



Ceramics for the Benefit of Patients and Healthcare Systems



Professor Francesco Traina
Rizzoli Orthopaedic Institute
Bologna, Italy

Dear colleagues,

The Corona pandemic has affected our lives and our work severely. Elective surgeries have been postponed, with a massive negative impact on orthopaedic care in general and also on the financial situation of many hospitals. We still do not know when we can return to something that resembles normality. Nevertheless, our professional focus as surgeons has not changed. Under any circumstances, our goal will be further to increase benefits for the patient.

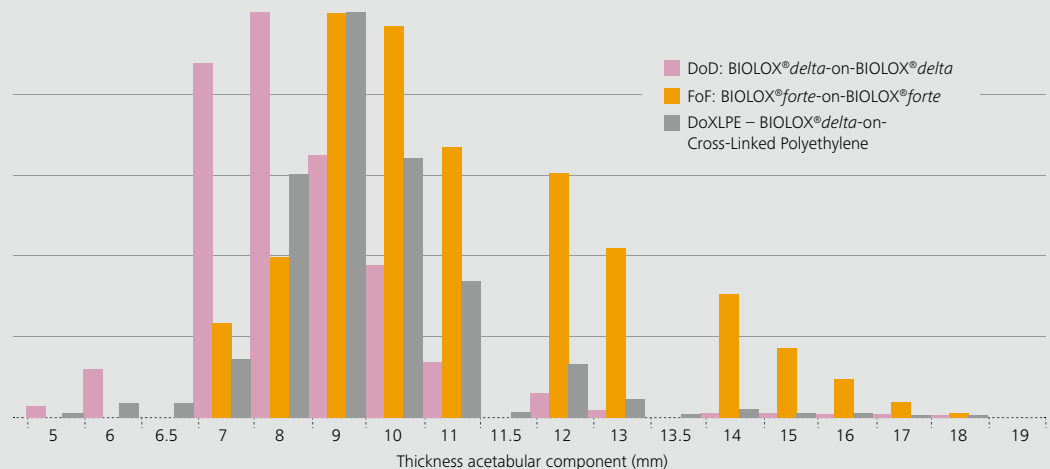
Arthroplasty is not only about pain relief but also about performance, long-term success (life-long if possible), and cost efficiency. In the field of revision, 3D printing and customization offer new chances adequately to treat even the most difficult cases. Advanced bearing materials allow us to achieve long-term survival. As the number of primary and revision procedures keeps increasing continuously, we must be aware that we are riding a tiger!

In revision cases, the choice of implant is especially crucial. In my department, we have been using ceramic femoral heads exclusively for all our patients for more than 20 years. Our clinical results with BIOLOX[®]forte ceramic bearings at Rizzoli were excellent compared to other materials¹, showing very good results even in difficult cases like DDH, Poliomyelitis or Legg-Calvé-Perthes disease, Slipped Capital Femoral Epiphysis (SCFE)²⁻⁵. Our regional hip registry (RIPO) documents twenty years of long-term results with a very low rate of ceramic failure in ceramic-on-ceramic. The rare cases of failure were mostly related to mishandling⁶⁻⁹.

With the next generation of ceramics, BIOLOX[®]delta introduced in 2003, new geometries became possible. The possibility to reduce the thickness of the acetabular liner and increase the diameter of the head was, in my mind, a true game-changer in our clinical practice. The introduction of sleeved ceramic heads for revision gave us an additional treatment option.

Bearing distribution according to the thickness of the acetabular component

Regional Register of Orthopaedic Prosthetic Implantology (RIPO),
1st January 2000 – 31st December 2013
Evaluation based on figures from RIPO for CeramTec GmbH





[To the video >>>](#)

Ceramics is the second hardest material after diamond. [It is also very tough](#). Only punctual and local stresses can lead to damage under extreme circumstances. Small metal elevations on the worn surface of the metal taper or micro-movements between head and taper may lead to the fracture of a ceramic component.

However, this risk is extremely low when we compare the fracture risk of a ceramic head with the risk of polyethylene wear or instability due to a small head diameter. This is clearly shown by the evidence we collected over the years. And if I have to choose between a material releasing toxic ions, compromising the immune system of already weakened patients on the one hand and ceramics on the other, my choice will clearly be for the second. A fractured ceramic component can be revised. Damage by metal intoxication cannot.

Ceramics in Revision – Treatment Algorithm

In revision, I usually choose the largest head diameter (>36mm) available to increase implant stability, and to date I can report very good clinical outcomes. Furthermore, large heads increase positive proprioceptive sensations for the patients¹⁰. I have never faced any cases of trunnionosis related to a large ceramic head, and I am not aware of any clinical studies or case reports stating the opposite¹¹.

In our recently published study, Delta-on-Delta bearings showed reliable outcomes in revision at mid-term, with no fractures¹². These outcomes were confirmed also in smaller case series involving total hip revisions or isolated acetabular revisions, and even in specific cases as metal-on-metal revisions¹³.

At Rizzoli, we have very few cases of patients with noise issues. None of them had to be revised and therefore, squeaking is not rated as a risk factor in our institution. In my opinion, the only true limit for ceramics in revision surgery is set by the cases in which good implant stability cannot be achieved. Implant manufacturers strongly advise the use of a titanium sleeve on the damaged taper, in order to recreate the pristine trunnion and still allow a uniform distribution of the stresses on the ceramic head.

In finite-element simulations the fracture strength of Delta heads strongly decreased on tapers showing small metal elevations¹⁴. On the other hand, the fracture strength of sleeved heads did not decrease significantly on severely damaged tapers¹⁵.

In conclusion, our extensive clinical experience supported by the data collected in the RIPO regional registry demonstrates that the use of Delta-on-Delta ceramic bearings in revision surgery shows very promising results at a mid-term follow-up. The Australian registry suggests that the use of prostheses with improved performance has a positive impact on the incidence of revision. At Rizzoli, we observed that even the number of re-revisions decreases with the use of ceramic bearings. As revisions have a strong impact on patients' quality of life and also on the healthcare system, implants with proven outcomes should be considered as best practice and as a valuable strategy to reduce healthcare expenditures in the long term.



1. Traina F, Sama D, Paderni S, Comitini V, Bordini B, Toni A. Ceramic on ceramic versus metal on polyethylene coupling: a long-term survival comparison. *Chir Organi Mov.* 2003;88(3):257-258.
2. Traina F, De Fine M, Sudanese A, Calderoni PP, Tassinari E, Toni A. Long-term results of total hip replacement in patients with Legg-Calvé-Perthes disease. *J Bone Joint Surg Am.* 2011;93(7):e25. doi:10.2106/JBJS.J.00648.
3. Traina F, De Fine M, Abati CN, Bordini B, Toni A. Outcomes of total hip replacement in patients with slipped capital femoral epiphysis. *Arch Orthop Trauma Surg.* 2012;132(8):1133-1139. doi:10.1007/s00402-012-1538-z.
4. Traina F, De Fine M, Tassinari E, Sudanese A, Calderoni PP, Toni A. Modular neck prostheses in DDH patients: 11-year results. *J Orthop Sci.* 2011;16(1):14-20. doi:10.1007/s00776-010-0018-y.
5. Faldini C, De Fine M, Di Martino A, et al. Outcomes of total hip replacement in limbs affected by poliomyelitis. *Hip Int.* 2017;27(2):198-204. doi:10.5301/hipint.5000451.
6. Traina F, De Fine M, Di Martino A, Faldini C. Fracture of ceramic bearing surfaces following total hip replacement: a systematic review. *Biomed Res Int.* 2013;2013:157247. doi:10.1155/2013/157247.
7. Traina F, Tassinari E, De Fine M, Bordini B, Toni A. Revision of ceramic hip replacements for fracture of a ceramic component: AAOS exhibit selection. *J Bone Joint Surg Am.* 2011;93(24):e147. doi:10.2106/JBJS.K.00589.
8. Traina F, De Fine M, Bordini B, Toni A. Risk factors for ceramic liner fracture after total hip arthroplasty. *Hip Int.* 2012;22(6):607-614. doi:10.5301/HIP.2012.10339.
9. Toni A, Traina F, Stea S, et al. Early diagnosis of ceramic liner fracture. Guidelines based on a twelve-year clinical experience. *J Bone Joint Surg Am.* 2006;88 Suppl 4:55-63. doi:10.2106/JBJS.F.00587.
10. Lavigne M, Therrien M, Nantel J, Roy A, Prince F, Vendittoli PA. The John Charnley Award: The functional outcome of hip resurfacing and large-head THA is the same: a randomized, double-blind study. *Clin Orthop Relat Res.* 2010;468(2):326-36. doi:10.1007/s11999-009-0938-z.
11. Eichler D, Barry J, Lavigne M, Massé V, Vendittoli PA. No radiological and biological sign of trunnionosis with Large Diameter Head Ceramic Bearing Total Hip Arthroplasty after 5 years. *Orthop Traumatol Surg Res.* 2020;S1877-0568(20)30045-1. doi:10.1016/j.otsr.2019.12.015.
12. Castagnini F, Bordini B, Tassinari E, Stea S, Ancarani C, Traina F. Delta-on-Delta ceramic bearing surfaces in revision hip arthroplasty. *J Arthroplasty.* 2019;34(9):2065-2071. doi:10.1016/j.arth.2019.04.068.
13. Castagnini F, Mariotti F, Tassinari E, Bordini B, Zuccheri F, Traina F. Isolated acetabular revisions of articular surface replacement (ASR) XL implants with highly porous titanium cups and Delta bearings. *Hip Int.* 2019;1120700019874442. doi:10.1177/1120700019874442.
14. Falkenberg A, Dickinson EC, Morlock MM. Adapter sleeves are essential for ceramic heads in hip revision surgery. *Clin Biomech (Bristol, Avon).* 2020;71:1-4. doi:10.1016/j.clinbiomech.2019.10.018.
15. Dickinson EC, Sellenschloh K, Morlock MM. Impact of stem taper damage on the fracture strength of ceramic heads with adapter sleeves. *Clin Biomech (Bristol, Avon).* 2019;63:193-200. doi:10.1016/j.clinbiomech.2019.03.005.