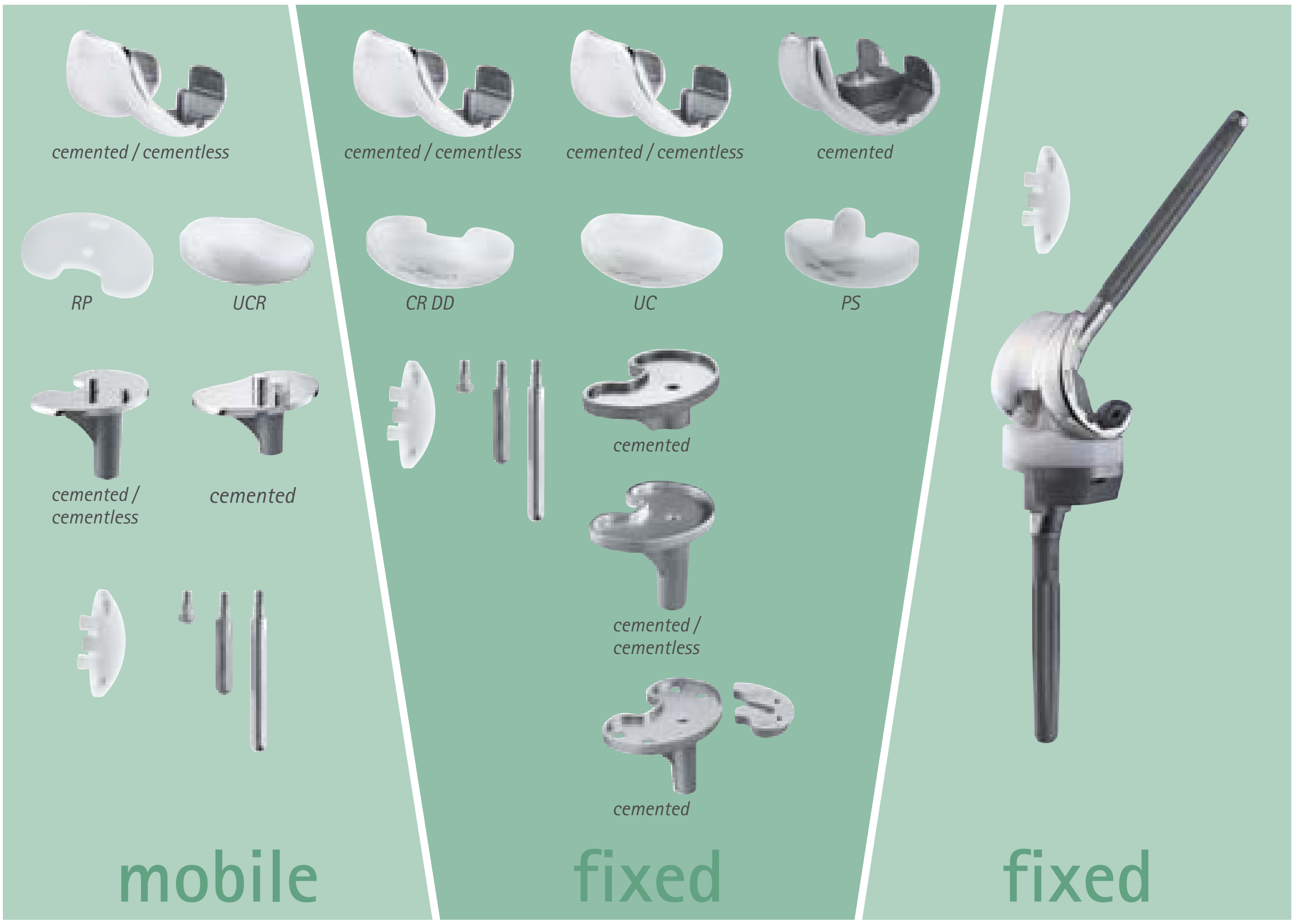


Figure 1: Columbus® product overview

2.1.1 PCL-retaining fixed gliding surface Columbus® CR DD

Thanks to its high stability, the PCL-retaining, fixed gliding surface CR DD is also suitable for difficult ligament conditions, such as a ruptured PCL, and at the same time offers natural kinematics.[5] The CR DD design is characterized by a deep concavity in the sagittal plane, enabling a high level of congruence to be achieved between the femoral components and the gliding surface. Stability is therefore increased particularly in the AP direction compared with the flatter gliding surface, without restricting bending capability.

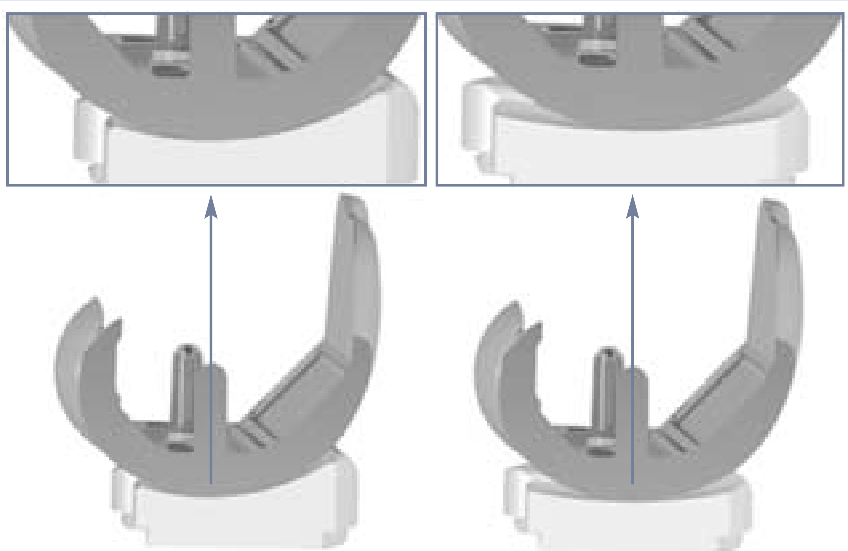


Figure 2: Sagittal section of the Columbus® CR DD meniscus components compared with the flatter CR meniscus design.

2.1.2 PCL-retaining rotating gliding surface Columbus® RP

The Columbus® RP variant allows a physiological rotational movement with a rotational freedom of +/- 10°. An optimum tibial coverage can also be achieved more easily. The RP design has been in successful use since 2002, offering high protection against luxation and an almost natural sequence of movements in the joint.

Figure 3: Columbus® RP gliding surface with tibial plateau.

2. The Columbus® Portfolio

Variety – Discover individuality

2.1.3 PCL-sacrificing fixed gliding surface Columbus® PS

In the event of PCL insufficiency, the Columbus® PS prosthesis takes on the role of the PCL and assures a dorsal rollback through its post-cam mechanism. With the Columbus® PS knee prosthesis, the "Jumping Distance" (JP) continuously increases with increasing flexion, enabling the increased risk of luxation with large flexion angles to be avoided.[6]

JP	30°	60°	90°	120°
F1	13.7	15.2	15.1	15.2
F2	12.8	14.4	14.4	14.4
F3	11.9	13.5	13.7	13.5
F4	11.2	13	13.4	13.1
F5	9.5	12.3	12.9	12.1
F6	8.6	11.7	12.7	11.9
F7	7.9	11.2	12.4	11.7

Figure 4: Jumping Distance of the Columbus® PS prosthesis in mm.

The limited translational and rotational possibilities increase with the size of the femur, allowing freedom of movement to be adapted to the anatomical conditions.

Columbus® PS	Translation AP in mm	Translation ML in mm	Rotation Int. / Ext.
F1	5.8 mm	± 1 mm	± 10°
F2	5.9 mm	± 1.25 mm	± 10°
F3	6 mm	± 1.75 mm	± 12°
F4	6.1 mm	± 1.75 mm	± 12°
F5	6.2 mm	± 2 mm	± 14°
F6	6.2 mm	± 2.5 mm	± 16°
F7	6.3 mm	± 3.5 mm	± 20°
F8	6.5 mm	± 3.5 mm	± 20°

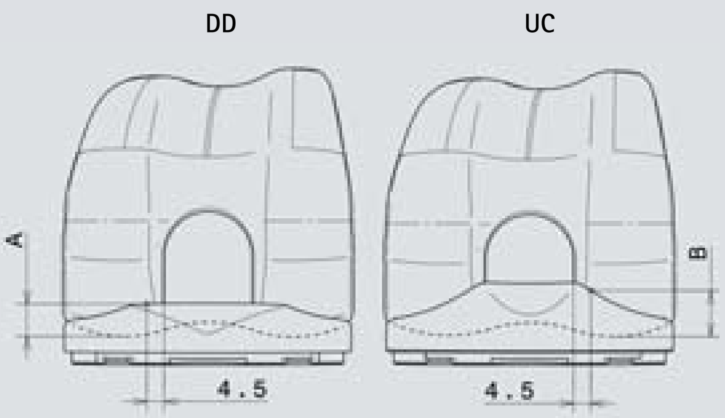
Translational and rotational freedoms of the Columbus® PS prosthesis.

2.1.4 PCL-sacrificing fixed gliding surface Columbus® UC

Treatment with the PCL-sacrificing Columbus® UC is easier on the bone than the PS variant, as no femoral box needs to be prepared for a post-cam mechanism.
The ventrally elevated edge also offers high stability in the AP direction when resecting the PCL.[7]

Benefits of the Columbus® UC:

- Additional option for cruciate ligament treatment.
- Bone sparing, as no bone needs to be removed for the PS box.
- Time saving, as there is no PS box preparation.
- High AP stability due to the ventrally elevated edge.
- Low risk of patellar impingement due to the ventrally flattened meniscus design.
- The decision regarding which Columbus® UC variant to use does not have to be made until after the final implantation of the metal components.



Jumping Distance

	T1	T2	T3	T4	T5
A	7.6	8	8.7	9.2	10.2
B	11.7	11.6	12.1	12	12.8

Figure 5: Jumping Distance of the Columbus® UC gliding surface compared with the Columbus® DD gliding surface in mm.

Columbus® UC gliding surface

2. The Columbus® Portfolio

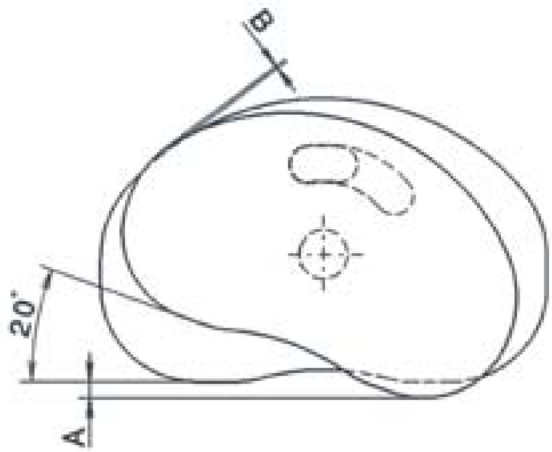
Variety – Discover individuality

2.1.5 PCL-sacrificing rotating gliding surface Columbus® UCR

The Columbus® UCR knee prosthesis enables a rotating gliding surface to be used for PCL resections:

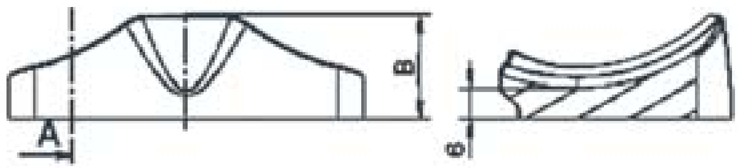
- Rotational freedom of +/- 20° provides great tibial coverage.
- The tibial overhang does not cause any adverse impingement due to the limited rotational freedom and a bevel of the gliding surface in the dorsal region (Fig. 6).
- The tibial implant stem length has been standardized at 28 mm for all tibia sizes.
- The rounded rotation stop ensures high stability.
- The ventral elevation of the PE components leads to high AP stability (Fig. 7).
- Elevated contact surfaces reduce the abrasion rate to under 1 mg per million cycles.
- An additional instrument set provides easy instrumentation.

Columbus® UCR



	20° Rotation		
Size	A (mm)	B (mm)	Surface (mm^2)
T5 (Worst Case)	3.6	0.8	75

Figure 6: Tibial overhang of the Columbus® UCR prosthesis in the worst case.



Size	T0	T1	T2	T3	T4	T5
B	18.8 mm	19.3 mm	19.7 mm	20.1 mm	20.5 mm	20.9 mm

Figure 7: Height of the ventral edge of a Columbus® UCR gliding surface with a height of 10 mm.

As all sizes are compatible for PCL-retaining treatments, the respective appropriate sizes of the prostheses can be used for both the femur and tibia.
For PCL-sacrificing prostheses, combinations of sizes are possible, but are more limited.

Recommended: minimum abrasion, highest stability, best kinematics

Possible: slightly increased abrasion, high stability and good kinematics

To be avoided: increased abrasion, low stability

Compatibility
FEMUR PS / PE PS
FEMUR CR / PE UC
FEMUR CR / PE UCR

Sizes	F1	F2 F2N	F3 F3N	F4 F4N	F5 F5N	F6 F6N	F7 F7N	F8 F8N
T0/T0+	Recommended	Recommended	Recommended	Possible	To be avoided	To be avoided	To be avoided	To be avoided
T1/T1+	Possible	Recommended	Recommended	Recommended	Possible	To be avoided	To be avoided	To be avoided
T2/T2+	To be avoided	Possible	Recommended	Recommended	Recommended	Possible	To be avoided	To be avoided
T3/T3+	To be avoided	To be avoided	Possible	Recommended	Recommended	Recommended	Possible	To be avoided
T4/T4+	To be avoided	To be avoided	To be avoided	Possible	Recommended	Recommended	Recommended	Possible
T5	To be avoided	To be avoided	To be avoided	To be avoided	Possible	Recommended	Recommended	Recommended

Compatibility
FEMUR Revision / PE HC or MC

Sizes	F1	F2	F3	F4	F5	F6	F7
T0/T0+	Recommended	Recommended	Recommended	Possible	Possible	Possible	Possible
T1/T1+	Recommended	Recommended	Recommended	Recommended	Possible	Possible	Possible
T2/T2+	To be avoided	Recommended	Recommended	Recommended	Recommended	Possible	Possible
T3/T3+	To be avoided	To be avoided	Recommended	Recommended	Recommended	Recommended	Possible
T4/T4+	To be avoided	To be avoided	Possible	Recommended	Recommended	Recommended	Recommended
T5	To be avoided	To be avoided	Possible	Possible	Recommended	Recommended	Recommended

Figure 8: Compatibility of the PCL-sacrificing Columbus® prostheses.

2. The Columbus® Portfolio

Variety – Discover individuality

2.1.6 Patella

There are four different sizes available for replacement for the posterior surface of the patella, which can be combined with any femur size. The radius of the patella corresponds with the radius of the trochlea for all sizes.
Therefore, despite the possibility of combining all sizes with each other, there is always an optimum contact surface between the trochlea and patella. The thickness of the replacement for the posterior surface of the patella increases by 1 mm for each increasing size. The three fixation pins ensure a rotationally stable fixation and their conical form is also more sparing on the bone than a central pin.

Columbus® Patella

2.1.7 Tibia augment and extension stems

For the treatment of small tibial defects, augment at a height of 4 and 8 mm are also available as part of primary treatment. Additional stability of the tibial implant can also be achieved using the extension stems.

Columbus® augments and extension stems

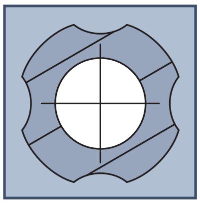
2.1.8 Columbus® Revision

Severe bone defects can be compensated with the Columbus® Revision prosthesis with wedges up to 15 mm. For unstable ligament conditions, the system offers gliding surfaces in a "Medium Constraint" and "High Constraint" design to support the implant. The limited ML translation and increased varus / valgus rotational stability provides good bending capability with a lower risk of luxation. The tibial and femoral offset stems, which are available in various lengths and diameters as cementless 5° / 7° and cemented 6°, provide appropriate support for the patient in the medullary cavity.

Columbus® Revision

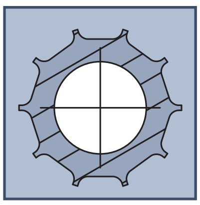
Tibial offset possibilities ML +/- 6 mm.

Femoral offset possibilities ML +/- 2 mm and AP up to +/- 4 mm.



4 Longitudinal grooves to prevent the risk of embolism

Cemented stem



10 Longitudinal grooves for a secure fixation in the medullary cavity (Wagner profile)

Cementless stem

Figure 9: Stem options of the Columbus® Revision System.

2. The Columbus® Portfolio

Variety – Discover individuality

2.2 Implant sizes

A comparison of the Columbus® femoral components with the femur sizes measured in the study by Yoshioka et al. indicates virtually complete coverage of all anatomical data.[8] With 13 femur sizes (8 standard sizes and 5 narrow sizes), the Columbus® Knee System provides good coverage for both the female and male morphotypes.[9]

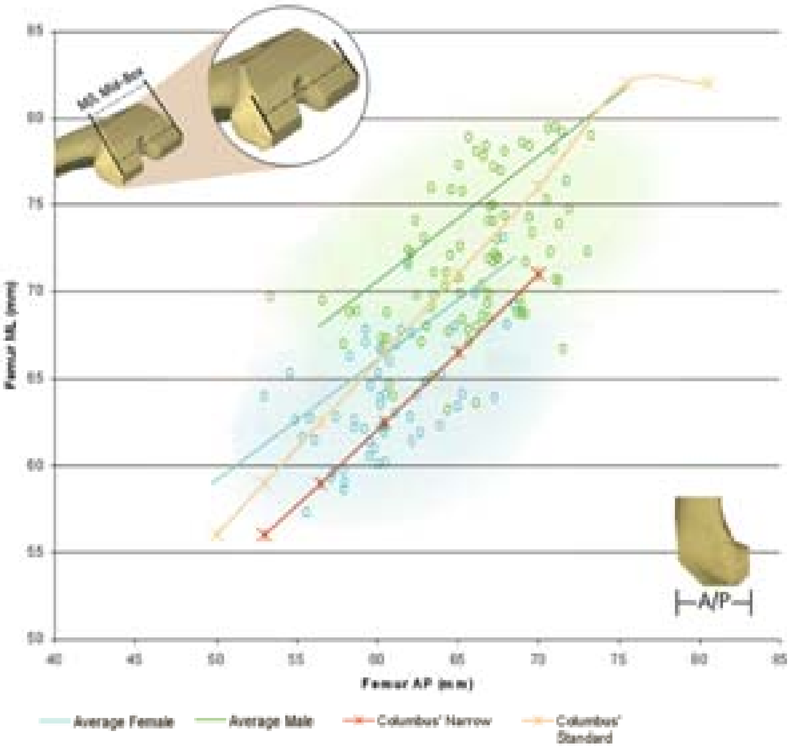
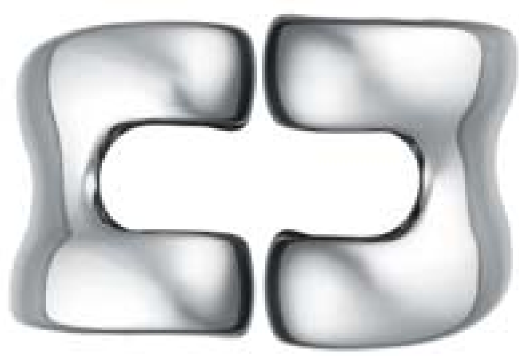


Figure 10: AP / ML ratio shown according to female and male morphotypes.

In ML, the narrow sizes "N" are one size smaller than the standard sizes.



	ML dimensions						
AP dimensions	F1	F2	F3	F4	F5	F6	F7
F1	F1						
F2	F2N	F2					
F3		F3N	F3				
F4			F4N	F4			
F5				F5N	F5		
F6					F6N	F6	
F7							F7
F8							F8

Figure 11: ML dimensions of Columbus® Femur Standard and in narrower "N" sizes.

Good tibial coverage is achieved by selecting a total of 9 symmetrical tibia sizes (5 standard sizes and 4 plus sizes).[9]

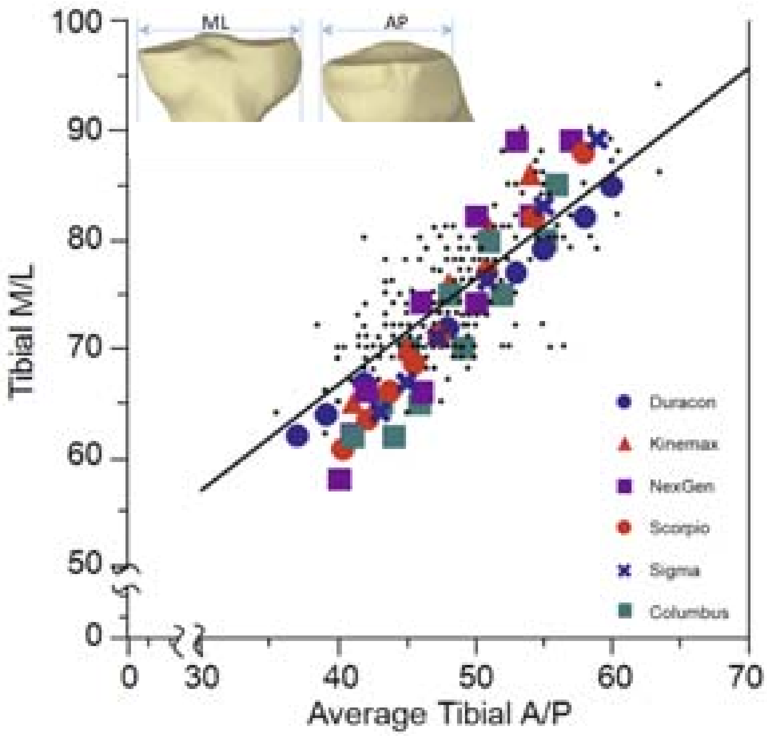
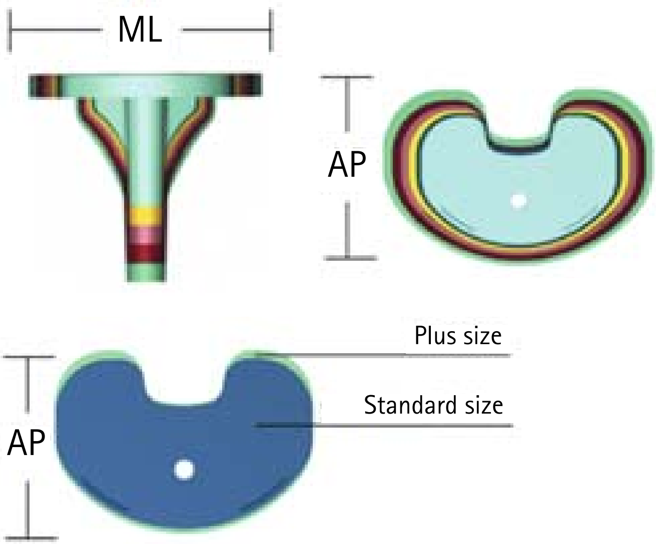


Figure 12: Tibial AP / ML ratio of 337 knees versus tibial AP / ML ratio of various implant systems.[9]

In AP the tibial plus sizes are 3-4 mm bigger than the standard sizes.



3. The Columbus® Design

Mobility – Discover stability

3.1 Patellofemoral kinematics

The multiple femoral radii imitate the anatomy of the human knee and ensure homogeneous extension and flexion. Tension peaks are avoided both in the patella and in the gliding surface.[12, 13]

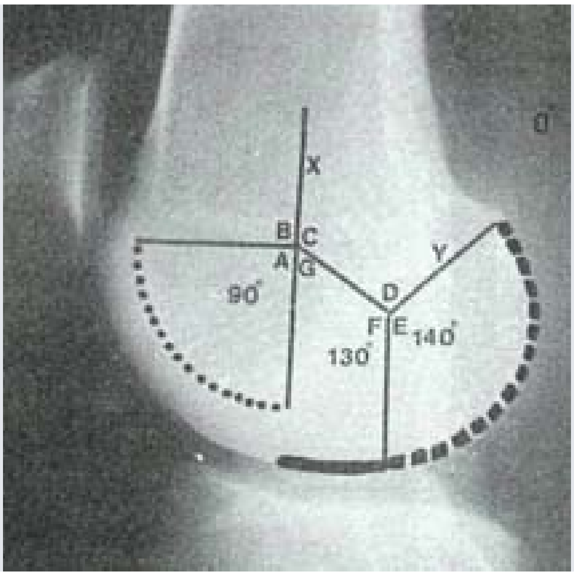


Figure 13: Anatomy and geometry of the distal femur.[13]

The Columbus® femur prosthesis has the following design features:

- The anterior 3° tapering of the femoral shield reduces the risk of anterior notching and increases the contact pressure of the implant on the bone.
- The patella radius (Rz) enables a constant patellar pressure up to 110° flexion and results in an anatomical patellar motion.[13, 14]
- The transition radius (Ry) creates a round sagittal femoral design, helping to avoid tension in the retinaculum and patellar ligament.
- The small dorsal femoral radius (Rx) and the short posterior condyles enable high flexion up to 140°.
- Due to the rounder Columbus® femoral design, an equal collateral ligament tension is achieved in flexion and extension. Tension peaks in the PE can therefore be avoided.

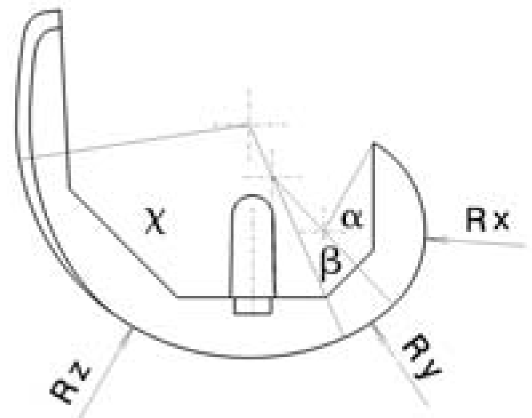


Figure 14: Sagittal profile of the Columbus® femur prothesis.

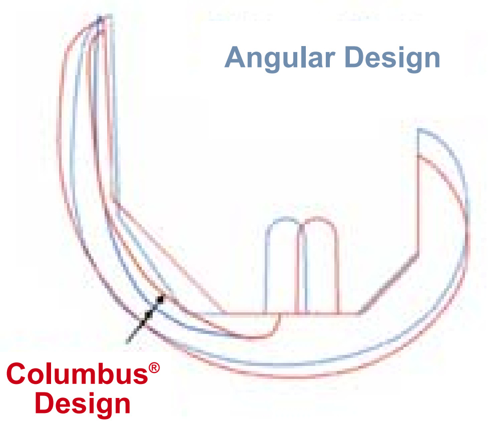


Figure 15: Columbus® femoral design compared with a more angular femoral design.

- The extended trochlear motion enables a surface contact between the femur and patella up to 110° flexion and therefore reduces stresses in the PE caused by point contacts.

Figure 16: Surface contact between the patella and femur up to a flexion angle of 110°.

- The retropositioned trochlea helps prevent too much patellar pressure.

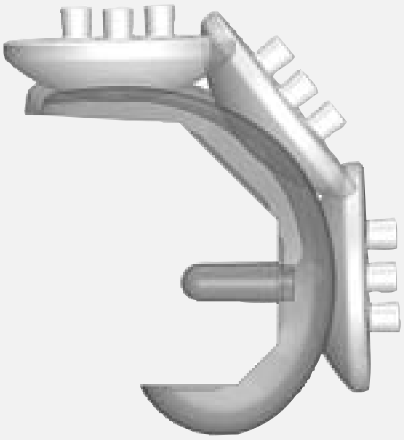


Figure 17: Retropositioning of the patella.

- The elevated antero-lateral femoral design helps prevent subluxation of the patella, including in the early flexion stage.[15]

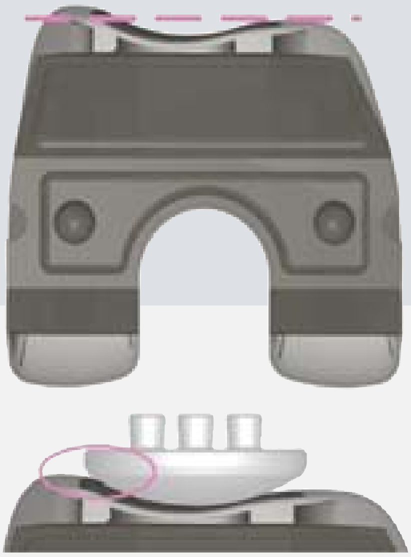


Figure 18: Elevated antero-lateral femoral design.

- According to Eckhoff, the trochlea with an anatomical valgus of 7° permits optimum patellar motion and load relief for the knee extensors.[16]

Figure 19: Anatomical valgus of 7° in the Columbus® trochlea.

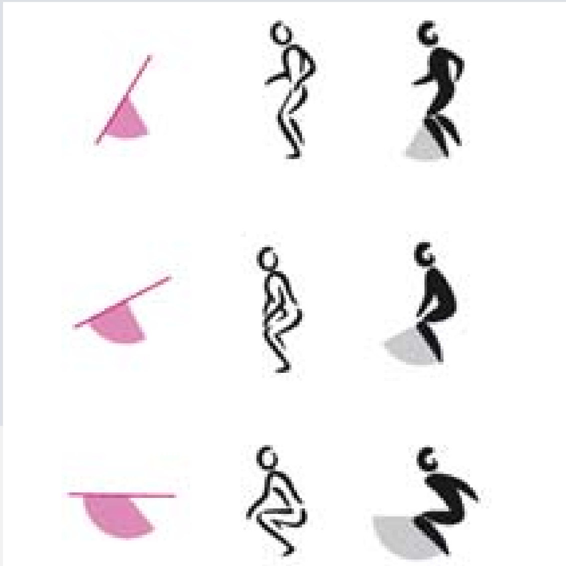
3. The Columbus® Design

Mobility – Discover stability

3.2 Tibiofemoral kinematics

The posterior slope of 3° built into all gliding surfaces facilitates deep flexion and prevents the increase of anterior micro-movements. Bai shows that this helps further reduce tension in the PE.[17]
With the anatomical slope in the gliding surface, the tibial resection can be carried out with 0° slope. This considerably reduces the shearing forces between the implant and bone.

Figure 20: Posterior slope of 3° in the Columbus® gliding surface.



Columbus® Design	RP	CR DD	UC	PS	Revision MC / HC
Theoretical maximum overextension	10°	10°	10°	5°	4°
Theoretical maximum flexion	140°	140°	140°	135°	130°

Figure 21: Maximum flexion angle of the Columbus® prosthesis.

3.3 Abrasion

The highly congruent degisn of Columbus® increases the contact surface between the femur and PE, helping to avoid peak stresses in the polyethylene, which are responsible for delamination and early implant failure.[20, 21, 22]

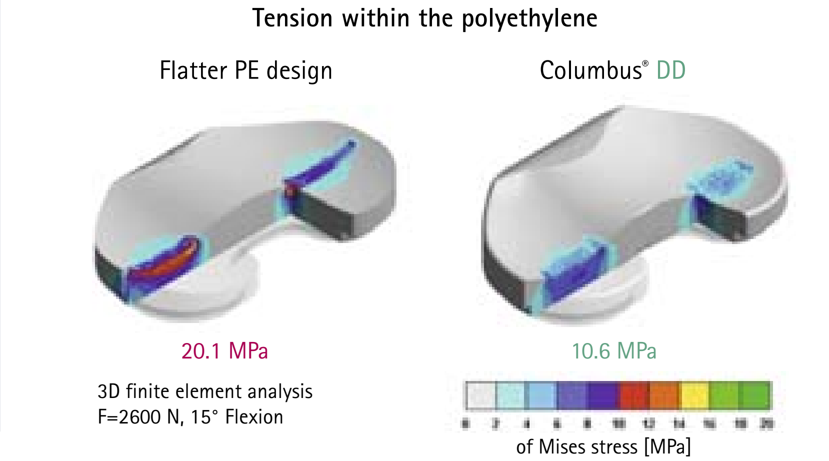
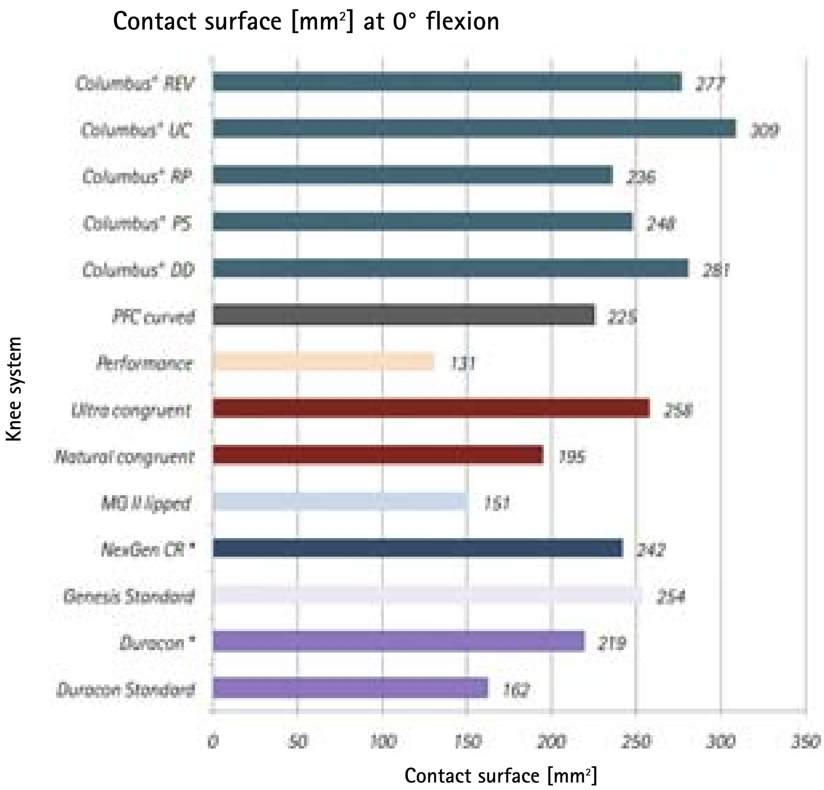


Figure 22: Tension and delamination risk in flat PE designs compared with the Columbus® DD PE Design.[26]



Note: All knee systems marked with * are not fully comparable, as the tests were carried out with a lesser force.

Figure 23: Contact surface of various knee implant systems.[18, 19]

3. The Columbus® Design

Mobility – Discover stability

Bartel et al show that there should be high congruence between the femur and PE above all in the medio-lateral direction to prevent high contact tension.[23]

Figure 24: Optimized congruence between the femur and PE shown in the frontal plane.

The radii of all Columbus® femur and meniscus components are identical in the frontal plane for all implant sizes to maintain congruence, even when femur and PE components of different sizes are combined with each other.

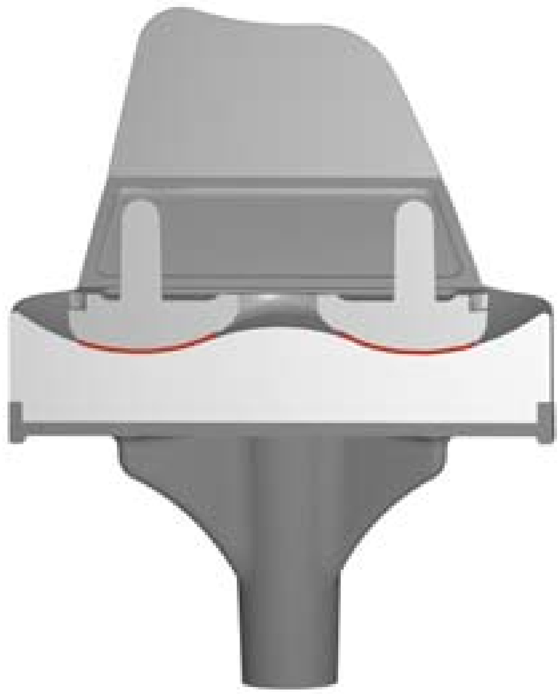


Figure 25: Small femoral components combined with larger tibial components shown in the frontal plane.

The reduced abrasion rate of the Columbus® knee prostheses, of up to less than 1 mg / million cycles, reduces the risk of osteolysis, and therefore the implant loosening rate.[24, 25]

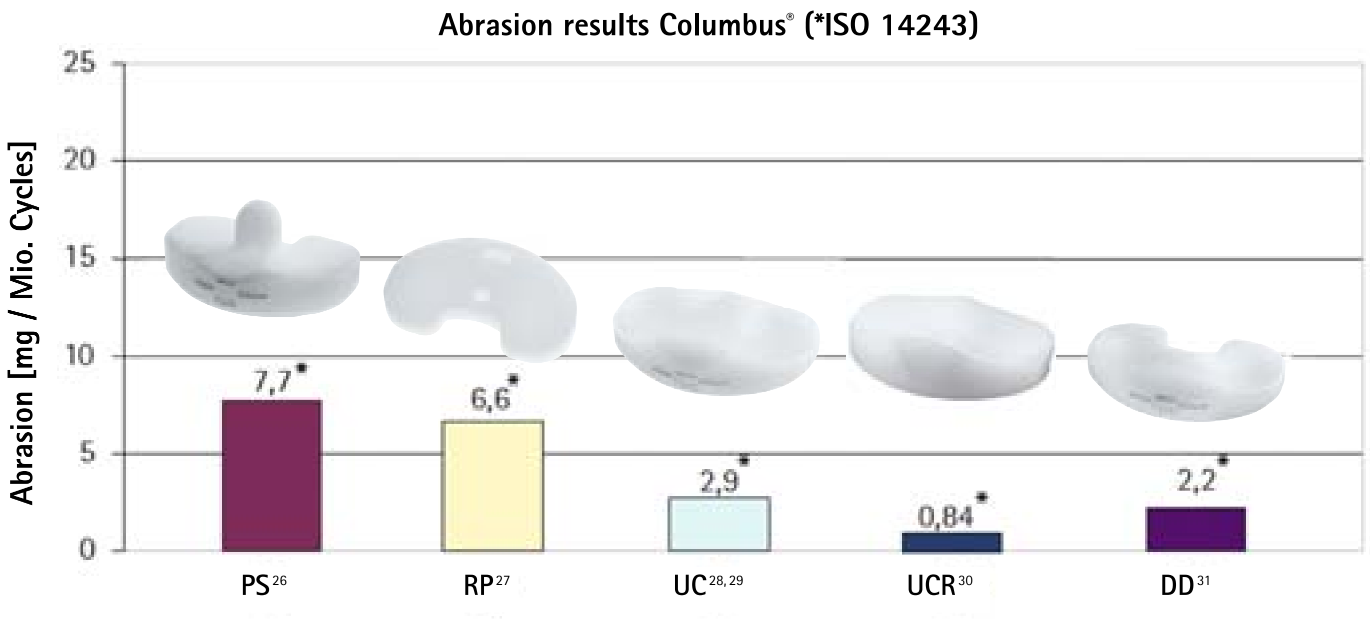


Figure 26: Abrasion rate of the Columbus® knee implant systems according to ISO Standard 14243.[26 - 31]

Note:
All results marked with * were carried out with ISO 14243.

3. The Columbus® Design

Mobility – Discover stability

3.4 Kinematic gait analysis

The gait cycle analysis according to ISO 14243-1 shows that, despite being highly stable, Columbus® enables natural kinematics to high extent. The AP force and internal / external torque represent the natural force effect during a gait cycle in a healthy knee. It has been established for all Columbus® implant variants that the AP force during the stance phase (0 to 0.5 seconds) barely leads to an AP shift. The high congruence of the prostheses at low flexion angles results in the AP force being largely absorbed by the prostheses, in addition to a reduction of contact tension.
In the swing phase (0.5 to 1 seconds), all design variants show a translation in the direction of the force being applied.
The reason for this is the reduced congruence at higher flexion angles, due to the reduced dorsal femoral radii and the reduced compression, as no more body weight is being applied. Likewise, the internal / external rotation follows in the direction of the torque. Here too, the maximum movement can be seen in the swing phase. The Columbus® prosthesis is therefore characterized by high stability in the stance phase and mobility in the swing phase. The motion of the prosthesis allows, among other things, a lower transfer of the forces occurring to the bony implant bed, thereby reducing the risk of early loosening of the implant. The reduced range of motion of Columbus® RP through DD, UC to PS can be explained by the increasing stabilization of the prosthesis designs. Columbus® UC and PS show less mobility in AP and therefore higher stability, enabling the implants to be inserted without PCL.

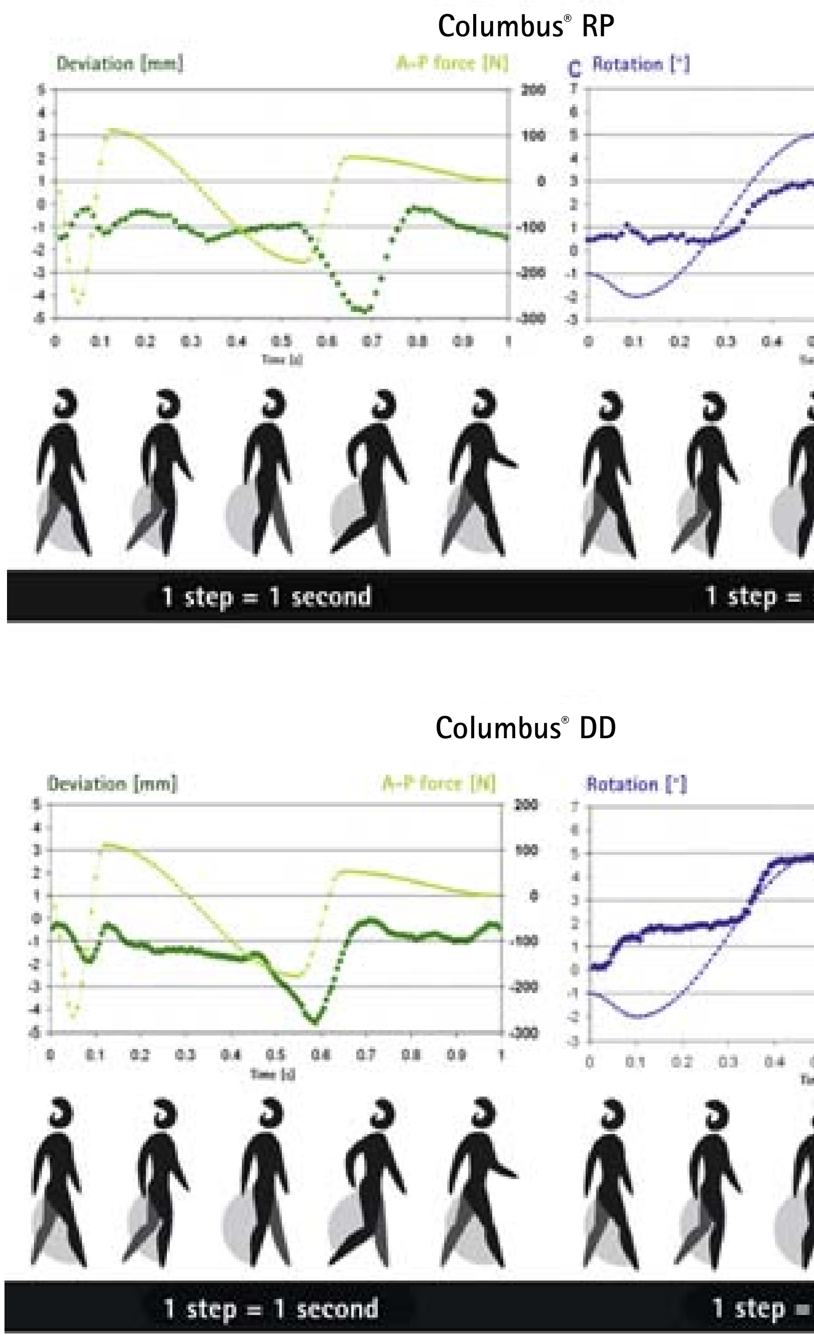
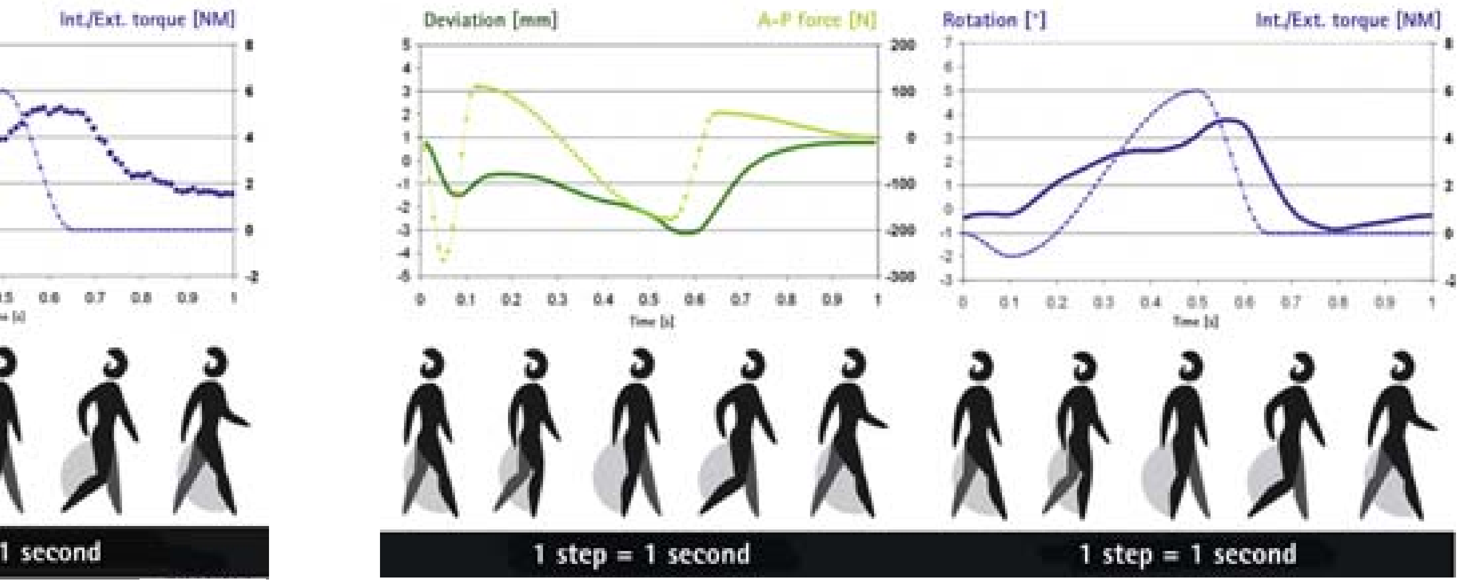
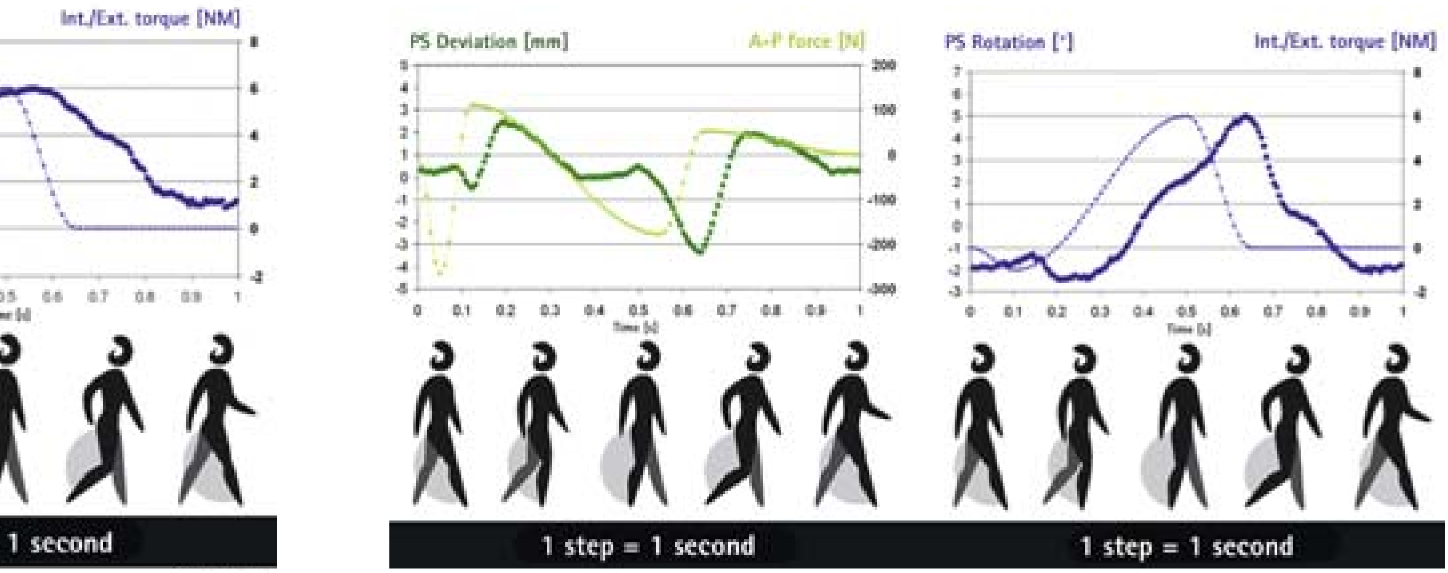


Figure 27: Kinematic behavior of the Columbus® design variants in the knee wear simulator according to ISO Standard 14243.[32]

Columbus® UC



Columbus® PS



Natural kinematics ➛	The motion of the Columbus® prothesis follows the natural force effect.
Good stability ➛	Deviations of the Columbus® prosthesis are limited.

3. The Columbus® Design

Mobility – Discover stability

3.5 Stability

The high congruence between the femur and gliding surface provides high stability. Laboratory tests show that the Columbus® knee prosthesis withstands stronger stresses than the maximum forces that generally occur in a healthy knee. The risk of subluxation is therefore extremely low with the Columbus® knee prosthesis. The lower stability with regard to torque is explained by the test only being performed in a healthy knee with collateral ligaments. In the test set-up, the function of the collateral ligaments cannot be represented.

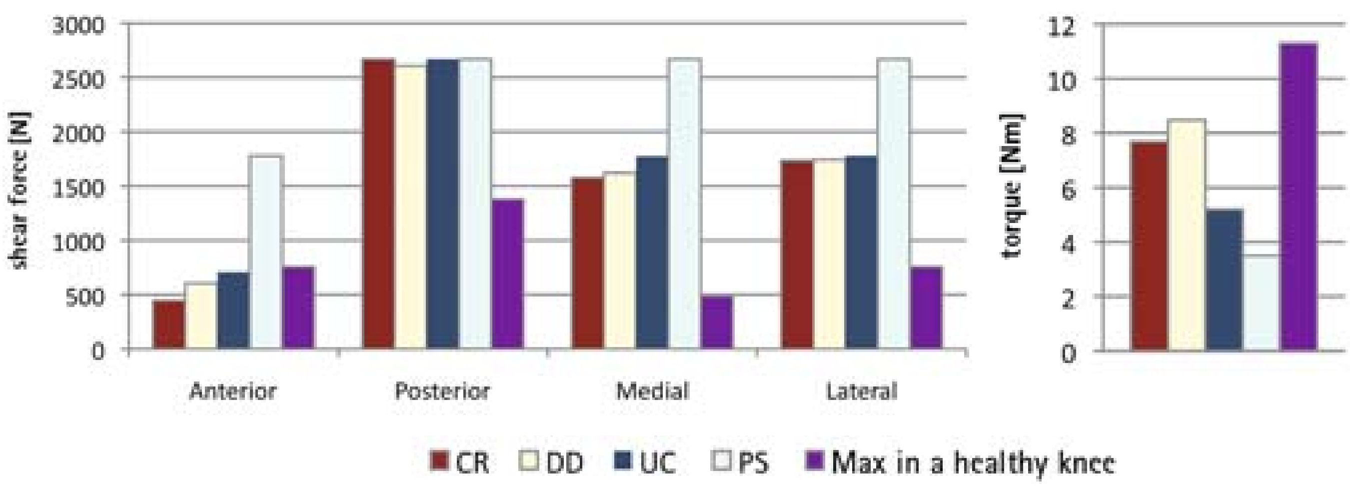


Figure 28: Stability of the Columbus® knee prosthesis. [33 - 37]

The corresponding gliding surfaces click into the tibial plateaus for the fixed gliding surfaces of Columbus® with a click mechanism and are thereby fixated to the tibial plateau at four fixation points. The PS gliding surfaces are additionally secured with a screw. The fixation of the tibial components has been successfully used for almost three decades, so the risk of subluxation of the gliding surface can be described as extremely unlikely.

Figure 29: Fixation of the fixed variants of the Columbus® tibial plateaus.

Figure 30: Additional securing of the Columbus® PS gliding surfaces with a screw.

Due to the slim wing design, only a small amount of tibial bone needs to be removed for the tibial wing preparation, and the width of the wing provides high rotational stability at the same time.

Figure 31: Design of the Columbus® tibial plateau.

4. Selected materials

Tried and tested – Discover Innovations

4.1 Surface properties

Due to improved surface finishing, the Columbus® knee prostheses achieve an optimum surface quality both for the articulating part of the femoral components and for the PE components.
The abrasion rate can therefore be reduced, particularly in the early post-operative phase as the bedding-in phase of the knee prostheses is significantly reduced.[38, 39] The surface quality of the fixed tibial plateaus has also been optimized to avoid micro-movements between the tibial plateau and the meniscus components. Wear of the PE on the underside of the meniscus components (backside wear) is therefore minimized.

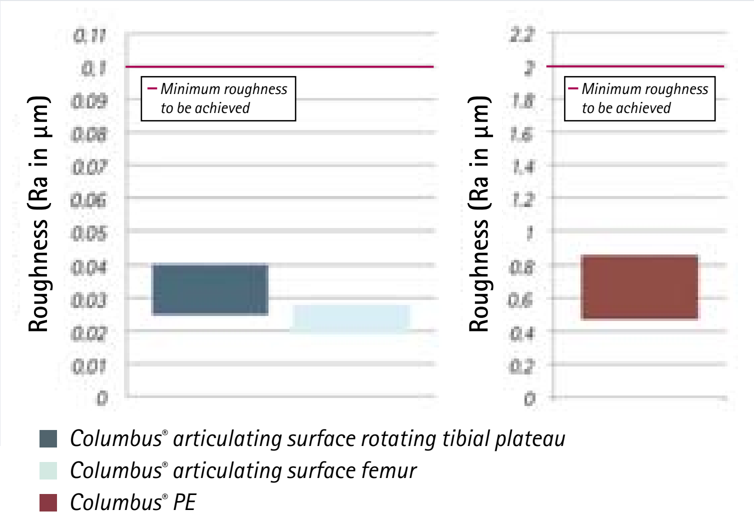


Figure 32: Analysis of the surface finish for the Columbus® knee prosthesis according to ISO 7207-2, ASTM F2083.[40, 41]

4.2 Plasmapore® cementless fixation

The cementless implants are available with the established Plasmapore® coating, which has been in widespread use since 1986. The coating is made of pure titanium and is therefore particularly well tolerated. The pore sizes of the Plasmapore® layer are between 50 and 200 µm, which has a positive effect on the growth of the bone tissue.[42, 43] The very rough Plasmapore® structure primarily supports the fixation of the implants and thereby creates a durable connection between the bone and implant.[44]

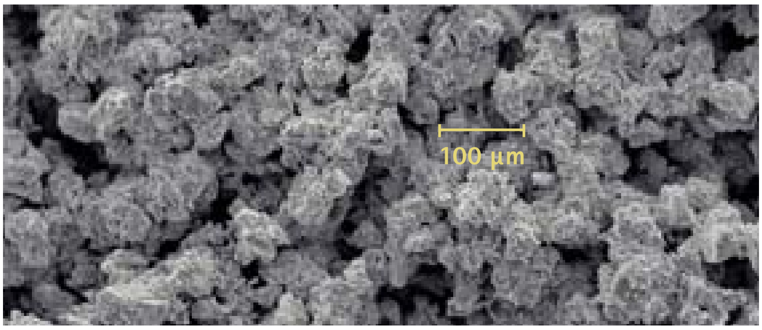


Figure 33: Microporous Plasmapore® surface.

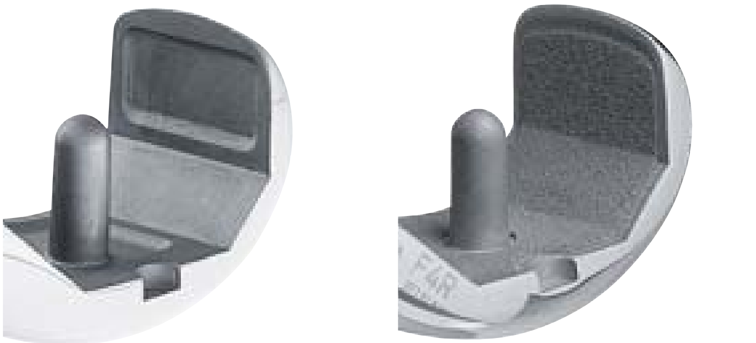


Figure 34: Columbus® femoral components with cement pocket and Plasmapore® coating.

4.3 Beta polyethylene

The Columbus® gliding surfaces are manufactured from high-quality Ultra-High-Molecular-Weight Polyethylene (UHMWPE). As defined in ISO 5834-2, the polyethylene is compression molded under low heat. To prevent the risk of oxidation, the implant is packaged in an inert gas atmosphere in the absence of oxygen. Aesculap is convinced of the benefits of moderately cross-linked beta PE and is therefore committed to its use. The gentle beta sterilization procedure considerably improves the oxidation resistance of the polyethylene. The ageing process of the polyethylene is slowed down and the tribological properties of the material are optimized.[45, 46]
The highly cross-linked polyethylene (HXLPE) offered by other prostheses manufacturers show no better abrasion rates than the Columbus® prostheses. There are also no long-term results available for the HXLPE to confirm suitable material properties in knee replacement surgery.[48, 49]

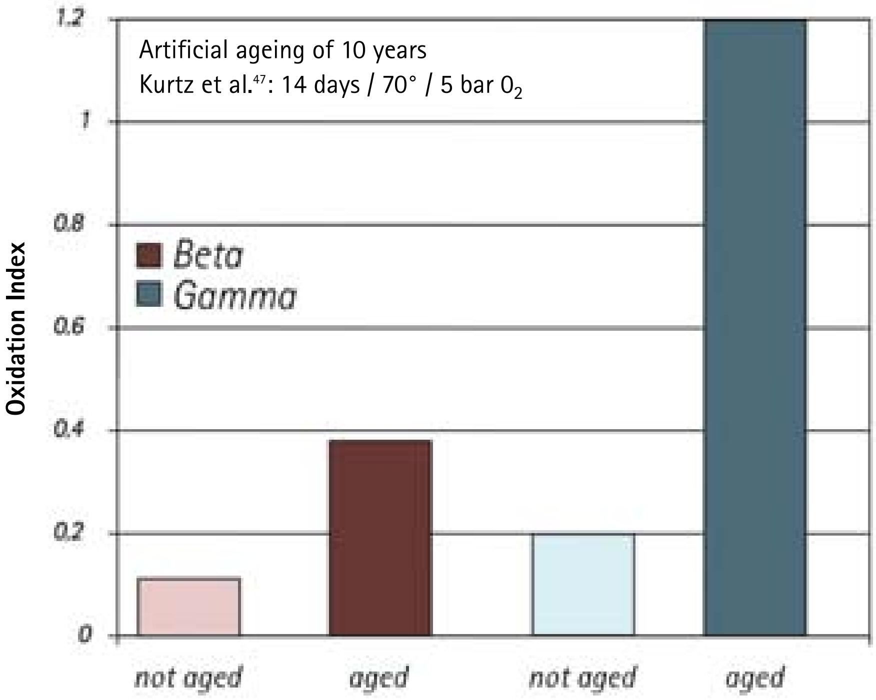


Figure 35: Oxidation gamma- versus beta-sterilized UHMWPE.

4. Selected materials

Tried and tested – Discover Innovations

4.4 AS Coating

The AS-coated Columbus® prostheses offer an innovative solution for patients who are hypersensitive to metals such as nickel, cobalt and chromium. The multilayer coating is designed to successfully prevent the release of metal ions. The risk of mechanical ablation, which has been known to occur with mono-layer coatings, is reduced due to the innovative layer architecture.[50, 51] The AS coating also improved the wear rate by 60 %.[52, 53] Almost all the primary Columbus® implant components are available in AS-coated variations.

- **Top layer made from zirconium nitride (approx. 2.5 µm thick)**
  The top layer is made from zirconium nitride, a ceramic surface that shows excellent tribological properties.
  The metal zirconium is one of the five best known metals for biocompatibility.
- **Five intermediate layers made from chromium nitride and chromium carbon nitride (approx. 2.0 µm thick)**
  The five intermediate layers are applied alternately. They enable the mechanical integrity of the layer system.
- **Chromium adhesive layer (approx. 0.1 µm thick)**
  The adhesive layer of chromium provides a tight connection between the base material and the following layers, thereby creating stability.

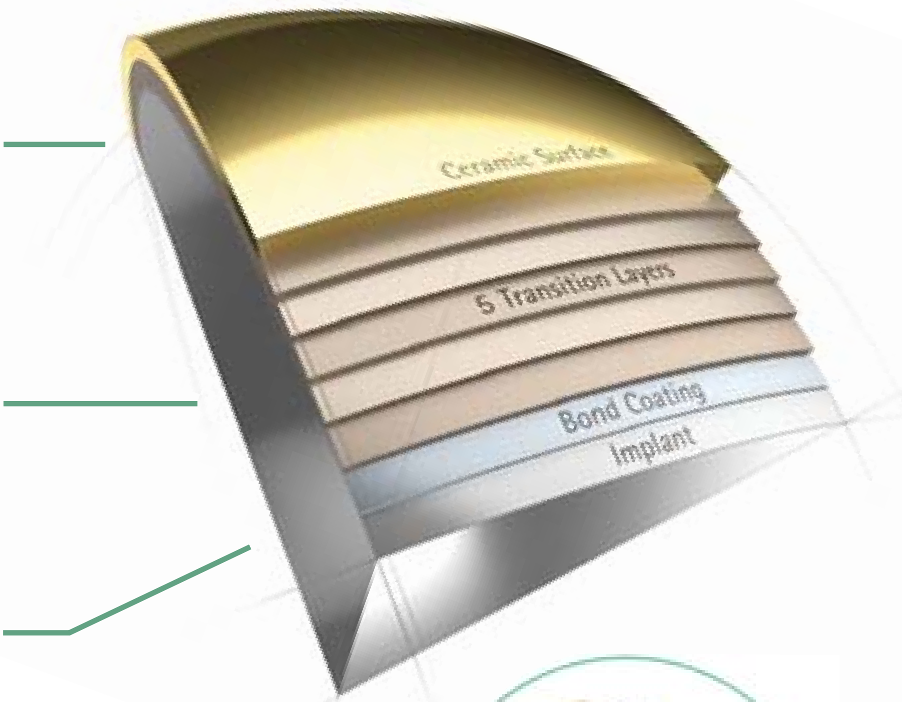


Figure 36: Composition of the AS layer architecture.

5. Versatile instruments

Discover precision

5.1 Overview

The Columbus® instrument set offers versatile surgical options.

- Navigated / Manual
- Tibia First / Femur First
- Conventional / MIOS®
- Optional instruments for an individualized surgical procedure.
- "Easy pack" solution for specified surgical procedures.

5.2 OrthoPilot® navigation system

The OrthoPilot® navigation system is proven to help in the precise alignment of the implant with the mechanical axis. The simple and interactive simulation of the femoral and tibial sections, taking into account the individual ligament conditions, enables excellent surgical outcomes.[54 - 62]

OrthoPilot® navigation system

5. Versatile instruments

Discover precision

In a study of 821 patients, Clemens et al. show that the OrthoPilot® navigation system helps in significantly reducing incorrect positionings of the implant components, thereby increasing the lifetime of the implant.[63]

Over the last 15 years, more than 150,000 knee prostheses have been successfully implanted using the OrthoPilot® navigation system.

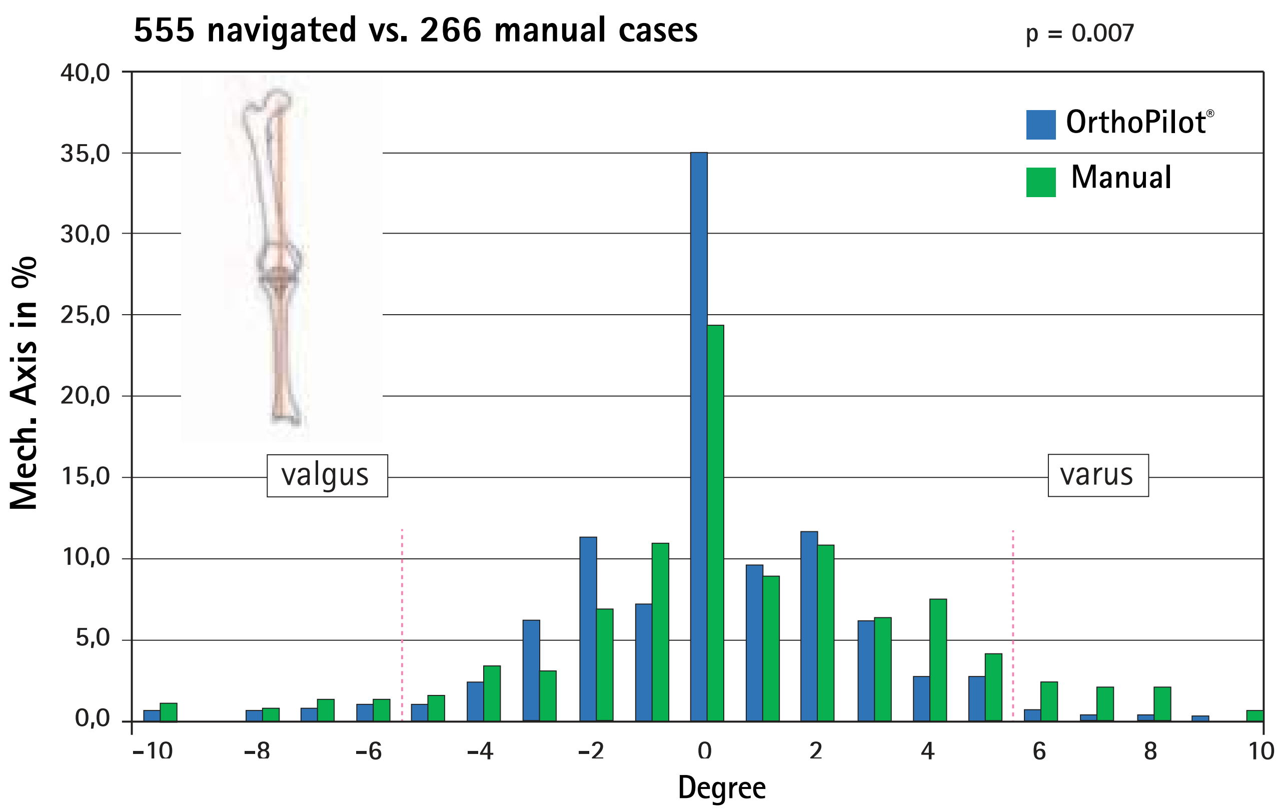


Figure 37: Mechanical axis in 555 navigated vs. 266 manually implanted knee prostheses.[63]

5.3 Columbus® MIOS® – Minimally Invasive Orthopaedic Solutions

A minimally invasive surgical procedure offers patients the following benefits:

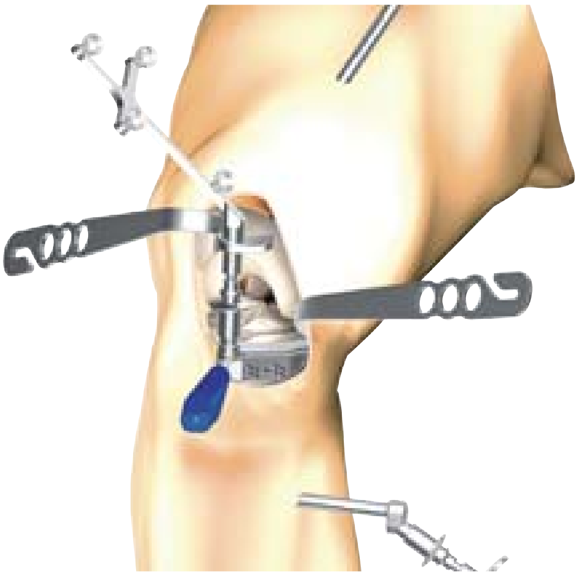
- Smaller incision length
- Less traumatic stress for the soft tissue
- Lower blood loss
- Less bone loss
- Faster post-operative mobilization

MIOS® Instruments

Aesculap offers useful instruments for minimally invasive implant surgery:

- Retractors
- Leg holders
- MIOS® saw blades
- MIOS® distractors

Minimally invasive surgical techniques speed up rehabilitation and enable faster recovery of the joint function.[64, 65] Studies also show that blood loss is reduced when utilizing the minimally invasive surgical technique, and that the hospital stay of the patients can also be reduced.[66, 67] The narrower approach of the surgical technique, which is kinder on the soft tissue, does however increase what is required of the surgeon. MIOS® instruments were developed with a focus on protecting the soft tissue and they take into account the restricted field of vision. The OrthoPilot® navigation system also enables a more exact positioning of the implant components despite the smaller field of vision.



Minimally invasive knee replacement surgery with the Columbus® MIOS® instruments.

6. Clinical outcomes

Discover quality

Hauschild et al.[69]

197 CR DD Columbus® knee prostheses were implanted in 125 patients and followed up after 5.8 years.

- The revision rate was 2 %.
- The patients achieved good post-operative stability and kinematics.
- In the 118 cases in which the OrthoPilot® navigation system was used, the implant position was improved.

Walde et al.[70]

60 cementless Columbus® CR knee prostheses were implanted with the OrthoPilot® navigation system and followed up after 5.6 years.

- No prostheses needed to be revised due to aseptic loosening.
- The average KSS increased from 75 to 180 points.
- No patient had problems with anterior knee pain.

Hakki et al.[71]

200 cementless Columbus® CR DD knee prostheses were implanted in 182 patients with the OrthoPilot® navigation system and followed up after 2 years.

- The Columbus® knee prosthesis showed good medium-term clinical and radiological outcomes without implant-related problems.
- The patients achieved an average flexion of 122°.
- No prostheses needed to be revised.

Picard et al.[72]

214 cemented Columbus® knee prostheses were implanted in 206 patients with the OrthoPilot® navigation system and followed up after 1 year.

- Problems with anterior knee pain occurred very rarely; in less than 1 % of patients.
- There were only 2 revisions due to infections.
- 98 % of the patients were satisfied or very satisfied.

Goebel et al.[73]

109 Columbus® knee prostheses were implanted and compared with 22 NexGen Full Flex knee prostheses (Zimmer, Warsaw, USA) and followed up after an average of 3.9 years.

- In the Knee Society Score Columbus® achieved good results, comparable to those of the NexGen Full Flex prosthesis.
- The operation time was significantly less for Columbus® at 53 minutes (66 minutes for NexGen).
- Columbus® was also judged to be the more bone-sparing implant design and the more flexible knee system.

Malzdorf et al.[74]

116 patients were treated with the Columbus® knee prosthesis. All implant procedures were carried out using the OrthoPilot® navigation system.

- 1 year after the procedure, the patients achieved a flexion angle of 113°.
- Thanks to the OrthoPilot® navigation system, good clinical and radiological outcomes were achieved.

Helwig et al.[75]

193 patients were treated with the Columbus® knee prosthesis and followed up 1 year after the procedure.

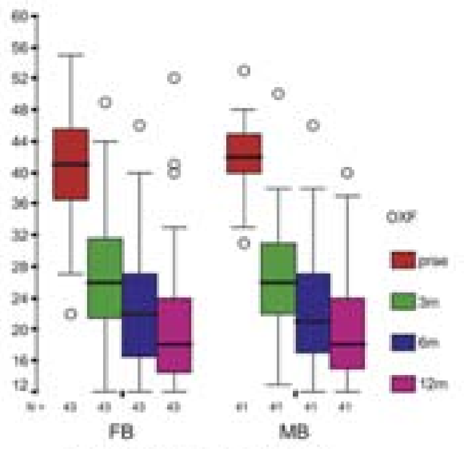
- The KSS-F and KSS-K were an average of 170 points one year after the procedure.
- With an OXF of 23 points, high patient satisfaction can be assumed.

Lampe et al.[76]

52 Columbus® protheses with a fixed platform and 48 Columbus® prostheses with a rotating platform were implanted using the OrthoPilot® navigation system.

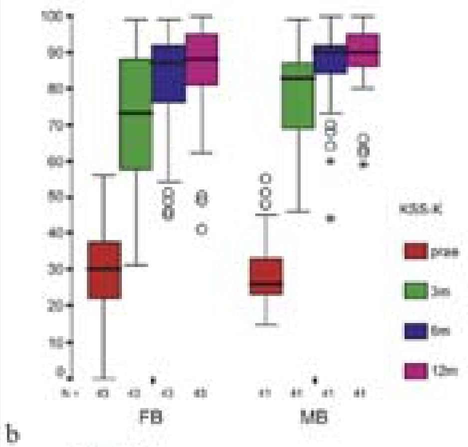
- Both the patients with the rotating platform and the patients with the fixed platform showed a good KSS-F 12 months after the procedure with a score of 87 points (before the procedure 47 points) and a good KSS-K with a score of 86 points (before the procedure 30 points).
- The OXF score of 21 points after the procedure (before the procedure 42 points), allows a high level of patient satisfaction to be assumed.

Oxford Score



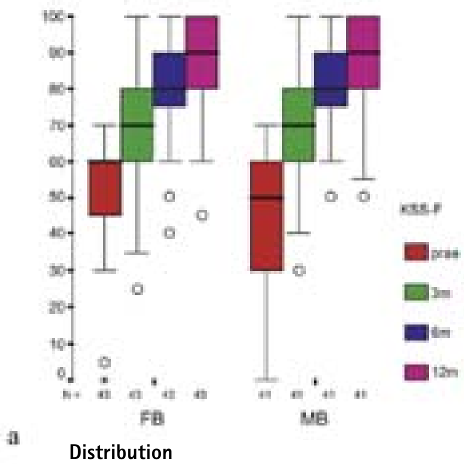
Patient estimation
60 points worst assessment
12 points best assessment

Knee Society Score – Clinical



Distribution
50 points walking
50 points stair rising

Knee Society Score – Function



Distribution
50 points pain
25 points RoM
25 points stability

Figures 38: Score results of the Lampe et al. study.

6. Clinical outcomes

Discover quality

Hasegawa et al.[77]

100 Columbus® PS prostheses were implanted using a minimally invasive surgical technique. 50 of these prostheses were implanted using the OrthoPilot® navigation system and 50 prostheses were implanted manually.

- No complications occurred in the post-operative phase.
- The ROM was significantly improved with an average flexion of 121° after 6 months (before the procedure 110°).
- Good post-operative KSS values were achieved both clinically and functionally.
- 94 % of the navigated group fell within the +/-3° varus / valgus axis deviation. Only 78 % of the conventional group achieved this result (P = 0.041).

Stulberg et al.[78]

78 patients were treated with a cementless Columbus® knee prosthesis, 40 of which were manually implanted and 38 with navigation.

- The patients achieved an average flexion of 116.4° six months after the procedure.
- The KSS improved from a pre-operative score of 46.3 points to a score of 84 points 6 months after the procedure.

		MIS Navigated Group	MIS Manual Group	P value
KSS-K	Pre-operative	32 (18)	31 (17)	n.s.*
	Post-operative	95 (7)	92 (9)	n.s.*
KSS-F	Pre-operative	43 (24)	37 (22)	n.s.*
	Post-operative	76 (16)	78 (14)	n.s.*

** n.s.= not significant (P>0.05)*

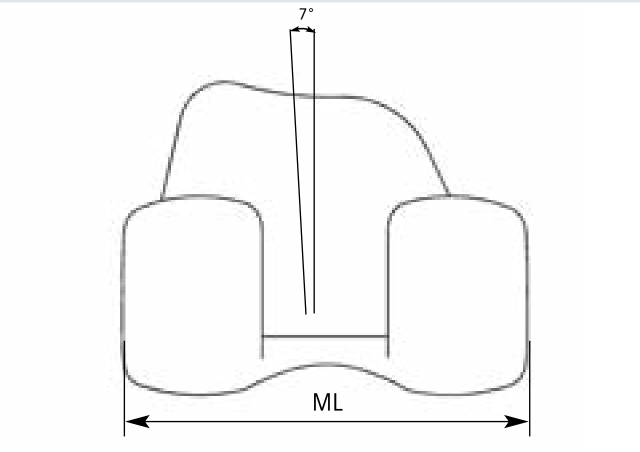
Figure 39: Average KSS in the Hasegawe et al. study (+/- standard deviation).

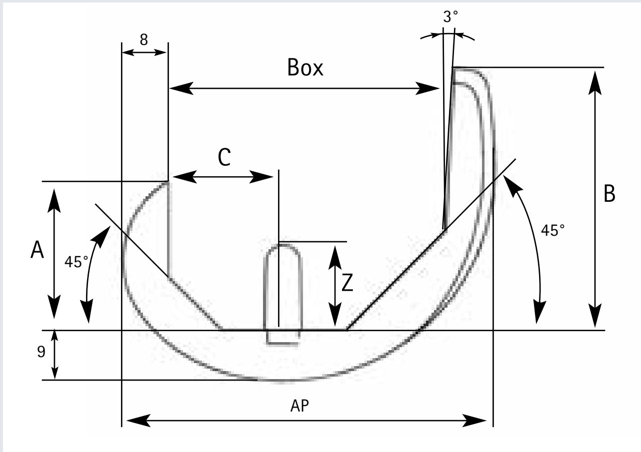
Pre-operative X-ray images

Post-operative X-ray images of the Columbus® CR DD knee prosthesis

7. Important parameters for Columbus® implants

Implant dimensions



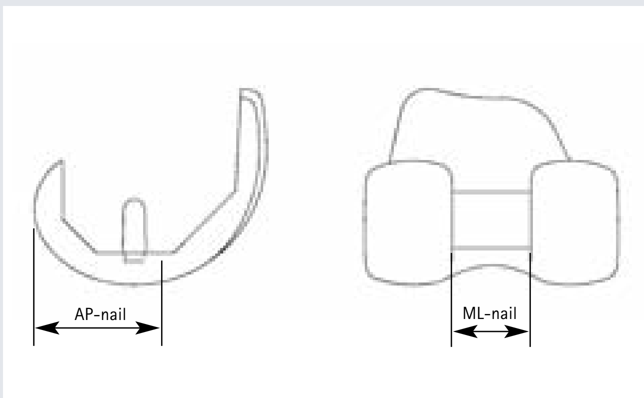


Dimensions in (mm)

Size	ML	AP	Box	A	B	C	Pin Z
F1	56	50	34	18.5	34	14	12
F2N	56	53	37	20	36	14.5	13.5
F2	59	53	37	20	36.5	14.5	13.5
F3N	59	56.5	40	21.5	39	16	15
F3	62.5	56.5	40	21.5	39.5	16	15
F4N	62.5	60.5	43.5	23	42	17.5	15
F4	66.5	60.5	43.5	23	42.5	17.5	15
F5N	66.5	65	47.5	26	45.5	20	15
F5	71	65	47.5	26	46	20	15
F6N	71	70	52	28	49	21.5	15
F6	76	70	52	28	49.5	21.5	15
F7	82	75.5	57	30	53.5	23	15
F8	82	80.5	62	32	58	26	15

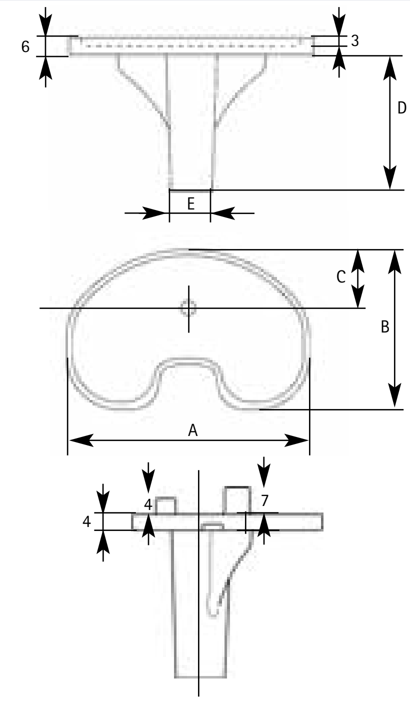
AP- / ML-dimensions [mm] of the Columbus® femoral implants for any necessary use of intramedullary nails

	AP-nail CR	AP-nail PS	ML-nail
F1	22.5	31	18
F2/F2N	24	32.5	19
F3/F3N	26	34	20.5
F4/F4N	28	36	21
F5/F5N	30	38	22
F6/F6N	32.5	40.5	23
F7	35	42.5	25
F8	39	47	25



Dimensions in (mm)

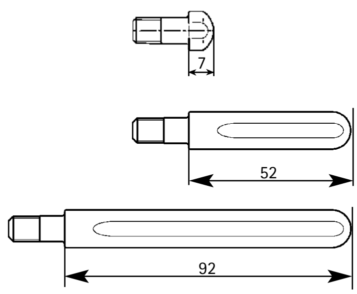
	T0/T0+	T1/T1+	T2/T2+	T3/T3+	T4/T4+	T5
A	62	65	70	75	80	85
B	41/44	43/46	45/49	48/52	51/55	56
C	14/14.5	15/16	16/17.5	17.5/19	19/20.5	20.5
D	28	28	33	38	43	48
E	12.3	12.3	12.3	12.3	14.3	14.3



Length of the extension stems
Dimensions in (mm)

	T0/T0+	T1/T1+	T2/T2+	T3/T3+	T4/T4+	T5
D	28	28	33	38	43	48
D+S Stem (Short)	80	80	85	90	95	100
D+L Stem (Long)	120	120	125	130	135	140

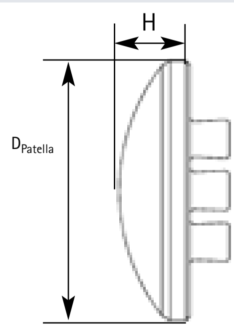
The overall length of the tibial plateau with the respective extension stem can be calculated by adding Dimension D of the upper table and the stem length Short (52 mm) or Long (92 mm).



The extension stems are available with the diameters 12 and 14 mm.

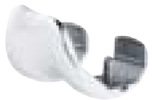
Patella dimensions

	$D_{Patella}$ x H
Patella P1	Ø 27 mm x 7 mm
Patella P2	Ø 30 mm x 8 mm
Patella P3	Ø 33 mm x 9 mm
Patella P4	Ø 36 mm x 10 mm



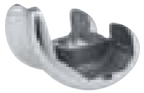
Columbus® Implant Matrix – Femoral Parts

Femur CR cemented



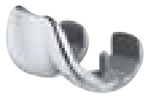
Types:	F1	F2N	F2	F3N	F3	F4N	F4	F5N	F5	F6N	F6	F7	F8
Left	NN001K	NN800K	NN002K	NN801K	NN003K	NN899K	NN004K	NN900K	NN005K	NN901K	NN006K	NN007K	NN008K
Left	NN001Z	NN800Z	NN002Z	NN801Z	NN003Z	NN899Z	NN004Z	NN900Z	NN005Z	NN901Z	NN006Z	NN007Z	
Right	NN011K	NN810K	NN012K	NN811K	NN013K	NN909K	NN014K	NN910K	NN015K	NN911K	NN016K	NN017K	NN018K
Right	NN011Z	NN810Z	NN012Z	NN811Z	NN013Z	NN909Z	NN014Z	NN910Z	NN015Z	NN911Z	NN016Z	NN017Z	

Femur PS cemented



Types:	F1	F2N	F2	F3N	F3	F4N	F4	F5N	F5	F6N	F6	F7	F8
Left	NN161K	NN840K	NN162K	NN841K	NN163K	NN939K	NN164K	NN940K	NN165K	NN941K	NN166K	NN167K	NN168K
Left	NN161Z		NN162Z		NN163Z		NN164Z		NN165Z		NN166Z	NN167Z	
Right	NN171K	NN850K	NN172K	NN851K	NN173K	NN949K	NN174K	NN950K	NN175K	NN951K	NN176K	NN177K	NN178K
Right	NN171Z		NN172Z		NN173Z		NN174Z		NN175Z		NN176Z	NN177Z	

Femur CR cementless



Types:	F1	F2N	F2	F3N	F3	F4N	F4	F5N	F5	F6N	F6	F7	F8
Left	NN021K	NN820K	NN022K	NN821K	NN023K	NN919K	NN024K	NN920K	NN025K	NN921K	NN026K	NN027K	NN028K
Right	NN031K	NN830K	NN032K	NN831K	NN033K	NN929K	NN034K	NN930K	NN035K	NN931K	NN036K	NN037K	NN038K

PS Fixation screw for PE in AS version (generally packed with gliding surface)

Types:	NN497Z	NN498Z	NN499Z
	Height 10/12	Height 14/16	Height 18/20

Patella-3-Peg

Types:	P1	P2	P3	P4
F1-F8	NN481	NN482	NN483	NN484

Columbus® Implant Matrix – Tibial Parts

Tibia cemented

Types:	T0	T0+	T1	T1+	T2	T2+	T3	T3+	T4	T4+	T5
CR/PS	NN070K	NN058K	NN071K	NN072K	NN073K	NN074K	NN075K	NN076K	NN077K	NN078K	NN079K
CRA/PSA	NN470K	NN469K	NN471K	NN472K	NN473K	NN474K	NN475K	NN476K	NN477K	NN478K	NN479K
RP	–	–	NN271K	NN272K	NN273K	NN274K	NN275K	NN276K	NN277K	NN278K	NN279K
UCR	NN670K	NN668K	NN671K	NN672K	NN673K	NN674K	NN675K	NN676K	NN677K	NN678K	NN679K

Tibia cementless

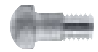
Types:	T0	T0+	T1	T1+	T2	T2+	T3	T3+	T4	T4+	T5
CR/PS	NN080K	NN059K	NN081K	NN082K	NN083K	NN084K	NN085K	NN086K	NN087K	NN088K	NN089K
RP	–	–	NN281K	NN282K	NN283K	NN284K	NN285K	NN286K	NN287K	NN288K	NN289K

CRA/PSA Tibia Hemispacers with screws

4 mm						
Types:	T0	T1	T2	T3	T4	T5
RM/LL	NN560K	NN563K	NN566K	NN569K	NN572K	NN575K
RL/LM	NN580K	NN583K	NN586K	NN589K	NN592K	NN595K

8 mm						
Types:	T0	T1	T2	T3	T4	T5
RM/LL	NN561K	NN564K	NN567K	NN570K	NN573K	NN576K
RL/LM	NN581K	NN584K	NN587K	NN590K	NN593K	NN596K

Obturator



Ø 12 mm	Ø 14 mm
NN261K	NN264K

Tibia Extension Stems

short	long	short	long
Ø 12 mm		Ø 14 mm	
NN262K	NN263K	NN265K	NN266K

Peek Plug

NN260P

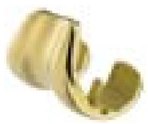
Gliding Surfaces

	T0/T0+						T1/T1+						T2/T2+					
Types:	10	12	14	16	18	20	10	12	14	16	18	20	10	12	14	16	18	20
CR	–	–	–	–	–	–	NN110	NN111	NN112	NN113	–	–	NN120	NN121	NN122	NN123	–	–
DD	NN200	NN201	NN202	NN203	NN204	NN205	NN210	NN211	NN212	NN213	NN214	NN215	NN220	NN221	NN222	NN223	NN224	NN225
UC fix.	NN400	NN401	NN402	NN403	NN404	NN405	NN410	NN411	NN412	NN413	NN414	NN415	NN420	NN421	NN422	NN423	NN424	NN425
UCR	NN600	NN601	NN602	NN603	NN604	NN605	NN610	NN611	NN612	NN613	NN614	NN615	NN620	NN621	NN622	NN623	NN624	NN625
RP	–	–	–	–	–	–	NN310	NN311	NN312	NN313	–	–	NN320	NN321	NN322	NN323	–	–
PS	NN500	NN501	NN502	NN503	NN504	NN505	NN510	NN511	NN512	NN513	NN514	NN515	NN520	NN521	NN522	NN523	NN524	NN525

Gliding Surfaces

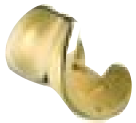
	T3/T3+						T4/T4+						T5					
	10	12	14	16	18	20	10	12	14	16	18	20	10	12	14	16	18	20
CR	NN130	NN131	NN132	NN133	–	–	NN140	NN141	NN142	NN143	–	–	NN150	NN151	NN152	NN153	–	–
DD	NN230	NN231	NN232	NN233	NN234	NN235	NN240	NN241	NN242	NN243	NN244	NN245	NN250	NN251	NN252	NN253	NN254	NN255
UC fix.	NN430	NN431	NN432	NN433	NN434	NN435	NN440	NN441	NN442	NN443	NN444	NN445	NN450	NN451	NN452	NN453	NN454	NN455
UCR	NN630	NN631	NN632	NN633	NN634	NN635	NN640	NN641	NN642	NN643	NN644	NN645	NN650	NN651	NN652	NN653	NN654	NN644
RP	NN330	NN331	NN332	NN333	–	–	NN340	NN341	NN342	NN343	–	–	NN350	NN351	NN352	NN353	–	–
PS	NN530	NN531	NN532	NN533	NN534	NN535	NN540	NN541	NN542	NN543	NN544	NN545	NN550	NN551	NN552	NN553	NN554	NN555

Columbus® Implant Matrix – AS Femoral Parts



AS Femur CR cemented

Types:	F1	F2N	F2	F3N	F3	F4N	F4	F5N	F5	F6N	F6	F7	F8
Left	NN001Z	NN800Z	NN002Z	NN801Z	NN003Z	NN899Z	NN004Z	NN900Z	NN005Z	NN901Z	NN006Z	NN007Z	–
Right	NN011Z	NN810Z	NN012Z	NN811Z	NN013Z	NN909Z	NN014Z	NN910Z	NN015Z	NN911Z	NN016Z	NN017Z	–



AS Femur PS cemented

Types:	F1	F2	F3	F4	F5	F6	F7	F8
Left	NN161Z	NN162Z	NN163Z	NN164Z	NN165Z	NN166Z	NN167Z	–
Right	NN171Z	NN172Z	NN173Z	NN174Z	NN175Z	NN176Z	NN177Z	–

Patella-3-Peg

Types:	P1	P2	P3	P4
F1-F8	NN481	NN482	NN483	NN484

Columbus® Implant Matrix – AS Tibial Parts

AS Tibia cemented


CR/PS

CRA/PSA

RP

UCR MIOS®

Types:	T0	T0+	T1	T1+	T2	T2+	T3	T3+	T4	T4+	T5
CR/PS	NN070Z	NN058Z	NN071Z	NN072Z	NN073Z	NN074Z	NN075Z	NN076Z	NN077Z	NN078Z	NN079Z
CRA/PSA	NN470Z	NN469Z	NN471Z	NN472Z	NN473Z	NN474Z	NN475Z	NN476Z	NN477Z	NN478Z	NN479Z
RP	–	–	NN271Z	NN272Z	NN273Z	NN274Z	NN275Z	NN276Z	NN277Z	NN278Z	NN279Z

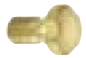
AS Tibia Extension Stems

short	long	short	long
Ø 12 mm		Ø 14 mm	
NN262Z	NN263Z	NN265Z	NN266Z

CRA/PSA Tibia Hemispacers with screws

	4 mm						8 mm					
Types:	T0	T1	T2	T3	T4	T5	T0	T1	T2	T3	T4	T5
RM/LL	NN560Z	NN563Z	NN566Z	NN569Z	NN572Z	NN575Z	NN561Z	NN564Z	NN567Z	NN570Z	NN573Z	NN576Z
RL/LM	NN580Z	NN583Z	NN586Z	NN589Z	NN592Z	NN595Z	NN581Z	NN584Z	NN587Z	NN590Z	NN593Z	NN596Z

Obturator



Ø 12 mm	Ø 14 mm
NN261Z	NN264Z

Peek Plug

NN260P

Fixation Screw for PS Gliding Surfaces

Types:	NN497Z	NN498Z	NN499Z
	10/12	14/16	18/20

Gliding Surfaces

	T0/T0+						T1/T1+						T2/T2+					
Types:	10	12	14	16	18	20	10	12	14	16	18	20	10	12	14	16	18	20
CR	–	–	–	–	–	–	NN110	NN111	NN112	NN113	–	–	NN120	NN121	NN122	NN123	–	–
DD	NN200	NN201	NN202	NN203	NN204	NN205	NN210	NN211	NN212	NN213	NN214	NN215	NN220	NN221	NN222	NN223	NN224	NN225
UC fix.	NN400	NN401	NN402	NN403	NN404	NN405	NN410	NN411	NN412	NN413	NN414	NN415	NN420	NN421	NN422	NN423	NN424	NN425
UCR	NN600	NN601	NN602	NN603	NN604	NN605	NN610	NN611	NN612	NN613	NN614	NN615	NN620	NN621	NN622	NN623	NN624	NN625
RP	–	–	–	–	–	–	NN310	NN311	NN312	NN313	–	–	NN320	NN321	NN322	NN323	–	–
PS	NN500	NN501	NN502	NN503	NN504	NN505	NN510	NN511	NN512	NN513	NN514	NN515	NN520	NN521	NN522	NN523	NN524	NN525

Gliding Surfaces

	T3/T3+						T4/T4+						T5					
	10	12	14	16	18	20	10	12	14	16	18	20	10	12	14	16	18	20
CR	NN130	NN131	NN132	NN133	–	–	NN140	NN141	NN142	NN143	–	–	NN150	NN151	NN152	NN153	–	–
DD	NN230	NN231	NN232	NN233	NN234	NN235	NN240	NN241	NN242	NN243	NN244	NN245	NN250	NN251	NN252	NN253	NN254	NN255
UC fix.	NN430	NN431	NN432	NN433	NN434	NN435	NN440	NN441	NN442	NN443	NN444	NN445	NN450	NN451	NN452	NN453	NN454	NN455
UCR	NN630	NN631	NN632	NN633	NN634	NN635	NN640	NN641	NN642	NN643	NN644	NN645	NN650	NN651	NN652	NN653	NN654	NN644
RP	NN330	NN331	NN332	NN333	–	–	NN340	NN341	NN342	NN343	–	–	NN350	NN351	NN352	NN353	–	–
PS	NN530	NN531	NN532	NN533	NN534	NN535	NN540	NN541	NN542	NN543	NN544	NN545	NN550	NN551	NN552	NN553	NN554	NN555

Columbus® Revision Implant Matrix – Femoral Parts

Femur CR cemented

27 Nm for femur stems

Types:	F1	F2	F3	F4	F5	F6	F7
Left	NR001K	NR002K	NR003K	NR004K	NR005K	NR006K	NR007K
Right	NR011K	NR012K	NR013K	NR014K	NR015K	NR016K	NR017K

Possible Combination Femur / Tibia

Types:	F1	F2	F3	F4	F5	F6	F7
T0/T0+	OK	OK	OK	+	+	+	+
T1/T1+	OK	OK	OK	OK	+	+	+
T2/T2+	–	OK	OK	OK	OK	+	+
T3/T3+	–	–	OK	OK	OK	OK	+
T4/T4+	–	–	+	OK	OK	OK	OK
T5	–	–	+	+	OK	OK	OK

– not compatible
+ possible, but not recommended by Aesculap

Femur stem 6° cemented

	Ø 12 mm		Ø 15 mm		Ø 18 mm	
Types:	77 mm	157 mm	77 mm	157 mm	77 mm	157 mm
F1-F7	NR291K	NR294K	NR292K	NR295K	NR293K	NR296K

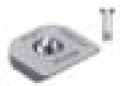
Femur stems cementless

		Ø 12 mm		Ø 13 mm		Ø 14 mm		Ø 12 mm		Ø 13 mm		Ø 14 mm		Ø 12 mm		Ø 13 mm		Ø 14 mm	
Types:		117 mm	177 mm	117 mm	177 mm	117 mm	177 mm	117 mm	177 mm	117 mm	177 mm	117 mm	177 mm	117 mm	177 mm	117 mm	177 mm	117 mm	177 mm
F1-F7	5° Neu	NR402K	NR432K	NR403K	NR433K	NR404K	NR434K	NR405K	NR435K	NR406K	NR436K	NR407K	NR437K	NR408K	NR438K	NR409K	NR439K	NR410K	NR440K
F1-F7	5°	NR412K	NR442K	NR413K	NR443K	NR414K	NR444K	NR415K	NR445K	NR416K	NR446K	NR417K	NR447K	NR418K	NR448K	NR419K	NR449K	NR420K	NR450K
F1-F7	5° Lat	NR422K	NR452K	NR423K	NR453K	NR424K	NR454K	NR425K	NR455K	NR426K	NR456K	NR427K	NR457K	NR428K	NR458K	NR429K	NR459K	NR430K	NR460K
F1-F7	7°	NR502K	NR532K	NR503K	NR533K	NR504K	NR534K	NR505K	NR535K	NR506K	NR536K	NR507K	NR537K	NR508K	NR538K	NR509K	NR539K	NR510K	NR540K
F1-F7	7°	NR512K	NR542K	NR513K	NR543K	NR514K	NR544K	NR515K	NR545K	NR516K	NR546K	NR517K	NR547K	NR518K	NR548K	NR519K	NR549K	NR520K	NR550K
F1-F7	7° Lat	NR522K	NR552K	NR523K	NR553K	NR524K	NR554K	NR525K	NR555K	NR526K	NR556K	NR527K	NR557K	NR528K	NR558K	NR529K	NR559K	NR530K	NR560K

Femur spacer distal

Types:	5 mm	10 mm	15 mm
F1	NR461K	NR471K	–
F2	NR462K	NR472K	–
F3	NR463K	NR473K	–
F4	NR464K	NR474K	–
F5	NR465K	NR475K	NR485K
F6	NR466K	NR476K	NR486K
F7	NR467K	NR477K	NR487K

Femur spacer posterior



5 mm	10 mm	15 mm
NR561K	NR571K	–
NR562K	NR572K	–
NR563K	NR573K	–
NR564K	NR574K	–
NR565K	NR575K	NR585K
NR566K	NR576K	NR586K
NR567K	NR577K	NR587K

Note: 15 mm femur spacer can be used either distal or posterior.
On the other side in the same condyle side, there is no space for any other spacer!

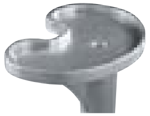
Femur nut for ext. stems

Types:	Neutral	Offset
F1-F7	NR400K	NR401K

Patella-3-Peg

	P0	P1	P2	P3
Types:	Ø 27 mm	Ø 30 mm	Ø 33 mm	Ø 36 mm
F1-F7	NN481	NN482	NN483	NN484

Columbus® Revision Implant Matrix – Tibial Parts



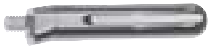
Tibia cemented with nut inside for ML fixation

Types:	T0	T0+	T1	T1+	T2	T2+	T3	T3+	T4	T4+	T5
	NR070K	NR068K	NR071K	NR072K	NR073K	NR074K	NR075K	NR076K	NR077K	NR078K	NR079K

Possible Combination Femur / Tibia

Types:	F1	F2	F3	F4	F5	F6	F7
T0/T0+	OK	OK	OK	+	+	+	+
T1/T1+	OK	OK	OK	OK	+	+	+
T2/T2+	–	OK	OK	OK	OK	+	+
T3/T3+	–	–	OK	OK	OK	OK	+
T4/T4+	–	–	+	OK	OK	OK	OK
T5	–	–	+	+	OK	OK	OK

– not compatible
+ possible, but not recommended by Aesculap



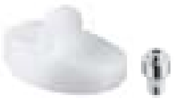
Tibia offset stems cemented

	Ø 12 mm		Ø 15 mm		Ø 18 mm	
Types:	52 mm	92 mm	52 mm	92 mm	52 mm	92 mm
F0-F5	NR191K	NR194K	NR192K	NR195K	NR193K	NR196K

Tibia offset stems cementless

	Ø 11 mm		Ø 12 mm		Ø 13 mm		Ø 14 mm		Ø 15 mm	
Types:	92 mm	132 mm	92 mm	132 mm	92 mm	132 mm	92 mm	132 mm	92 mm	132 mm
T0-T5	NR171K	NR181K	NR172K	NR182K	NR173K	NR183K	NR174K	NR184K	NR175K	NR185K

	Ø 16 mm		Ø 17 mm		Ø 18 mm		Ø 19 mm		Ø 19 mm	
Types:	92 mm	132 mm	92 mm	132 mm	92 mm	132 mm	92 mm	132 mm	92 mm	132 mm
T0-T5	NR176K	NR186K	NR177K	NR187K	NR178K	NR188K	NR179K	NR189K	NR180K	NR190K

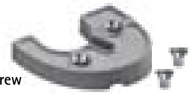


PE Gliding Surface Medium Constraint with screw — 10 Nm for PE screw

Types:	10 mm	12 mm	14 mm	16 mm	18 mm	20 mm	24 mm	28 mm	32 mm
T0/0+	NR100	NR101	NR102	NR103	NR104	NR105	NR106	–	–
T1/1+	NR110	NR111	NR112	NR113	NR114	NR115	NR116	–	–
T2/2+	NR120	NR121	NR122	NR123	NR124	NR125	NR126	NR127	–
T3/3+	NR130	NR131	NR132	NR133	NR134	NR135	NR136	NR137	–
T4/4+	NR140	NR141	NR142	NR143	NR144	NR145	NR146	NR147	NR148
T5	NR150	NR151	NR152	NR153	NR154	NR155	NR156	NR157	NR158

PE Gliding Surface High Constraint with screw — 10 Nm for PE screw

Types:	10 mm	12 mm	14 mm	16 mm	18 mm	20 mm	24 mm	28 mm	32 mm
T0/0+	NR600	NR601	NR602	NR603	NR604	NR605	NR606	–	–
T1/1+	NR610	NR611	NR612	NR613	NR614	NR615	NR616	–	–
T2/2+	NR620	NR621	NR622	NR623	NR624	NR625	NR626	NR627	–
T3/3+	NR630	NR631	NR632	NR633	NR634	NR635	NR636	NR637	–
T4/4+	NR640	NR641	NR642	NR643	NR644	NR645	NR646	NR647	NR648
T5	NR650	NR651	NR652	NR653	NR654	NR655	NR656	NR657	NR658



Tibia Hemi Spacer RM/LL with screw

Types:	5 mm	10 mm	15 mm
T0/0+	NR040K	NR041K	NR042K
T1/1+	NR044K	NR045K	NR046K
T2/2+	NR048K	NR049K	NR050K
T3/3+	NR052K	NR053K	NR054K
T4/4+	NR056K	NR057K	NR058K
T5	NR060K	NR061K	NR062K

Tibia Hemi Spacer RL/LM with screw

Types:	5 mm	10 mm	15 mm
T0/0+	NR240K	NR241K	NR242K
T1/1+	NR244K	NR245K	NR246K
T2/2+	NR248K	NR249K	NR250K
T3/3+	NR252K	NR253K	NR254K
T4/4+	NR256K	NR257K	NR258K
T5	NR260K	NR261K	NR262K

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