



Materialise aMace

Patient-Specific Acetabular Implants

Manufactured by:
Materialise NV
Technologielaan 15, 3001 Leuven
Belgium, Manufactured in 2018

1. Summary

Up to 27% of hip revisions are re-revisions due to a suboptimal fixation and suboptimal biomechanical reconstruction of the joint^a when combining standard components. Furthermore, hip re-revisions are 3 times more likely to fail compared to a primary acetabular revision^b. These failures often lead to ever enlarging bone defects which render the next revisions more and more complex and frequent.

Based on +10 years of technical and clinical research, the **Materialise aMace Acetabular Revision System** is designed to **break this revision cycle**. The following, exhaustive clinical data proves this is actually successful. About 10% of all cases by Materialise have been reported in scientific studies from Germany, United Kingdom, The Netherlands and Belgium. This representative sample shows a **98% implant survival rate** at an average follow-up of 2 years (maximum 5 years)^{1,2,3,4,5,6}, which is the critical time frame for implant failure of standard components according to national registries^{1,2}.

1.1. Complications

As these are complex surgeries, complications cannot be completely avoided. Nevertheless, Materialise aMace shows **high performance in terms of complications** in these studies^{1,2,3,4,5,6}.

- ▶ Dislocations were reported in 13% of the studied cases up to 2 years post-surgery. None led to aMace revision, all were resolved by closed reduction.
- ▶ Studies report no signs of radiological loosening up to 2 years post-surgery.
- ▶ Studies report post-operational hematomas in 6% of the cases.
- ▶ Only 2 neurological complications reported so far.
- ▶ 2 Deaths were reported, both high-risk patients, no relation with the implant was inferred.

1.2. Satisfaction

Multiple studies also show that the use of Materialise aMace results in a **high patient satisfaction**^{1,3,4,6}:

- ▶ 100% of patients were satisfied with a high satisfaction score of 8.5/10.
- ▶ Almost all patients (98%) of queried patients would recommend the procedure to a family member or friend.
- ▶ The overall majority of patients (83%) reports a positive impact on their daily life after receiving an aMace implant.
- ▶ With an average follow-up time of 2.5 years post-surgery, the Harris Hip Score even improves from 22/100 (pre-surgery) to 59/100.
- ▶ Difficulty of the surgery was rated as very easy, easy or normal by 73% (16/22) of queried surgeons.

The clinical data on the use of the Materialise aMace Acetabular Revision System shows that the 3D preoperative planning combined with patient-specific instrumentation and implants, helps to provide a good fixation of the acetabular component. Therefore, Materialise aMace represents a viable solution for re-revision cases.

2. Key Studies

	Design	Publication	Key Points
Clinical	Evaluation of the accuracy with which a custom-made acetabular component can be positioned	Baauw et al. <i>Bone Jt J</i> 2015 (n=16) ¹	<ul style="list-style-type: none"> 3 complications, no infections, no additional surgeries 13/16 patients within Lewinnek's safe zone 2/3 implants with deviating orientation had no complications Encouraging results
	Retrospective clinical and radiological short-term follow-up (18-39 months) study	Baauw et al. <i>Orthopedics</i> 2017 (n=12) ²	<ul style="list-style-type: none"> 4 complications, no infections and no additional surgeries 92% of patients would recommend the treatment 83% of patients report improvement in daily functioning, had better mobility and less pain Valuable 3D analysis of the defects prior to surgery
	Retrospective clinical and radiological short-term follow-up (10-58 months) study (2 surgeons)	Citak et al. <i>Hip Int</i> 2017 (n=9) ³	<ul style="list-style-type: none"> Case series with complex acetabular defects (average 5 previous revisions, range 2-8) Overall implant-associated survival rate was 89% at mean follow-up of 29 months: 1 implant failure in patient with bilateral pelvic discontinuity 5/9 non-implant related complications Significant improvement of HHS score in 91% The study suggests a promising future for the technique
	short-term follow-up (10-58 months) study	Colen et al. <i>Acta Orthop Belg</i> 2013 (n=6) ⁴	<ul style="list-style-type: none"> No component removals, no revisions, no dislocations and no evidence of infection No signs of loosening, migration or hardware breakage All patients were satisfied with the clinical results. Good clinical outcome (HOOS score: 54-89) Patient-specific guides and titanium porous structure with triflange design are added value in the treatment of severe acetabular bone loss and pelvic discontinuity and provide the best chances for long term stability of the implant
	In-vitro and in-vivo study of 3D-printed acetabular implant with autologous skeletal stem cells	Goriainov et al. <i>Ren Med</i> 2018 (n=11) ⁵	<ul style="list-style-type: none"> In-vitro study shows that autologous bone marrow cells adhere on porous titanium surfaces and express osteogenic genes Case series of 11 patients with mean follow-up of 19.5 months no complications or need for further surgery indications of bone formation at bone-implant interface on CT significant improvement of Oxford Hip score
	Early (2009-2014) Belgian (13 surgeons) retrospective clinical short-term follow-up (3-50 months) study + focus on experience with the aMace Acetabular Revision System	Myncke et al. <i>Acta Orthop Belg</i> 2017 (n=20) ⁶	<ul style="list-style-type: none"> Good overall experience with aMace Acetabular Revision System (mean score 8.1/10) All surgeons would consider using the solution again 8 complications, no radiographic signs of implant loosening and no additional surgeries Patient satisfaction is high with almost all patients pain free All but one patient would go for the same surgery again

	Design	Publication	Key Points
Technical	Comparative study between radiographic and CT-based defect analysis for periacetabular bone defects	Horas et al. Orthopäde 2017 ⁷	<ul style="list-style-type: none"> ➤ Radiographic analysis often underestimates larger defects using Paprosky classification ➤ Intra- interobserver reliability of radiographic analysis is low ➤ Novel software tools based on CT data make it possible to anticipate volumetric bone loss, periacetabular bone quality and the intraoperative Paprosky grade in more detail.
	Quantification of in vivo bone ingrowth and fixation of clinically used Ti scaffolds in adult goats	Demol et al. J. Tissue Eng. and Reg. Med. 2012 ⁸	<ul style="list-style-type: none"> ➤ Porous Ti implants have good osseointegration characteristics ➤ Titanium surface allows good bone apposition ➤ The porous structure enables the bone to grow into the pores of the construct so that strong biological fixation of the implant in the bone is achieved

3. References

3.1. Publications

3.1.1. Clinical

1. Baauw M, van Hellemond GG, Spruit M. A custom-made acetabular implant for Paprosky type 3 defects. Orthopedics 2017;40(1):195-198.
<https://www.ncbi.nlm.nih.gov/pubmed/27610701>
2. Baauw M, van Hellemond GG, van Hooff ML, Spruit M. The accuracy of positioning of a custom-made implant within a large acetabular defect at revision arthroplasty of the hip. Bone Jt J 2015;97-B:780-5.
<https://www.ncbi.nlm.nih.gov/pubmed/26033057>
3. Citak M., Kochsiek L., Gehrke T., Haasper C., Suero E., M., Mau H. Preliminary results of a 3D-printed acetabular component in the management of extensive defects. Hip Int 2017; 4:0
<https://www.ncbi.nlm.nih.gov/pubmed/29218689>
4. Colen S, Harake R, De Haan J, Mulier M. A modified custom-made triflanged acetabular reconstruction ring (MCTARR) for revision hip arthroplasty with severe acetabular defects. Acta Orthop Belg 2013;79:71-5.
<https://www.ncbi.nlm.nih.gov/pubmed/23547519>
5. Goriainov, V., McEwan, J.K., Oreffo, R.O., Dunlop, D.G., 2018. Application of 3D-printed patient-specific skeletal implants augmented with autologous skeletal stem cells. Regen. Med. 13, 283-294.
<https://www.ncbi.nlm.nih.gov/pubmed/29715068>
6. Myncke I, van Schaik D, Scheerlinck T. Custom-made triflanged acetabular components in the treatment of major acetabular defects. Short-term results and clinical experience. Acta Orthop Belg 2017;83:341-350.
<http://www.actaorthopaedica.be/acta/article.asp?lang=en&navid=4&id=15844&mod=Acta>

3.1.2. Technical

7. K. Horas, J. Arnholdt, A. F. Steinert, M. Hoberg, M. Rudert, B.M. Holzapfel. Acetabular defect classification in times of 3D imaging and patient-specific treatment protocols. *Orthopäde* 2017; 46(2):168-178.
<https://www.ncbi.nlm.nih.gov/pubmed/28078371>
8. J. Demol, B. Lenaerts, S. Leuridan, S. De Boodt, P. Delpont. Bone ingrowth and biological fixation of selective laser melted porous scaffolds for the reconstruction of severe bone defects. *Journal of Tissue Engineering and Regenerative Medicine* 2012, 6 (Suppl 1), 401.
9. P. Vanden Berghe. Design of Custom Implants – Patient-specific analysis and evaluation. Doctoral thesis 2017, Faculty of Engineering, K.U. Leuven, Leuven, Belgium
10. P. Vanden Berghe, J. Demol, F. Gelaude, J. Vander Sloten. Virtual anatomical reconstruction of large acetabular bone defects using a statistical shape model. *Computer Methods in Biomechanics and Biomedical Engineering* 2017;20(6):577-586
<https://www.ncbi.nlm.nih.gov/pubmed/27957883>
11. P. Vanden Berghe, J. Demol, F. Gelaude, J. Vander Sloten. Automatic reconstruction of large acetabular bone defects using statistical shape models. *Orthopaedic Proceedings* 2014; 96-B; 11.
https://online.boneandjoint.org.uk/doi/abs/10.1302/1358-992X.96BSUPP_11.CORS2013-051
12. M. Van Parys, E. Audenaert, C. Pattyn. Threedimensional imaging and applications in the orthopaedic practise: state of affairs (original title: Driedimensionale beeldvorming en toepassingen in de orthopedische praktijk: een stand van zaken.) 2014; *Tijdschr. voor Geneeskunde*; 70 (5):233-242.
13. W. Bartels, J. Demol, F. Gelaude, I. Jonkers, J. Vander Sloten. Computed tomography-based joint locations affect calculation of joint moments during gait when compared to scaling approaches. *Computer Methods in Biomechanics and Biomedical Engineering*, 2014:1238-1251
<https://www.tandfonline.com/doi/abs/10.1080/10255842.2014.890186>
14. Delpont H, Mulier M, Gelaude F, Clijmans T. Complex acetabular revision using computer-aided planning for patient-specific implant and guide. *J Bone Joint Surg* 2012;94-B:40
https://online.boneandjoint.org.uk/doi/abs/10.1302/1358-992X.94BSUPP_XXV.ISTA2010-040
15. W. Bartels, J. Vander Sloten, I. Jonkers. Sensitivity analysis of hip joint centre estimation based on three-dimensional CT scans. *Computer Methods in Biomechanics and Biomedical Engineering* 2012, Vol. 15(5):539-546.
<https://www.tandfonline.com/doi/abs/10.1080/10255842.2010.548323>
16. W. Bartels, Biomechanical Modeling of the Lower Limb for Pre-Operative Planning. Doctoral thesis 2011, Faculty of Engineering, K.U.Leuven, Leuven, Belgium, 300 pages
17. F. Gelaude, T. Clijmans, H. Delpont, Quantitative computerized assessment of the degree of acetabular bone deficiency: Total radial Acetabular Bone Loss (TrABL). *Advances in Orthopedics* 2011; Article ID 494382, 12 pages
<https://www.hindawi.com/journals/aorth/2011/494382/>
18. G. Lenaerts, W. Bartels, F. Gelaude, M. Mulier, A. Spaepen, G. Van der Perre, I. Jonkers. Subject-specific hip geometry and hip joint centre location affects calculated contact forces at the hip during gait. *J Biomech* 2009; 42:1246-1251.
<https://www.ncbi.nlm.nih.gov/pubmed/19464012>
19. F. Gelaude, J. Vander Sloten, B. Lauwers. Accuracy assessment of CT-based outer surface femur meshes. *Computer Aided Surgery* 2008; 13(4):188-199.
<https://www.ncbi.nlm.nih.gov/pubmed/18622793>
20. F. Gelaude 2007, Medische beelden: concrete steun bij complexe bekkenchirurgie. *Het Ingenieursblad (HIB) (Koninklijke Vlaamse Ingenieursvereniging)* 2007(2): 34-39.
21. F. Gelaude, Computer-aided planning of bone reconstructive surgery: optimization of implant design through automation, integration and biomechanical validation. Doctoral thesis 2007, Faculty of Engineering, K.U.Leuven, Leuven, Belgium, 375 pages.

22. F. Gelaude, T. Clijmans, P.L. Broos, B. Lauwers, J. Vander Sloten. Computer-aided planning of reconstructive surgery of the innominate bone: automated correction proposals. *Computer Aided Surgery* 2007; 12(5):286-294.
<https://www.tandfonline.com/doi/full/10.3109/10929080701684762>
23. F. Gelaude, J. Vander Sloten, B. Lauwers. Semi-automated segmentation and visualisation of outer bone cortex from medical images, *Computer Methods in Biomechanics and Biomedical Engineering* 2006; 9(1):65-77.
<https://www.tandfonline.com/doi/abs/10.1080/10255840600604474>

3.2. Presentations

3.2.1. Clinical

- B. W. Wippermann. Solutions for complex hip surgery: How to get started. Materialise THINK Idea to Patient Care Webinar Series, 2018
- W. Rijnen, G. Flivik. Battle 'Acetabular revision arthroplasty; restoring bone defects with 3D-printed metal cups or bonegrafting'. NOV 2018, Rotterdam, The Netherlands
- Ph. Van Overschelde. Clinical and radiological outcome up to 4 years after hip revision surgery of complex acetabular defects with the aMace custom-made acetabular cup - a retrospective study. EHS 2018, The Hague, The Netherlands
- W. Rijnen. Patient specific 3D printed acetabular cages as last resort. EHS 2018, The Hague, The Netherlands
- G.G. van Hellemond. First experience with custom made 3D printed cups in revision. EHS 2018, The Hague, The Netherlands
- M. Baauw, Clinical results at 2-years follow-up of a 3d-printed custom-made acetabular implant for paprosky 3 defects. NOF 2018, Reykjavik, Iceland
- G. Flivik. 3D Implants, The Swedisch Experience. EFORT 2018, Barcelona, Spain
- G. Flivik. First experience with 3D implants. SOF 2017, Umea, Sweden
- G.G. van Hellemond. 3D printed cups in massive acetabular deficiency. AORcon 2017, Vancouver, Canada.
- D. van der Jagt, J. Pietrzak, L. Mokete. Two custom systems – comparisons, results and cost implications. Johannesburg Arthroplasty discussion group & Division of Orthopaedic Surgery University of the Witwatersrand, 2016, Johannesburg, South Africa
- G. Flivik. Challenging acetabular revisions – a truly patient-matched solution. CCJR Winter meeting, 2016, Orlando, Florida, US
- T. Gehrke #101 The Custom Acetabular Component: The 3D Printed Solution. CCJR Spring Meeting, 2016, Las Vegas
- S. Weidert, Patient-specific Implant for Post-Traumatic Acetabular Defect Reconstruction. Materialise THINK Medical 3D Printing Webinars, 2016.
- P. Van Overschelde. Complex acetabular reconstruction with custom made Mobelife implant. ICJR Middle East 2015, Dubai, United Arab Emirates
- H. Mau, S. Luck, T. Gehrke. Versorgung ausgedehnter acetabulärer Defekte mit Individualimplantaten. Endoprothetik 2015, Berlin, Germany
- J. Nilsson, Extreme acetabular reconstruction. BVOT Spring Symposium 2013, Antwerpen, Belgium
- M. Spruit, Custom implants for the treatment of Paprosky type IIIa and IIIb acetabular defects. BVOT Spring Symposium 2013, Antwerpen, Belgium
- M. Spruit. Challenging acetabular revision: Detailed analysis and patient specific approach. Early results. Orthopaedic Revision Forum. Challenges in the Hip. 2013, Leuven, Belgium
- J. Vuorinen, T. Suutarinen. Challenging pelvic defect reconstruction by patient-specific technology. Mobelife Symposium @ NOF 2012, Tallin, Estonia
- M. Spruit, G. Van Hellemond. Case specific acetabular reconstructions for challenging defects. Mobelife Symposium @ NOF 2012, Tallin, Estonia

3.2.2. Technical

- P. Tack. 3D is Here, But Can We Afford It Moving Forward? Materialise World Summit 2017, Brussels, Belgium
- F. Gelaude. Patient specific implant solutions. Regensburger Revisions-symposium 2015, Regensburg, Germany
- K. Govaers. Innovative custom technology in hip replacement. BVOT Spring Symposium 2013, Antwerpen, Belgium
- P. Vanden Berghe, J. Demol, F. Gelaude, J. Vander Sloten. Automatic reconstruction of large acetabular bone defects using statistical shape models. CORS 2013, Venice, Italy
- T. Clijmans, CT-based quantification of bone loss for refined classification of acetabular deficiencies: comparison of 30 Paprosky type IIIA-B cases. BOA Congress 2012, Manchester Central, Manchester, UK
- J. Demol, B. Lenaerts, S. Leuridan, H. Delpont. Bone loss management with 3D printed metal augments: in vivo evaluation of bone ingrowth and fixation. EHS 2012, Milano, Italy
- J. Vander Sloten. Engineering for health: the case of patient-specific implants. Mobelife Symposium @ NOF 2012, Tallin, Estonia
- J. Demol, A. Soares, B. Lenaerts, S. Leuridan, S. de Boodt, H. Delpont. In vivo biological fixation of selective laser melted bone scaffolds. 6B.6. EORS 2012, Amsterdam, Netherlands
- H. Delpont, M. Mulier, P. Vanderschot. Treatment of Paprosky IIIb acetabular deficiencies with personalised implants: a case report. 30. Jahrestagung der Österreichischen Gesellschaft für Orthopädie und Orthopädische Chirurgie, 2011, Linz, Austria
- H. Delpont, M. Mulier, P. Vanderschot. Paprosky type IIIb pelvic defect reconstruction by patient-specific technology. International Society for Technology in Arthroplasty (ISTA), 2011, Bruges, Belgium
- F. Gelaude for M. Mulier, M. Raaijmakers, A. Willems, T. Clijmans. Personalized implant design for acetabular revision. IMUKA 2010, Maastricht, Netherlands
- T. Clijmans. 3D image processing and pre-operative planning in orthopaedics. EHS 2010, Athens, Greece
- F. Gelaude for H. Delpont, M. Mulier, P. Vanderschot. All-in-one patient-specific implant solution for severe acetabular revision – a case report. EHS 2010, Athens, Greece
- H. Delpont, M. Mulier, T. Clijmans, F. Gelaude. Complex acetabular revision using computer-aided planning for patient-specific implant and guide. International Society for Technology in Arthroplasty (ISTA), 2010, Dubai
- M. Raaijmakers. Surgical guides for hip joints. 33ème Journée Informelle HIS - site Ixelles 2010, Brussels, Belgium

3.3. Abstracts & Posters

- J. Demol, A. Soares, B. Lenaerts, S. Leuridan, S. De Boodt, H. Delpont. Custom metal augments produced by selective laser melting for the reconstruction of severe bone defects: in vivo evaluation of bone ingrowth and biological fixation. Poster @ EFFORT 2013
- F. Gelaude, J. Demol, T. Clijmans, H. Delpont. Acetabular deficiency classification by numbers: overview of 40 Paprosky type IIIA-B cases. Abstract n° 32465 @ Combined 33rd SICOT & 17th PAOA Orthopaedic World Conference 2012, Dubai, United Arab Emirates
- J. Demol, B. Lenaerts, S. Leuridan, S. De Boodt, H. Delpont. Osseointegration of personalized 3D printed metal augments for the management of severe acetabular bone loss. Abstract n° 32461 @ Combined 33rd SICOT & 17th PAOA Orthopaedic World Conference 2012, Dubai, United Arab Emirates
- W. Bartels, J. Demol, F. Gelaude, J. Vander Sloten, I. Jonkers. Patient-specific musculoskeletal models can predict the impact of acetabular reconstruction on hip muscle length. Abstract n° 32471 @ Combined 33rd SICOT & 17th PAOA Orthopaedic World Conference 2012, Dubai, United Arab Emirates
- J. Demol, A. Soares, B. Lenaerts, S. Leuridan, S. De Boodt, H.P. Delpont. Bone ingrowth and biological fixation of selective laser melted porous scaffolds for the reconstruction of severe bone defects. Poster @ TERMIS World Congress 2012 "Tissue Engineering and Regenerative Medicine". 2012, Vienne, Austria Journal of Tissue Engineering and Regenerative Medicine 2012: 6(Suppl.1):401

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- W. Bartels, J. Demol, F. Gelaude, J. Vander Sloten, I. Jonkers. Simulation tool for predicting the impact of acetabulum reconstruction on hip muscles. Abstract @ NOF 2012
- T. Clijmans for F. Gelaude, J. Demol, H. Delpport. Computerised quantification of the degree of bone loss in 30 Paprosky type IIIA-B cases: comparison and relevance to classification. Abstract @ NOF 2012
- B. Lenaerts for J. Demol, S. Leuridan, H. Delpport. Bone ingrowth in porous titanium bone augments in in vivo goat model: customization and functionalization. Abstract @ NOF 2012
- H. Delpport, M. Mulier. Custom implant for Paprosky IIIB acetabular revision: a case report. E-poster #5499 @ EFORT 2012, Berlin, Germany
- H. Delpport, M. Mulier. Extreme acetabular reconstruction: Solving the impossible requires innovative techniques. A Case illustration. E-poster @ EHS 2012, Milano, Italy
- F. Gelaude, J. Demol, T. Clijmans, H. Delpport. CT-based acetabular deficiency classification by numbers: illustration on 50 Paprosky type IIIA-B cases. E-poster @ EHS 2012, Milano, Italy
- T. Clijmans, F. Gelaude, J. Demol, H. Delpport. Refined classification of acetabular deficiencies using CT-based quantification of the amount of bone loss: overview of 30 Paprosky type IIIA-B cases. Abstract FM 64 @ SGOT 2012, Basel, Switzerland
- B. Lenaerts, J. Demol, S. Leuridan, H. Delpport. Management of acetabular bone loss with 3D printed metal augments: in vivo bone ingrowth and fixation. Abstract FM 1 @ SGOT 2012, Basel, Switzerland
- F. Gelaude, T. Clijmans, H. Delpport. 3-dimensional quantitative classification of acetabular defects: Total radial Acetabular Bone Loss (TrABL). E-poster @ 30. Jahrestagung der Österreichischen Gesellschaft für Orthopädie und Orthopädische Chirurgie, 2011, Linz, Austria
- W. Bartels, G. Lenaerts, M. Mulier, G. Van der Perre, J. Vander Sloten, I. Jonkers. Subject-specific musculoskeletal models are needed to accurately predict hip loading. Abstract @ ISB Congress 2011, Brussels, Belgium
- H. Delpport, M. Mulier, T. Clijmans, F. Gelaude. Bone and joint implant fixation personalized. Poster @ International Society for Technology in Arthroplasty (ISTA), 2011, Bruges, Belgium
- T. Clijmans, M. Mulier, P. Broos, F. Gelaude. Custom pelvis salvage surgery planning and implantology for better functionality. Poster @ EMSOS 2010, Birmingham, UK
- A. Willems, M. Mulier, M. Raaijmakers, T. Clijmans, F. Gelaude. Reconstruction of complex acetabular deficiencies with patient-specifically designed and evaluated implants. Poster 53 @ EORS 2010, Davos, Switzerland
- P. Broos, T. Clijmans, J. Dille, J. Vander Sloten, F. Gelaude. Contribution of 3D image processing and pre-operative planning to orthopaedic health care. Poster 26306 @ 7th SICOT/SIROT Annual International Conference & SOF Ortopediveckan 2010, Gothenburg, Sweden
- M. Mulier, M. Raaijmakers, F. Gelaude, A. Willems, T. Clijmans. Severe acetabular revision surgery: a personalized approach. Poster 26290 @ 7th SICOT/SIROT Annual International Conference & SOF Ortopediveckan 2010, Gothenburg, Sweden
- M. Raaijmakers, K. De Smedt, F. Gelaude, T. Clijmans, F. Stockmans, M. Mulier. Patient-Specific guide technology in orthopaedics. Poster 26263 @ 7th SICOT/SIROT Annual International Conference & SOF Ortopediveckan 2010, Gothenburg, Sweden
- F. Gelaude, W. Bartels, P. Bertrand, P.L. Broos, B. Lauwers, G. Van der Perre, J. Vander Sloten. Inter-subject variability of hip moment arms. Poster @ Symposium 'Prediction and evaluation of THR performance: can we plan success?' Proceedings of Symposium 'Prediction and evaluation of THR performance: can we plan success?' 2007, Leuven, Belgium: 37-38.
- F. Gelaude, P.L. Broos, M. Mulier, B. Vandenbroucke, J-P. Kruth, B. Lauwers, J. Vander Sloten. Treatment of massive acetabular defects with excessive bone loss: from automated computer-based reconstruction proposal to biomechanically justified defect-filling Triflange Cup implant. Poster 72 @ Proceedings of the International Society for Computer Assisted Orthopaedic Surgery (CAOS) 2007, Heidelberg, Germany: 514-517.
- F. Gelaude, T. Clijmans, B. Lauwers, J. Vander Sloten. A database for muscle attachment regions: femur and pelvis. Poster @ Computer assisted radiology and surgery conference (CARS) 2006, Osaka, Japan

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