Editorial

20 years of porous tantalum in primary and revision hip arthroplasty—time for a critical appraisal

After almost 2 decades of clinical use, porous tantalum has become an important component in the orthopedic surgeon's toolbox, and its most common use today is as acetabular cups, cages, or augments in revision arthroplasty. For many revision surgeons, porous tantalum has significantly changed their practice when addressing more complex acetabular bone loss. However, now porous tantalum is also increasingly used as a coating for cups used in primary total hip arthroplasty (THA). It is time for a critical appraisal of porous tantalum in hip arthroplasty, and this issue of Acta Orthopaedica contains an article that investigates the use of porous tantalum cups in primary THA (Laaksonen et al. 2018).

**Porous tantalum in revision THA**

Tantalum was first described in 1802 by the Swedish chemist Anders Ekeberg, who isolated it from the rare mineral tantalie. In modern times, pure tantalum has been manufactured into 3-dimensional, macroporous structures that closely resemble cancellous bone, so-called "trabecular metal" (TM). Its mechanical and biological properties make porous tantalum well suited for orthopedic applications:

- **Mechanically,** a fairly unique combination of high elasticity and a high coefficient of friction (Levine et al. 2006) gives porous tantalum implants their much appreciated "grip" in situations where primary stability is critical but difficult to achieve, such as in acetabular revision surgery with a high degree of bone loss and sclerotic acetabular rims.
- **Biologically,** tantalum and titanium share a very pronounced osteoconductivity that is observed in different in vivo models investigating the integration of porous tantalum into host bone (Levine et al. 2006). The next step of using porous tantalum as a cup material even in primary arthroplasty surgery was both logical and tempting, and initial medium-term reports showed good results (Malizos et al. 2008, Macheras et al. 2009). Subsequently, 2 randomized controlled trials comparing porous tantalum with hemispherical titanium cups in primary THA. When measured by radiostereometry, porous tantalum cups had slightly better initial stability than titanium fiber-mesh cups, but they were accompanied by a similar degree of periprosthetic bone loss (Baad-Hansen et al. 2011). A randomized controlled trial comparing porous tantalum monoblock with porous-coated titanium monoblock cups found fewer radiolucencies around the porous tantalum cups (Wegrzyn et al. 2015), but of course none of these trials was designed or powered to detect differences in the risk of revision.

**Porous tantalum cups in primary THA**

The first clinical reports on porous tantalum shells were on patients with technically demanding acetabular defects (Sporer and Paprosky 2006, Flecher et al. 2008). Further applications included the combination of porous tantalum shells with differently shaped augments or cages that are manufactured from the same material, again for use in large acetabular defects or even in pelvic discontinuity (Abolghasemian et al. 2014). Comparative retrospective studies indicate that porous tantalum cups used in revision situations are at least as good as conventional uncemented titanium cups (Jafari et al. 2010, Mohaddes et al. 2015), and that they can be superior to Müller acetabular reinforcement rings in terms of a reduced risk of aseptic loosening (Brüggemann et al. 2017).

On the other hand, dislocation seems to be a recurrent issue after the use of porous tantalum shells in revision THA (Skytta et al. 2011, Brüggemann et al. 2017), a problem that has not been investigated in depth. This instability could be related to difficulties in restoring a correct center of rotation, or in less than optimal abduction and anteversion angles, possibly related to the strategy of "going for bone" as opposed to reconstructing the acetabular bed, as in the old-fashioned techniques. The combination of dual-mobility cups with porous tantalum shells may reduce the problem of instability (Brüggemann et al. 2018), but this hypothesis needs further investigation.
that were used in primary THA, in part due to an increased risk of dislocation. In contrast, a recently published registry study from the England and Wales National Joint Registry that compares porous tantalum-coated cups with titanium-coated cups from the same manufacturer finds a lower risk of revision due to aseptic loosening in the group of patients operated with porous tantalum cup (Matharu et al. 2018). Authors from the Australian and Swedish joint registries have now collaborated in a joint effort to compare the outcome after the use of porous tantalum cups in primary THA with that of other common uncemented cups. In the present issue of Acta Orthopaedica, Laaksonen et al. (2018) report a 1.5-fold higher risk of revision for the porous tantalum-coated cups.

**Porous tantalum—what needs to be done?**

Porous tantalum cups undoubtedly confer highly desirable effects in terms of excellent initial and long-term stability in demanding acetabular revision surgery, and they have certainly come to stay. Further studies are needed to investigate whether a combination of porous tantalum shells with dual-mobility systems reduces instability after complex revision procedures.

However, what is good in revision surgery is not necessarily superior in standard primary THA surgery. Could it be that—in the context of primary THA—the terrific grip of porous tantalum cups makes them more likely to jam in suboptimal positions, maybe retroverted, or steeper than intended, but that the surgeon refrains from correcting their position simply because they are difficult to get out? This is entirely speculative, and a systematic analysis of the mechanisms underlying the potentially increased risk of dislocation after the use of porous tantalum cups has not yet been done.

The orthopedic community will have to keep an eye on the evolving evidence in order to critically assess whether we should continue to be as tantalized by tantalum in primary THA as we are in complex revision situations.

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Abolghasemian M, Tangsapor S, Drexler M, Barbuto R, Backstein D, Safir O, Kuzyk P, Gross A. The challenge of pelvic discontinuity: cup-cage reconstruction does better than conventional cages in mid-term. Bone Joint J 2014; 96-B: 195-200.

Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR). Annual report; 2017. Available from: http://www.aoa.org.au

Baat Houlder T, Kold S, Nielsen P T, Laursen M B, Christensen P H, Soballe K. Comparison of trabecular metal cups and titanium fiber-mesh cups in primary hip arthroplasty: a randomized RSA and bone mineral densitometry study of 50 hips. Acta Orthop 2011; 82: 155-60.

Balla V K, Bodhak S, Bose S, Bandyopadhyay A. Porous tantalum structures for bone implants: fabrication, mechanical, and in vitro biological properties. Acta Biomater 2010; 6(8): 3349-59.

Brüggemann A, Fredlund E, Mallmin H, Hailer N P. Are porous tantalum cups superior to conventional reinforcement rings? Acta Orthop 2017; 88: 35-40.

Brüggemann A, Mallmin H, Hailer N P. Do dual-mobility cups cemented into porous tantalum shells reduce the risk of dislocation after revision surgery? Acta Orthop 2018; 89(2): 156-62.

Flecher X, Splorer S, Papsosky W. Management of severe bone loss in acetabular revision using a trabecular metal shell. J Arthroplasty 2008; 23: 949-55.

Hong J, Azena A, Ekdahl K N, Gramunt C G, Nilsson B. Material-specific thrombin generation following contact between metal surfaces and whole blood. Biomaterials 2005; 26(12): 1397-403.

Jafari S M, Bender B, Coyle C, Purvizi J, Sharkey P F, Hozack W J. Do tantalum and titanium cups show similar results in revision hip arthroplasty? Clin Orthop Relat Res 2010; 468: 459-65.

Laaksonen I, Lorimer M, Gromov K, Eskeleinen A, Rolfson O, Graves S E, Malchau H, Mohaddes M. Trabecular metal acetabular components in primary total hip arthroplasty. Acta Orthop 2018; 89(3): 259-64.

Levine B R, Splorer S, Poggie R A, Della Valle C J, Jacobs J J. Experimental and clinical performance of porous tantalum in orthopedic surgery. Biomaterials 2006; 27(27): 4671-81.

Macheras G, Kateros K, Kostakos A, Koussostathi S, Danomaras D, Papangelopoulos P J. Eight- to ten-year clinical and radiographic outcome of a porous tantalum monoblock acetabular component. J Arthroplasty 2009; 24: 705-9.

Malizos K N, Bargiotas K, Papatheodorou L, Hantes M, Karachalios T. Survivorship of monoblock trabecular metal cups in primary THA: midterm results. Clin Orthop Relat Res 2008; 466: 159-66.

Matharu G S, Judge A, Murray D W, Pandit H G. Trabecular metal acetabular components reduce the risk of revision following primary total hip arthroplasty: a propensity score matched study from the National Joint Registry for England and Wales. J Arthroplasty 2018; 33(2): 447-52.

Mohaddes M, Rolfson O, Karrholm J. Short-term survival of the trabecular metal cup is similar to that of standard cups used in acetabular revision surgery. Acta Orthop 2015; 86: 26-31.

Skytta E T, Eskelinen A, Paavolainen P O, Remes V M. Early results of 827 trabecular metal revision shells in acetabular revision. J Arthroplasty 2011; 26: 342-5.

Splorer S M, Papsosky W G. Acetabular revision using a trabecular metal acetabular component for severe acetabular bone loss associated with a pelvic discontinuity. J Arthroplasty 2006; 21: 87-90.

Swedish Hip Arthroplasty Register. Annual report 2016. Available from: https://shpr.registercentrum.se/shar-in-english/annual-reports-from-the-swedish-hip-arthroplasty-register/rikeyel2z

Wegrzyn J, Kaufman K R, Hanssen A D, Lewallen D G. Performance of porous tantalum vs. titanium cup in total hip arthroplasty: randomized trial with minimum 10-year follow-up. J Arthroplasty 2015; 30(6): 1008-13.