Principles of acetabular fixation in primary and revision hip arthroplasty

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• Do we see the difference?
• Which type of acetabular cup should be the gold standard?
The survival of acetabular cup depends on the stability in surrounding bone stock.


Aseptic loosening of the acetabular component shortens the functioning of hip prosthesis significantly.

The most common reasons:
• osteolysis of bone stock caused by macrophages (reaction "around the foreign body")
• loss of bone stock due to overloading and micromotions of acetabular cup
Stability of uncemented acetabular cup depends on:

- initial mechanical stability: caused by proper shape (threaded cylindrical surfaces, conical, elliptical or semi-circular)
- secondary stability after bone ingrowth at the bone–implant interface (hydroxyapatite-coated acetabular cups, porous, porous - coated with hydroxyapatite)

Secondary stability prevents micro-movements between cup and the bone more than 40-50 um

Threaded cup

- Threaded cup was applied by Sivash in 1957 and gained popularity in Europe and later the US.

- Cup stability is obtained only by screwing into the bone like the screw – it makes impossible the long term survival.

- It gives a very good initial stabilization (> 2.5x than press fit), but lack of secondary stability (especially in case of incorrect implantation) leads to loosening because of multidirectional loads.

- The disappointing long-term outcomes led to the development others designs of shape (truncated conical-screw socket developed by Zweymuller had the longest survival).
Threaded cup

- Loosening of threaded cup:
  - it is difficult to make the threaded surface capable to bone ingrowth
  - there is a small contact area of the thread with the surrounding bone stock which causes a loss of bone and the formation of connective tissue because of overloads
- It causes high rates of aseptic loosening; 4% - 31%, with a mean follow-up 3.5-10 years (Fox i wsp. JBJS 1994), and after 10 years 17% require revision procedure (Malchau i wsp. JBJS 2002)
Threaded cup

- Threaded cup is used mainly in:
  - Osteoporosis
  - Osteoarthritis secondary to dysplasia
- They should not be used in revision arthroplasty:
  - difficult of obtained the initial stability in acetabulum with bone defects
  - lack of secondary stability
- Hemispherical press-fit uncemented cup was introduced for use in the 80’s.

- It provides a longer survival time, which results of fixing into the bone:
  - it transmits the loads in physiological way to the surrounding bone tissue
  - secondary stability is achieved by the bone ingrowth

- Cup is universal

- You can use it in any type of acetabulum while the primary or revision arthroplasty

- There is no difference in survivorship with an additional screw stabilization - **100% / 98.4% after 15 years** (spikes shorten cup survival time)


Press-fit cup - advantages

- Cup in universal:
  - it is a modular structure, allowing to management the acetabular bone loss with implants
Press-fit cup - advantages

- Cup is universal:
  - it easily recreates the center of rotation of the hip joint
Press-fit cup limitations

- In case of lack of initial stability, cup micro-movements make the secondary stability impossible.
- In osteoporotic bone is difficult to obtain the initial stability without additional screws.
- While impacting the walls bend, the deformation should not exceed 75 um in order not to change the shape of polyethylene or metal insert (causing them to excessive wear, especially when using "large" heads or rupture the ceramic insert).


- Aseptic loosening is more often when the lateral inclination angle is more than 50 degrees.
- They loosen quickly (after 5 years) when the outer surface is smooth and covered only with hydroxyapatite.

Kin-Wing i wsp. Early Failure of Smooth Hydroxyapatite-Coated Press-Fit Acetabular Cup-7 Years of Follow-up. The J Arthroplasty. 2006; 20(5): 627-631
Press-fit cup limitations

- Fundamental for stable cup implantation is placing in preserved bony ring of acetabulum
- The contact surface of the implant to the bone acetabulum:
  - > 70% bone graft is not needed,
  - 50-70% support for the roof and the rear column of a bone graft (screws as an option)
  - <50% is not enough to support (cage or screws)
Press-fit cup limitations

- More often we use screws for cup stabilization:
  - when the center of rotation of the hip joint is > 3 mm above the anatomical center of the acetabulum
  - in patients with osteoporosis
  - in women
  - in less active patients

Garcia-Rey E i wsp: Cup Press Fit in Uncemented THA Depends on Sex, Acetabular Shape, and Surgical Technique. Clin Orthop Relat Res, 2012; 470: 3014-3023
• The risk of damage the neurovascular structures because of additional stabilization with screws

Female K. B., 43 years old, BMI 23, repeatedly treated surgically in childhood because of DDH hip L and P

Primary endoprostheses 02.07.2014, without blood transfusion on religious grounds
- Male Ž.K., 45 years old, BMI 31, ANV
- Primary endoprosthesis

Case 2
- Female B.B., 82 years, BMI 32, RA, endoprosthesis 2007
- Revision 06.10.2015
- Aseptic loosening

Case 3
Female **M. A.**, age **75**, BMI **28**

Primary endoprosthesis LSB **2005**, PSB **2006**

Revison LSB **21.09.2010**

aseptic loosening

**Case 4**
...reconstruction of bone grafts with osseointegration THA...
Female K.M., age 74, BMI 34, LSB 1990, PSB 1998

Revision PSB: screwed acetabulum and stem 01.07.2008,

Antiprotrusio acetabuli GAP II 26.05.2011

aseptic loosening, RA

Case 5
...questionable effectiveness in RTHA...
• What is similar in those cases of patients with threaded cups?
  • the rate and extent of bone destruction
  • quite long time from primary surgery to revision? average of 7 years (5 - 10)
Registers

![Graph showing the proportion of primary THAs by type of acetabulum from 2010 to 2013. The graph includes columns for cemented, press-fit, and screw cup types. The data for screw cup is highlighted in red.](image-url)
<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cemented cups</td>
<td>22,1%</td>
<td>13,4%</td>
</tr>
<tr>
<td>Threaded cups</td>
<td>22,4%</td>
<td>8,8%</td>
</tr>
<tr>
<td>Press-fit cups</td>
<td>55,5%</td>
<td>77,8%</td>
</tr>
</tbody>
</table>
**Secondary stability** has **only press-fit acetabular cup** because covering surface is similar to structure of cancellous bone to allow bone ingrowth.

**Threaded cup** has no such surface because we couldn’t screw in it.

Forces needed to insert the threaded and the press-fit cups are different:

- screw in – it is 1500J (i.e. 1500 W. The 100W light bulb will stay lit for about 10 seconds) or 2 KM
- press – fit – it is 125 J (i.e. 125 W. The 100W light bulb will stay lit for about 1,5 second) or 0,16 KM

Hemispherical press - fit uncemented cup is the **gold standard** in THA

Additional stabilization with screws do not worsen the osteointegration

Threaded cup is an alternative with high risk of aseptic loosening and the probability is greater with time

In situation when we could implant the treader cup we can also implant the press-fit one

When we **cannot implant the treated cup** we certainly **could implant the press-fit cup** 😊
Thank you for your attention