

40th anniversary of a publication presenting an implant that is still in use: “ENDO model”

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ABSTRACT

The year 2021 marks the 40th anniversary of the original publication describing the “Endo-model intracondylar rotational” implant, the evolution of the previous St Georg design, now providing two-degree-of-freedom motion and reducing stress on the cement-bone interface. A unique condition is that the publication is not reported in bibliometric studies, although its elective indication still exists after four decades. A work deserves the qualification of “classic” not only for the volume of citations but fundamentally for the confidence that the application of its content inspires in the long term. Currently all the leading international companies in the implant industry have included in their catalogs their own rotating hinge implants. The scale of comparative constriction is a dilemma and thus a topic for discussion. Currently, the matter has been solved applying inertial sensors technology: the rotating hinge provides less constriction than the condylar constriction implant.

Key words: Total knee arthroplasty; hinge; rotating hinge; story of knee replacement; ENDO model.

Level of Evidence: V

40° aniversario de una publicación introduciendo un implante aún vigente: “ENDO model”

RESUMEN

En 2021, se cumplen 40 años de la publicación original que describió al implante “*intracondilar con capacidad rotatoria Endo-Model*”, evolución del diseño precedente St. George, ahora capaz de proveer doble grado de libertad de movimiento y reducir la tensión en la interfase cemento-hueso. Condición singular es que dicha publicación no es referida en estudios bibliométricos, a pesar de lo cual su indicación electiva está aún vigente tras cuatro décadas. Un trabajo merece la calificación de “clásico” no exclusivamente por el volumen de citaciones, sino fundamentalmente por la confianza que inspira la aplicación de su contenido en el largo plazo. Contemporáneamente, todas las compañías de la industria de implantes que lideran el mercado internacional han incorporado en sus catálogos un modelo propio de implante a bisagra rotacional. La magnitud de constricción comparativa es un dilema y, por ende, materia de discusión. Contemporáneamente aplicando la tecnología de sensores inerciales se ha logrado resolver la cuestión: la bisagra rotacional ofrece menor constricción que el implante de constricción condilar.

Palabras clave: Reemplazo total de rodilla; bisagra; bisagra rotacional; historia del reemplazo de rodilla; ENDO-Model.

Nivel de Evidencia: V

Not many of the currently available prostheses have been used for 40 years.

The oldest designs still in use in our specialty are probably the Kirschner wires and the Steinmann pins and pin holder. Martin Kirschner (1879-1942), a Heidelberg surgeon, and Fritz Steinmann (1872-1932), born in Bern, introduced their designs in the first decade of the 19th century, which are milestones in the history of osteodesis and skeletal traction.¹

In prosthetic arthroplasty, homage should be paid to the “ENDO model” intracondylar hinge knee design, as originally described.

This year marks the 40th anniversary of the original publication in German authored by referents of the Hamburg School.²

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The authors described in the publication:

- The modification of the St. Georg implant to include rotation of the tibial component. The surgeons of the Hamburg ENDO Klinik were the intellectual authors of the "St Georg model" and "ENDO model" designs. Before that, in 1970, Buchholz and Engelbrecht designed the St. Georg prototype: intracondylar hinge prosthesis based on the low friction principle; the original prototype had a single blocked central axis, respected the femoral trochlea and was fixed with cement.
- The kinematics resembles the natural knee, by providing two degrees-of-freedom motion.
- Stress or tension attenuation in the cement-bone interface.
- *"The St. Georg total knee prosthesis has been modified to incorporate axial rotation of the tibial component. The kinematics approximate more those of the normal knee and the stress imposed at bone-cement interface are attenuated, thus reducing the risk of mechanical failure. The construction and laboratory testing are described."*

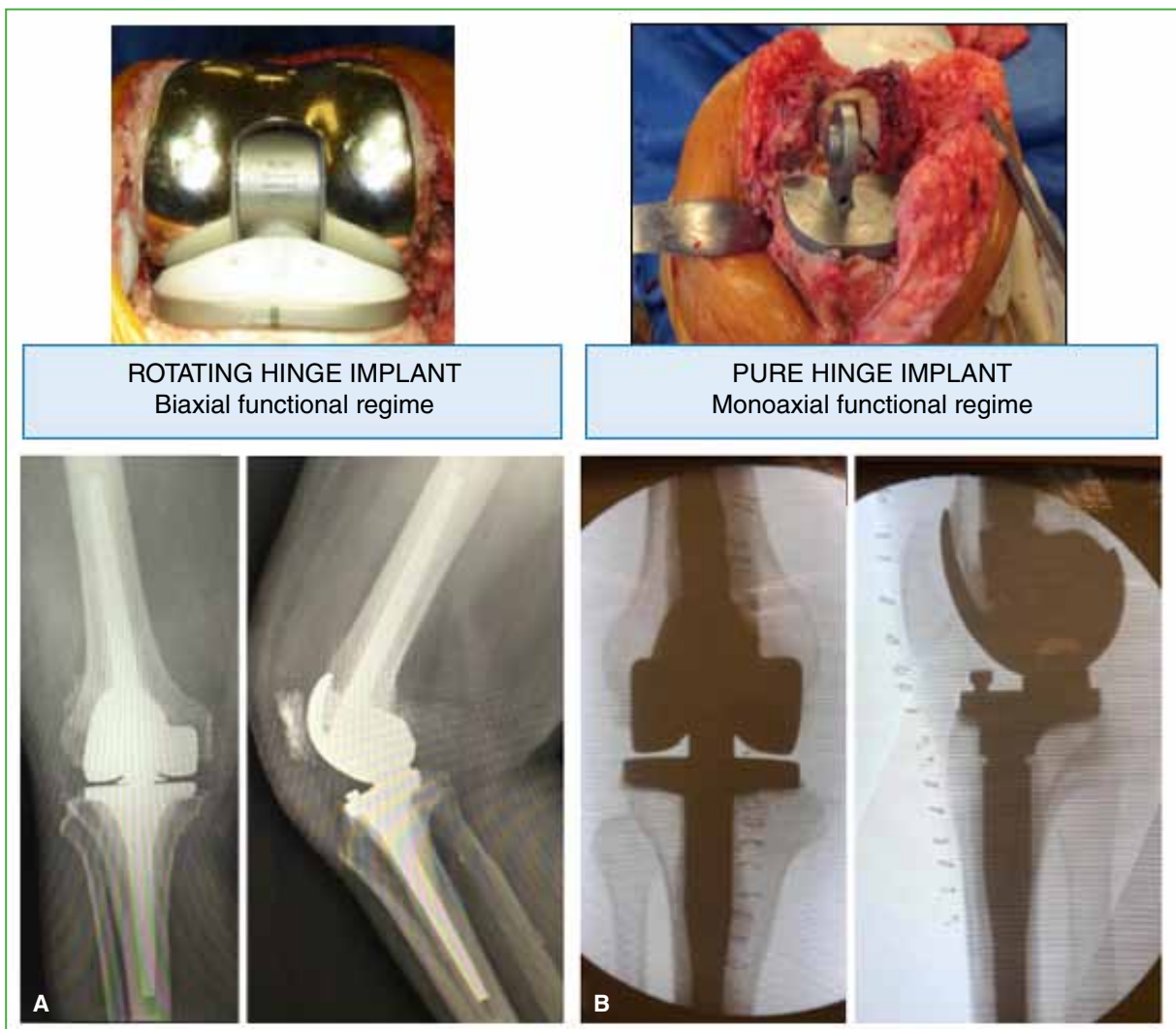


Figure 1. The hinge implant is marketed in two versions: A. "rotational hinge": the functional regime is biaxial. The freedom of movement develops along the transverse (flexion-extension) and longitudinal (internal and external rotation) axes. B. "pure or simple hinge": the functional regime is monoaxial. The freedom of movement develops along the transverse axis. Its main indication is for patients with impaired extension (eg, quadriceps palsy).

In 1991, despite the fact that the pure hinge model 10-year survival was 94% (thus exceeding the results of the then used total hip replacements), the disadvantage of the more rigid models was acknowledged, highlighting insufficient damping during knee motion. Moreover, the aseptic loosening of the tibial component was recognized as a common failure mechanism of the St. Georg “sled” model, especially in ligament laxity cases.³

In 1997 authors from the same school reported the long- and medium-term results, consolidating a continuous and unmatched quality control cycle of the procedures and failure analyses.⁴

In the year 2000 the experience and outcomes after 20 years of implant use were reported. The title of the above mentioned publication includes an emblematic phrase, from the point of view of the 40 years’ use of the implant: “Endo-Model Hinge prosthesis®. A model with a future?”

In the above mentioned paper the implant is already presented with the “registered trademark symbol” (“Endo-Modell®”). (“Scharnierendoprothese Endo- Modell®. Modell mit Zukunft”)⁵ (Figures 1 and 2).



Figure 2. The implant design offers modularity and fixation alternatives. Modularity allows the replacement of femoral and tibial segmental defects. Stems can be “uncemented” and “cemented”.

The EndoKlinik colleagues have advocated that the Endo-model indication should be elective. It is interesting to explore the then contemporary scenario in Germany, the implant’s country of origin.

Not only are the hinged implants, but also those with varus-valgus stabilization classified as constrained by the German Registry. According to the Registry’s 2019 Annual Report the prescription frequency of the hinged prostheses is 2.3% and 2% for varus-valgus stabilized implants.⁶

It should be noted that the criteria used by the German Registry for implants puts together under the same category those with **varus-valgus stabilization** (still inaccurately and generically called “semi-constrained” by numerous colleagues on this side of the Atlantic) and the **hinged ones**.

The scale of comparative constriction is a dilemma and thus a topic for discussion. Currently, the matter has been solved applying the inertial sensors technology: the rotational hinge provides less constriction than the condylar constriction implant.⁷

In 2020, while coordinating a Seminar sponsored by *Asociación Argentina para el Estudio de la Cadera y la Rodilla (ACARO)* (Argentine Hip and Knee Association) I had the opportunity to conduct a survey of experienced experts in reconstructive knee surgery; 51% of the colleagues had never been trained on this implant during their residency; 11% had seen between one and maximum three Endo-model implanting surgeries. Contrary to the initial limitations, **96% of the responders recognized they had had more opportunities to electively indicate this type of implants as they progressed in their professional careers.**⁸

Allow me to add a comment from the bibliometric perspective.

The study that inspired this paper is far from being included in the list of 50 to 100 most frequent citations in reconstructive knee surgery.⁹⁻¹³

The critical analysis of the cited bibliometric reviews allows assuming reasons that account for the omission of such paper:

- Exclusion of several periodic publications
- German language
- Because of its limited indications, its practical impact does not affect a large population group.

This is not a timely opportunity to justify the omission; I rather value, from the critical study perspective, the usefulness of bibliometric indexes to assume that:

- Various implants originally described in some of the bibliometric citations have been withdrawn from the market.
- Some classifications have been modified.
- Certain theories have become outdated by experimental evidence.

This is an example showing that it can be deceitful to undervalue scientific work on account of its low bibliographic impact; from an educational perspective I generally explain such paradox to the colleagues in their basic training cycle as the "**Cinderella effect**".

A paper deserves to be called "classic" not only by the number of citations but mainly by the confidence the application of its content inspires in the long term.

The evidence is overwhelming: after forty years from the original publication that has inspired this homage, the implant is still in use.

Currently many leading international companies in the implant industry have included in their catalogs their own rotational hinge implants.¹⁴

I pay homage to a referential study in the history of reconstructive knee surgery and share it with the orthopedic community.

Many thanks to the Hamburg ENDO Klinik School!!

Happy birthday, ENDO model!!

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