TRABECULAR TITANIUM™
WHAT BONE REALLY WANTS TO BE NEXT TO

CLINICAL CASES
**Trabecular Titanium** is a three-dimensional, multiplanar, regular, hexagonal cell structure characterised by a high open porosity that imitates the morphology of the trabecular bone. The biocompatibility of Titanium, the optimal pore size, the structure and the elastic module that mimic the natural bone have been combined to enhance the process of bone in-growth and vascularisation.

In vitro analysis of genetic expression on human osteoblast-like cells reports that **Trabecular Titanium** is able to stimulate osteoblasts proliferation and differentiation and to limit osteoclastogenesis. Furthermore, **Trabecular Titanium** demonstrates to have an osteoinductive behavior. Human adipose stem cells grown on TT are able to adhere, proliferate and differentiate into osteoblast-like phenotype thus producing a mineralized extracellular bone matrix. If compared to other biocompatible scaffolds of different material and structure, the amount of proteins of the bone matrix is significantly higher. This leads to the conclusion that not only the material but also the structure significantly affects cell proliferation.

The analysis of the osteointegrative potential in an in vivo sheep model reports significantly high bone in-growth percentages, both in cancellous and cortical bone.

Preliminary results from a prospective densitometric study on 89 patients (91 hips), that underwent primary THA with a DELTA-TT cup, reported a postoperative recovery of bone mineral density in DeLee and Charnley zones 12 and 24 months after surgery. Radiographic assessment confirmed the osseointegration therefore the stability of the acetabular cups. Relevant clinical outcomes have been reported: the average Harris Hip Score and range of motion significantly improved from preoperative analysis to 24 months, with a constant progression in the intermediate follow-ups.

**Early improvement in clinical and functional recovery** after THA with DELTA-TT cup has been also confirmed by a clinical study performed on 150 patients with an average follow-up of 12 months.

The following nine interesting clinical cases illustrate some examples of preoperative situations and postoperative results that can be achieved with the DELTA-TT cup and the excellent osteointegrative properties of **Trabecular Titanium**.
A 69-year-old man (170 cm, 70 kg, 24 BMI) with a bilateral primary coxarthrosis suffered from severe, persistent weight-bearing pain and significant limitations in activities of daily living due to a very poor functional condition (HHS 44). From radiographic evaluation, advanced-stage osteoarthritis with the presence of osteophytes, cysts and calcifications was observed.

The patient underwent a right primary total hip arthroplasty through postero-lateral approach with the implantation of 56 mm DELTA-TT cup, a BIOLOX® delta large liner and a BIOLOX® forte 36 mm medium head.
Immediate postoperative x-rays showed a good restoration of biomechanical parameters with normally anteverted cup and 50° inclination angle. The cup had a very good primary stability that was an important prerequisite to secondary osseointegration.

X-rays of right hip showed a very good osseointegration thanks to the new bone formation inside the open porosity of TT. The patient recovered with excellent functional outcomes already after 3 months (HHS 100 points). These results have been also confirmed at 12 months.
The results of the right THA were so stable and satisfactory after 12 months that he underwent the contralateral surgery. The contralateral total hip arthroplasty was performed with a 54 mm DELTA-TT cup, a Biolox® delta large liner and a BIOLOX® delta 36 mm long head. The left acetabular bone was more sclerotic than the right one. Both hips had a standard cementless straight PLS stem (# 4). Postoperative x-rays of the left hip showed a stable normally anteverted cup with 45° inclination angle.
A very good clinical and functional outcome (HHS: 100 points for left hip and 85 points for right hip) allowed the patients to regain a normal life style with no pain and no limitations in daily activities.

The high results of SF-36 gave evidences of patient satisfaction (93 points).

Both cups were stable with a very good osseointegration without signs of radiolucent lines or osteolysis.
74-year-old woman suffered from untreatable pain in her right hip associated with important limping and limited mobility. Rotation of the hip joint was blocked and flexion was very painful and below 90°. Weight bearing x-rays showed a reduced articular space and the MRI scan revealed an aseptic necrosis of the femoral head.

A right primary total hip arthroplasty was performed implanting a 48 mm DELTA-TT cup, a cross linked polyethylene–ceramic coupling and a cementless anatomic modular SAM-FIT stem (# 2) with a standard long neck. Intraoperatively, significant intrarticular fluid caused by the necrotic bone was found and the collapse of the femoral head was confirmed. At the end of surgery the joint was stable and with good mobility.

The hip reconstruction allowed restoring a good alignment of the joint with an optimal positioning of the cup that ensured a strong primary stability thanks to the high press-fit of the Trabecular Titanium™.
The patient quickly regained a good joint functionality with no pain. From radiographic evaluation, a stable cup was evident with good initial signs of new bone formation. A good restoration of hip parameters was also confirmed.

12-MONTH FOLLOW-UP

The osteointegration of the DELTA-TT cup was significant and gave a definite secondary stability to the cup. The patient assured to have completely forgotten to have an operated hip, thanks to the very satisfactory clinical results. She showed a complete, pain-free ROM, reaching 120° flexion, 40° abduction/adduction and 40° internal/external rotation. Absence of pain and a good walking performance without supports or limping did not limit her normal daily activity anymore.
A 67-year-old woman (53 kg, 160 cm, 21 BMI) was affected by a left osteoarthritis secondary to a slipped capital femoral epiphysis that caused her severe, continuous, weight-bearing pain. Trendelenburg sign was negative but she had consistent limitations to mobility (HHS: 50 points). A 10 mm limb length discrepancy was reported.

A left primary total hip arthroplasty through direct lateral approach was performed with the implantation of a 52 mm DELTA-TT cup with a BIOLOX® delta medium liner and a BIOLOX® forte medium 36 mm head. The stem used was a 21 mm Modulus with a 125° short neck.

Immediate postoperative x-rays showed a good restoration of biomechanical parameters with the restoration of the centre of rotation and limb length correction. The cup was normally anteverted with 40° inclination angle. The cup had a very good primary stability and after only 1 week from surgery the patient had first signs of improvement (HHS: 68 points).
Clinical and functional evaluation significantly improved (HHS: 98 points) thanks to complete pain relief and very good ROM. X-rays analysis highlighted a good result with an optimal osseointegration of the cup that gave stability to the implant. No radiolucent lines or osteolysis were seen. Despite the very short term of this evaluation, the patient was very satisfied with the outcome because she was able to return to her normal daily activity without pain and limitations.

12-MONTH FOLLOW UP
From radiographic evaluation, the cup resulted well osseointegrated and stable, without signs of radiolucent lines or osteolysis. The clinical outcome was excellent because of total pain relief, an excellent walking performance and very good ROM (HHS: 100 points). The general health status of the patient was significantly improved with the hip reconstruction (SF-36: from 48 preoperatively to 91 postoperatively).
An active 56-year-old man (175 cm, 88 kg, 29 BMI) had an idiopathic avascular necrosis of the left hip with presence of osteophytes mainly at the superior part of the acetabulum and head, where bone was sclerotic. He had marked pain and functional limitations in daily activities (HHS: 49 points).

A left primary total hip arthroplasty was performed through postero-lateral approach with a 56 mm DELTA-TT cup coupled with a CoCrMo neutral large liner and a CoCrMo 36 mm short head. Primary stability was guaranteed by the high friction of Trabecular Titanium™. Two screws have been used not because of micro-instability, but as an additional measure due to bone stock and cup orientation.

The cup was implanted with a correct anteversion and 40° inclination angle in order to restore biomechanical parameters. The patient had a good immediate postoperative recovery.
Clinical recovery was fast. Already after 6 months, it corresponded to very good results (HHS 100 points) living up to the expectations of the patient that was able to return to his active life style. Complete pain relief and good mobility were achieved.

**6-MONTH FOLLOW-UP**

The radiographic assessment reported a good bone ingrowth leading to an optimal stability of the cup, without signs of radiolucent lines or osteolysis. Clinical results are confirmed to be excellent, stable and fully satisfactory, in terms of walking performance and ROM (HHS: 100 points). As demonstrated by a significant increase of the subjective evaluation results (SF-36: from 44 preoperatively to 85 postoperatively), the patient was extremely happy with the outcome.

**12-MONTH FOLLOW-UP**
A sedentary 75-year-old woman (170 cm, 80 kg, 28 BMI) had an advanced primary osteoarthritis with a long medical history of persistent severe hip pain. Conservative treatments, as physiotherapy and infiltrations, were not successful and pain compromised her daily activities due to functional limitation (HHS: 45 points; SF-36: 40 points). X-rays showed a slight varus deformity with periacetabular osteophytes, presence of cysts on the femoral head and small calcifications near the greater trochanter. Sclerotic areas could be observed especially on the acetabular roof.

A right primary total hip arthroplasty through lateral approach was performed with a 52 mm DELTA-TT cup coupled with a cross-linked polyethylene neutral medium liner and a BIOLOX® delta 32 mm medium head. A cementless anatomic modular SAM-FIT (#5) stem was implanted with a standard long neck.

Immediate postoperative x-rays showed a good restoration of biomechanical parameters with normally antverted cup and 45° inclination angle. The cup had a very good primary stability that was an important prerequisite to secondary osseointegration.
The patient had complete pain relief that allowed her to quickly regain a normal functionality and an excellent clinical outcome (HHS: 94 points). The cup was stable thanks to an optimal osseointegration, with absence of radiolucent lines.

6-MONTH FOLLOW-UP
X-rays confirmed a good radiographic result with a complete osseointegration. The patient reached stable satisfactory functional outcomes with a good impact on her general health status (HHS: 98 points; SF-36: 92 points).

24-MONTH FOLLOW-UP
63-year-old man had been suffering from inguinal and periarticular pain for over 3 years. It was initially considered a sciatic symptom due to a long medical history of lumbar painful degeneration, instead of due to a hip problem. The patient had a very limited and painful ROM with a flexion reduced to 60° and no rotation.

Standard weight-bearing x-ray did not reveal important signs of degeneration, but the MRI showed an important necrosis of the left femoral head.

The reconstruction of the left hip joint was performed with a 54 mm DELTA-TT cup with a ceramic-ceramic coupling (BIOLOX® delta large 40 mm femoral head).

A cementless anatomic modular SAM-FIT stem (# 4) was implanted with a standard long neck. The cup was implanted in the anatomical situ, providing the patient a correct centre of rotation.

Thanks to the highly porous structure of TT, a good primary stability was achieved, even if the acetabular bone was partially necrotic.
The postoperative x-ray confirmed a good positioning of the cup with correct alignment of the stem. The first day after surgery, the patient started to move the operated hip showing rotations of over 30°.

X-rays confirmed the absence of radiolucent lines, osteolysis or sign of instability. The osteointegration of the cup was complete thanks to the extensive bone in-growth of TT. The patient was very satisfied with the functional outcome. He was able to regain a normal ROM and good walking performance that allowed him to return to his daily activities without pain or limitations.
A 54-year-old woman was affected by secondary osteoarthritis after Pemberton pelvic osteotomy. A pericapsular osteotomy through the full thickness of the ileum, using the triradiate cartilage as hinge for anterior and lateral rotation of the acetabular roof was performed. The patient had severe pain and limited ROM, with a clinical state similar to a hip arthrodesis but without the advantages of a stable fixation.

A right primary total hip arthroplasty through postero-lateral approach was performed with the implantation of a 50 mm DELTA-TT cup and ceramic-ceramic coupling (36 mm medium head).

The postoperative x-rays showed a good restoration of biomechanical parameters. The centre of rotation was reconstructed thanks to a further acetabular roof reconstruction and the offset was restored with a lateralising stem.
The patient gained complete hip function with balanced pelvic stability.
No Trendelenburg sign was observed thanks to good muscle recovery and balance.

12-MONTH FOLLOW-UP
X-rays showed a progressive bone remodelling and good osseointegration of the cup which ensured an optimal stability.
Clinical and functional results were very satisfactory with no pain and good mobility.
The patient was able to acquire normal daily activities improving her quality of life.
8 DELTA-TT CUP IN A CASE OF PRIMARY OSTEOARTHRITIS

PREOPERATIVE

74-year-old woman had been suffering from inguinal pain on her right side with irradiation up to the ventral part of the right knee for 4 years. She had a long medical history of spondyloarthritis of the lumbar spine. She had severe limitations to normal mobility. The clinical examination showed a painful rotation (20°-0°-10°) a reduced passive flexion (70°) and extension (30°). From radiographic analysis, a degeneration of the right hip with a significant reduction of the joint space was visible.

INTRAOPERATIVE

A right primary total hip arthroplasty was performed with a 50 mm DELTA-TT cup, a polyethylene-ceramic coupling and a cementless anatomic modular SAM-FIT stem with a lateralising long neck. Despite the poor acetabular bone, the cup had a good intraoperative “grip” thanks to the highly porous TT structure that ensured an optimal primary fixation.
The short term clinical outcome and the rapidity of the functional recovery were excellent, considering the preoperative condition. The patient had no pain and she was able to regain a complete range of motion and a good walking performance.

Radiographically, no signs of radiolucent lines or osteolysis but a very good osseointegration were observed. She was definitely satisfied by the fact that this outcome significantly improved her quality of life.

**POSTOPERATIVE**

X-rays showed that a correct joint configuration was restored and a normal anteversion of the cup with 55° inclination angle.

**12-MONTH FOLLOW-UP**

The short term clinical outcome and the rapidity of the functional recovery were excellent, considering the preoperative condition. The patient had no pain and she was able to regain a complete range of motion and a good walking performance. Radiographically, no signs of radiolucent lines or osteolysis but a very good osseointegration were observed. She was definitely satisfied by the fact that this outcome significantly improved her quality of life.
A 54 year-old man was affected by a bilateral Crowe type-4 dysplasia previously treated with a right Mills-Cherry type pelvic support osteotomy. A transiliac lengthening accomplished by modification of Salter technique was performed. The patient suffered from severe pain, functional limitations and extreme limping.

A right primary total hip arthroplasty through postero-lateral approach with Ganz osteotomy of the greater trochanter was performed with the preservation of the insertions of both gluteus medius and vastus lateralis. A 46 mm DELTA-TT cup with a ceramic-ceramic coupling (32 mm short head) was implanted. The tendon insertion was reconstructed and an osteosynthetic replacement with screws and a cerclage of the greater trochanter was performed.

The postoperative x-rays showed a good restoration of biomechanical parameters and demonstrate that the pelvic axis results in perfect balance even with the contralateral iliac dislocation.
X-rays demonstrate a complete osseointegration of the cup. The patient had a good functional recovery. Despite the pseudoarthrosis of the greater trochanter, a satisfactory abduction was possible thanks to the digastric technique.

Following the good results of the right hip, one year later the patient underwent the contralateral total hip arthroplasty with a 44 mm DELTA-TT cup and a ceramic-ceramic coupling (32 mm short head).

A shortening subtrochanteric osteotomy was performed to balance the biomechanical parameters.
DELTA-TT CUP IN A CASE OF BILATERAL CROWE IV DYSPLASIA

24 months after the primary right THA and 12 months after of the contralateral side, it was possible to observe the bone healing of the acetabular dome following the osteotomy. Thanks to the highly porous TT structure, primary stability was combined with an adequate osseointegration.
DELTA-TT CUP IN A CASE OF BILATERAL CROWE IV DYSPLASIA
The high porosity of \textit{Trabecular Titanium} can ensure a good osseointegration of the DELTA-TT cup. Already at 12 months, x-rays showed all the most sensitive signs reported to be indicative of bone in-growth: the absence of radiolucent lines, the presence of a supero-lateral dense bone buttress, the presence of medial stress-shielding in DeLee and Charnley zone II, the presence of radial trabeculae oriented in a direction perpendicular to the surface of the cup in DeLee and Charnley Zone I or Zone II and the presence of an infero-medial bone buttress.\textsuperscript{4}


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