WAGNER CONE PROSTHESIS™

Surgical Technique

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WAGNER CONE PROSTHESIS SURGICAL TECHNIQUE

CONTENTS

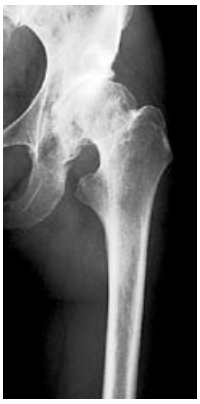
Indications

The Cone Prosthesis is designed for cylindrical proximal femoral bone that could fracture when conventional flared stems are used. The Cone Prosthesis is also designed for deformities of the femur where fixation of conventional stems is problematic. Specifically, the Cone Prosthesis is indicated when the following factors are present:

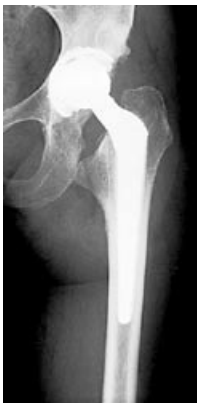
- A cylindrical configuration of the proximal medullary cavity, as found with congenital dysplasia of the hip (CDH), which causes problems for conventional flared stems. Cylindrical femoral bone is usually delicate and found in combination with coxa valga.
- Increased anteversion of the femoral neck, e.g., CDH, where the cross section of the proximal medullary cavity is anteverted even after resection of the femoral neck. With the circular cross section of the stem of the cone prosthesis, the angle of anteversion can be adjusted as desired.
- Deformities and intramedullary bony scarring of the proximal end of the femur after osteotomies, fractures, growth disorders or congenital deformities. Preparing the medullary cavity to receive the stem with a conventional reamer can be very tedious or even impossible, whereas preparation with the conical awls of the Cone Prosthesis can be carried out more easily and safely.

Contraindications

The most important contraindication is the trumpet-shaped proximal widening of the medullary cavity where there is no support for the prosthetic stem in its middle and proximal thirds. In addition, a Cone Prosthesis should not be considered when there is considerable weakening of the bone structure at the proximal end of the femur; implants with a greater length of stem will provide more stable fixation.



49-year-old woman with dysplastic arthritis of the left hip



6 years after implantation of a Cone Prosthesis and standard cup with metal articulation

Biomechanical Concept

The Cone Prosthesis has a conical angle of 5 degrees and fits the proximal medullary cavity better than a conventional flared stem. The concept of conical fixation is derived from positive experience with the 2 degree Wagner revision stem in which fixation is predominantly diaphyseal.

The circular conical stem is not subject to any rotation force during insertion, i.e., the angle of anteversion can be determined by the surgeon. The stem has 8 sharp longitudinal ribs. The relatively sharp ridges of the ribs cut into the bone, thus allowing for optimum rotational stability. This also explains why the typical thigh pain associated with some uncemented prosthetic systems is practically unknown with the Cone Prosthesis.[1]

The depth of penetration of the longitudinal ribs depends on the hardness of the bone. The depth of penetration of these ribs is slight on the whole and usually ranges from 0.1 – 0.5mm. Nevertheless, the penetration of the ribs into the bone is important for the depth of fixation of the stem and thus for the length of the leg and the tension in the soft tissues. With a cone angle of 5 degrees, a 1mm variation in the stem diameter leads to a variation of 12mm in the depth of insertion. This means that if a prosthetic stem that is 1mm too thin is inserted into the conically reamed medullary cavity, the stem will be anchored 12mm further down. The same applies if the longitudinal ribs of the stem cut 0.6mm instead of 0.1mm into the bone in the case of soft bone. This phenomenon therefore demands sensitivity on the part of the surgeon when using the awls: softer bone requires slightly less reaming than hard bone.

In addition to providing rotational stability, the sharp longitudinal ribs of the stem are also beneficial for bony apposition. Schenk's[2] investigations have shown very clearly that bone forms and attaches preferentially on the sharp-edged prominences of the implant and less in the hollows of the surface.

The round stem facilitates unimpeded rotation during implantation to adjust the anteversion angle.

1 Wagner H, Wagner M. Cone prosthesis for the hip joint. *Arch Orthop Trauma Surg*. 2000; 120: 88-95.
2 Schenk RK, Wehrli U. Zur Reaktion des Knochens auf eine zementfreie SL-Femur-Revisionprothese. *Orthopade*. 1989; 18: 454-462.

The Implant

The Cone Prosthesis, designed for uncemented fixation, is manufactured from the tissue-compatible titanium-aluminium-niobium alloy Protasul™-100.

The surface of the prosthesis is grit-blasted which, together with the characteristic shape, promotes bony apposition over a large area.[2]

To enhance fixation, the prosthesis has a conical shape, and the core and cover angles are each 5 degrees. There are eight longitudinal sharp conical ribs arranged on the circumference of the stem, which serve for the actual fixation of the prosthesis.

The height of the ribs varies between 1 and 2.5mm depending on the diameter of the stem. The ribs are the same height along their entire length. They are shaped so that they penetrate 0.1 to 0.5mm into the bone, depending on the hardness of the bone, and ideally make contact with bone over their entire length. To achieve this, there is a sharp conical awl for each diameter that has a shape adapted to the implant, i.e., it has a cover angle of 5 degrees.

The eight ribs give the prosthesis a high degree of rotational stability.[3] In order to reduce the bending and torsional stresses in the ribs that can occur under loading, they are not knife-edged but have a ridge surface with a radial width of 0.4 to 0.5mm. This shape increases the strength of the prosthetic stem.

In order to achieve broad-based support of the prosthesis in the region of the calcar, the medial rib is inserted distal to this area into the convex support surface. All the other ribs are inserted somewhat further proximally in order to ensure the greatest possible area of contact in the trochanter to provide rotational stability.

The CCD angle is 135 degrees for all sizes and the neck length increases as the stem diameter increases. The stem has a standard 12/14 taper to take ceramic, metal or Metasul® femoral heads, which are all available in multiple sizes.

The stem is available in 12 diameters from 13 to 24mm to fit the width of the patient's medullary cavity.

3 Buhler D, Berlemann U, Lippuner K, Jaeger P Nolte L. Three-dimensional primary stability of cementless femoral stems. *Clinical Biomechanics.* 1997; 12: 75-85

Instruments

Surgeons have a set of user-friendly instruments at their disposal for implantation of the Cone Prosthesis. The core instruments are reamers (awls) which are used for the careful preparation of the medullary canal, as well as trial prostheses, used for determining the best-suited size of implant.

Reamers (Awls)

The Cone Prosthesis, with its circular cross-section, is indicated particularly for slender configurations of the proximal femur, as well as for cases involving pathologic morphology. When these indications are present, an important focus should be placed on the preparation of the medullary canal in the most bone-preserving manner. The use of reamers allows the surgeon to prepare the medullary canal with care and precision, even in cases of poor bone quality of the proximal femur where the use of rasps is not an option. The range of instruments includes a set of conical reamers, graded in millimeter increments corresponding exactly to the diameter of the implants. The medullary canal can therefore be enlarged in a stepwise fashion. The markings on the reamers determine the position of the center of rotation of the femoral head, which enables the surgeon to have continuous control as to the depth of the reamer.

Trial Stems

Trial stems are used to determine the exact positioning and correct size of the final implant. Trial stems are designed to duplicate the size and fit of the actual implants, to allow the surgeon to determine optimum implant diameter with a high degree of precision.

Trial stems are available in sizes identical to those of the corresponding implants. Please note that the trial stems have only four ribs (instead of eight, as on the actual implants) to facilitate easy extraction of the trial prosthesis, and to avoid unnecessary damage to the bone in the trial procedure.

The trial stem may be inserted as far as the intended anchoring depth of the implant, affording the surgeon an exact replication of the implant positioning so he or she can accurately assess tension of the soft tissue, range of motion, and degree of anteversion. As a result, accurate final seating of the implant can be achieved.

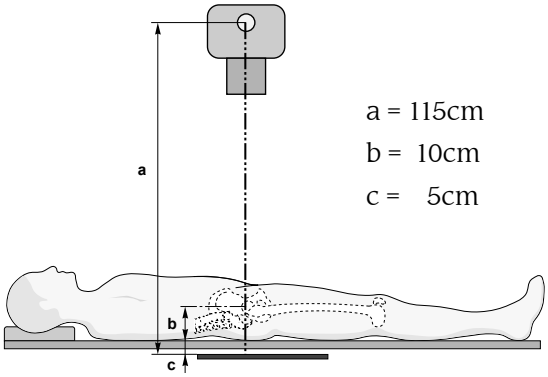
Preoperative Planning

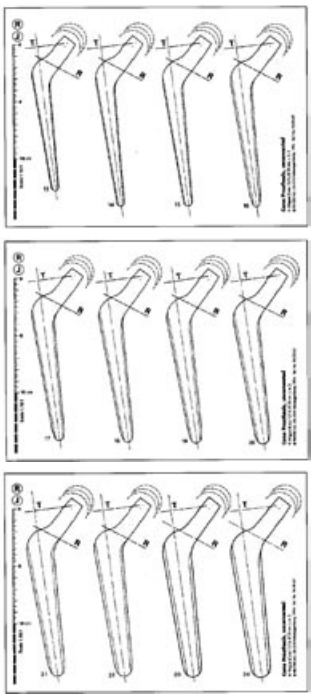
The preoperative planning follows standard procedures.

A good-quality x-ray with a magnification of 1.15:1 is essential. The usual planning templates fit this scale. To achieve this degree of magnification, it is assumed that the bone lies 10cm above the tabletop of the x-ray machine. In addition, the distance from the tabletop to the level of the film should be 5cm and the distance from the focus of the x-ray tube to the film should be 115cm (Fig. 1).

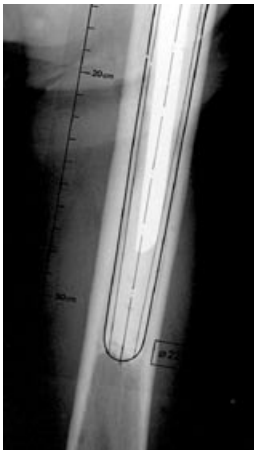
In very obese patients, the bone can lie higher above the table. In this case, either the distance from the tube to the film must be increased or a marker of precisely defined length must be imaged on the x-ray film at the height of the bone at the same time.

Fig. 1

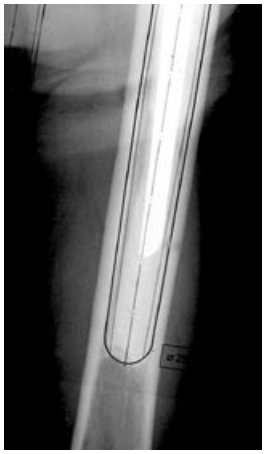




Planning templates for cone prosthesis, 13–24mm diameter, 06.01148.000



Determination of the appropriate stem diameter with the planning template. The contour of the template lies on the contour of the cortical bone. This stem diameter is too small.



With the correct diameter, the contour of the template must overlap the contour of the cortical bone by 1mm.

The first step in planning consists of selecting suitable implants for the acetabulum and the femur using the planning templates on the original x-ray films.

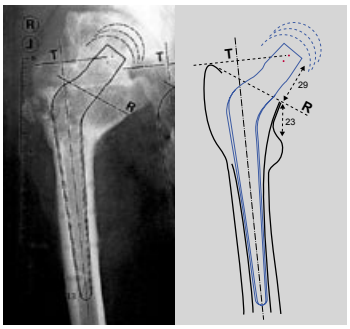
When selecting the Cone Prosthesis, it is important that the configuration of the femur allows close contact between the middle third of the prosthetic stem and the cortex, and not just that the tip of the stem fits tightly in the medullary cavity.

Selection of the correct stem diameter is particularly important. It is important not to choose a stem diameter that is too small. Such a decision can result in secondary subsidence of the prosthesis in its conical fixation. The outline on the planning template corresponds exactly to the dimensions of the implant. In choosing the diameter, it must be remembered that reaming with the awl removes a thin layer of bone and that the sharp longitudinal ribs cut slightly into the bone during insertion. The outline of the prosthetic stem on the planning template must therefore overlap the inner outline of the cortex in the region of the middle third of the stem by 1mm on each side.

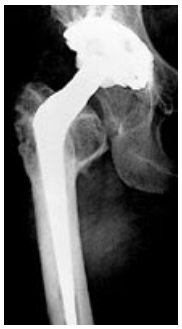
On the outline drawing of the pelvis, the position of the cup implant with the center of rotation is first sketched and the current and desired position of the tip of the trochanter is marked in order to check the leg length.

Using the planning template, the outline of the selected Cone Prosthesis is then transferred to the planning sketch and the line of resection and the trochanteric reference line are also drawn from the template. The planning sketch is now laid on the x-ray film and the outline of the femur is transferred carefully. The tip of the greater trochanter on the x-ray is at the level of the previously made marking for the desired trochanter position and usually coincides with the trochanteric reference line transferred from the template.

Finally, the distance between the line of resection and the proximal limit of the lesser trochanter is measured. This gives the level of resection of the femoral neck. In reconstructing deformed hip joints, further marking points can be given and their distances measured. All longitudinal measurements must be made according to the scale on the template as this takes into account the degree of magnification of the x-ray. All measurements should be entered on the planning sketch so that they can be referred to during the operation.



X-ray example of preoperative planning with superimposed template



3 years postoperative

Surgical Technique

The Cone Prosthesis can be implanted using all of the usual operative approaches. However, posterior access with the patient in the lateral position is particularly suitable. The awl for the Cone Prosthesis has a straight stem, which is introduced into the axis of the medullary cavity. With the posterior approach, when the hip and knee are flexed, the way to the medullary cavity is free without the need for temporary removal of the greater trochanter and without the instrument exerting pressure on the muscles.

With the lateral, transgluteal and anterior approaches, retraction of the muscles is more difficult. Moreover, with the posterior approach, the incision is smaller and there is less blood loss with the patient in the lateral position. This is particularly apparent in obese patients.

The incision or resection of the posterior joint capsule is a critical point in the posterior approach. Posterior dislocation of the prosthesis can occur more readily during the healing phase if the prosthetic cup and/or the stem are placed in insufficient anteversion. This problem can be counteracted by a test reduction before definitive fixation of the Cone Prosthesis, but nonetheless, this phenomenon requires particular care. In borderline cases, it can be useful to position the leg in slight external rotation and to avoid hip flexion greater than 60 degrees during the postoperative period.

1

Place the patient in lateral position. The skin incision is 3cm posterior to the intertrochanteric ridge, running in the direction of the fibers of the gluteus maximus and fascia lata (Fig. 2).

2

The gluteus maximus and the fascia lata are split in the direction of the fibers. By retracting the gluteus maximus, the greater trochanter and short external rotators are exposed (Fig. 3).

Fig. 2

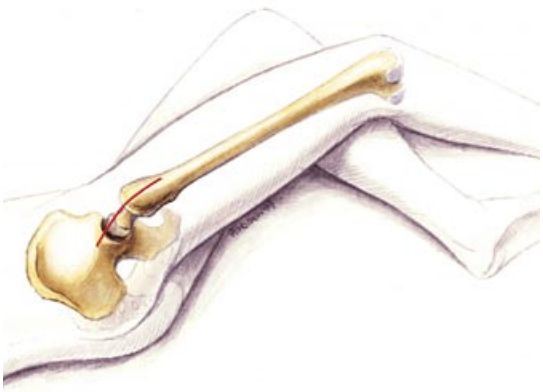
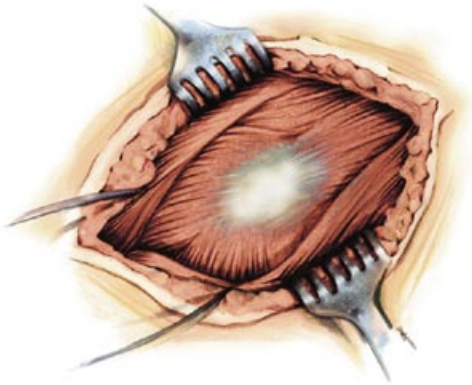


Fig. 3



3

The sciatic nerve is identified. Division of the tendon of gluteus maximus is very rarely necessary (Fig. 4).

4

The short external rotators including the piriformis muscle are detached from the greater trochanter. Slight internal rotation of the leg facilitates the dissection. The hip joint is then exposed (Fig. 5).

5

After exposure of the hip joint, Hohmann retractors are inserted at the cranial and caudal margins of the femoral neck and the posterior hip capsule is incised or resected. Another Hohmann retractor with a sharp tip is then inserted under the posterior rim of the acetabulum.

The head of the femur can be carefully dislocated by a combined movement of internal rotation, flexion and adduction. The resection line is then marked according to preoperative planning. If dislocation cannot be achieved, even after further soft tissue attachment, an in situ osteotomy of the femoral neck is performed (Fig. 6).

Fig. 4

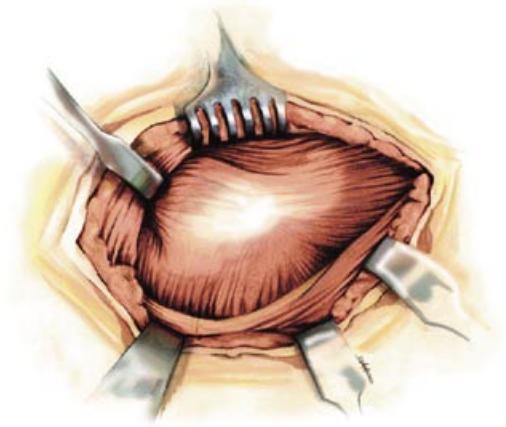


Fig. 5

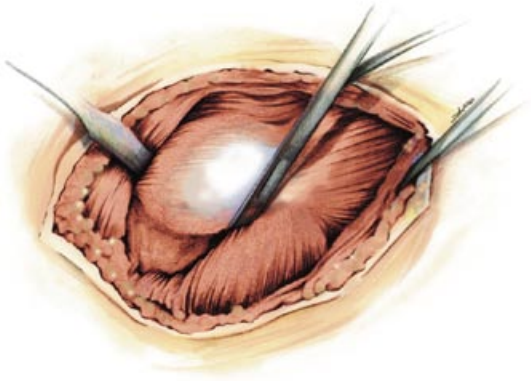
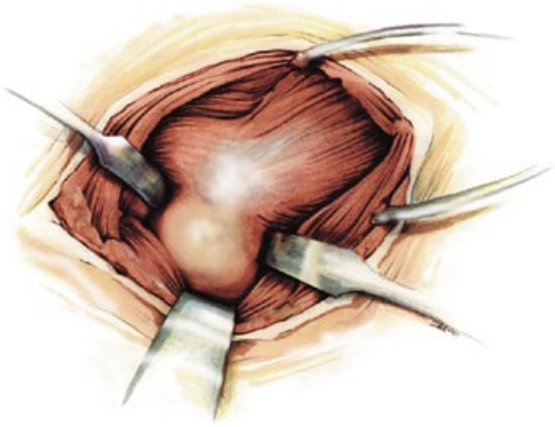


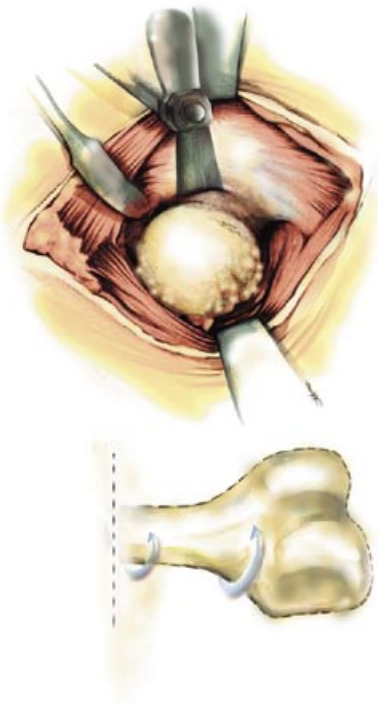
Fig. 6



6

Perform an osteotomy of the femoral neck at the marked site 45 degrees to the femoral axis. The osteotomy with the oscillating saw should involve only the medial 2/3 of the cross section of the femoral neck so that the saw does not run into the greater trochanter. The remaining third is divided with a chisel along the medial surface of the trochanter in the direction of the femoral shaft (Fig. 7).

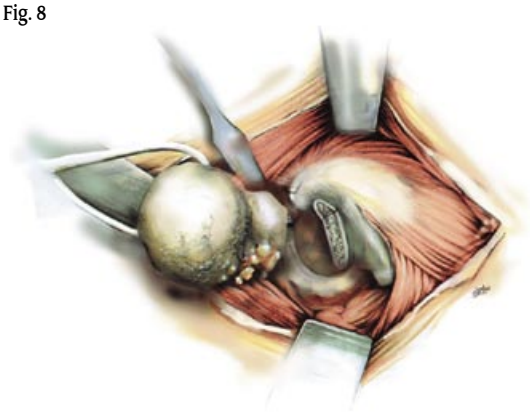
Fig. 7



7

Remove the femoral head. Insert a retractor at the anterior rim of the acetabulum to expose the entire rim of the acetabulum. Proceed at this point with the preparation of the acetabulum (Fig. 8).

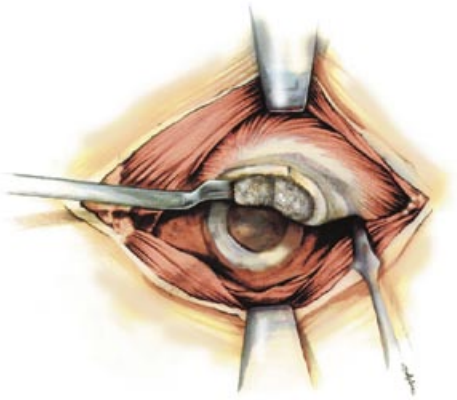
Fig. 8



8

Open the medullary cavity with a hollow chisel. At the same time, taking into account the planned anteversion of 10–15 degrees, the greater trochanter is grooved inside so that the awl and prosthesis are not subsequently diverted in a varus direction. The cancellous bone is resected sparingly and only enough to allow sufficient room for the awl (Fig. 9).

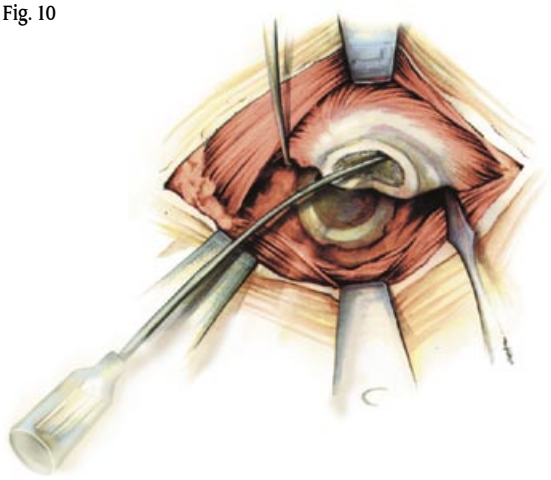
Fig. 9



9

Explore the medullary cavity with the medullary cavity gauge. This is used mainly to check that there is free access to the medullary cavity and locates any bony barriers (Fig. 10).

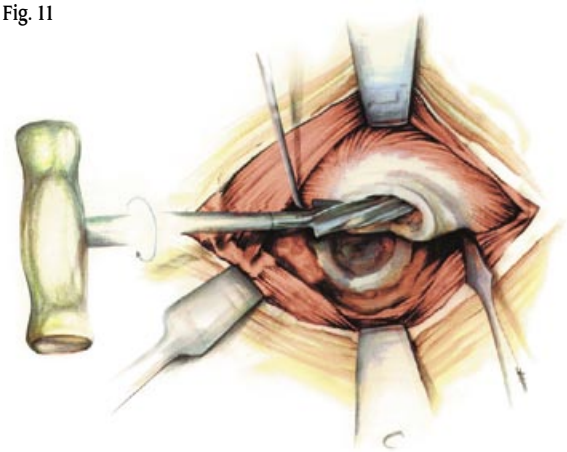
Fig. 10



10

The femoral medullary cavity is widened conically with the modular awls in the longitudinal direction of the femur until noticeable resistance is felt (Fig. 11).

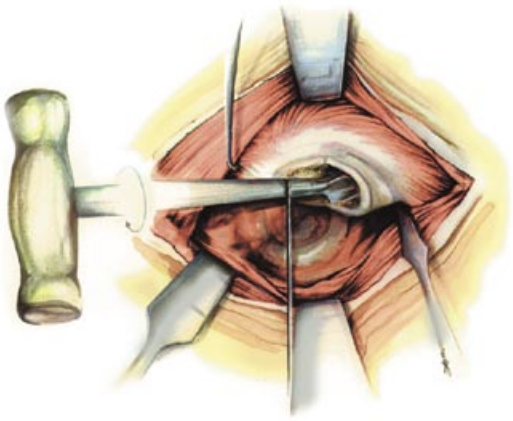
Fig. 11



11

The depth of penetration of the awl is checked with a Kirschner wire which is placed on the tip of the trochanter (Fig. 12).

Fig. 12



12

The trial stem, with a diameter in accordance with the last awl to have been used, is connected to the impactor/extractor (01.00109.808). While connecting, ensure that the tab at the distal tip of the impactor is placed in the designated slot and then firmly connected.

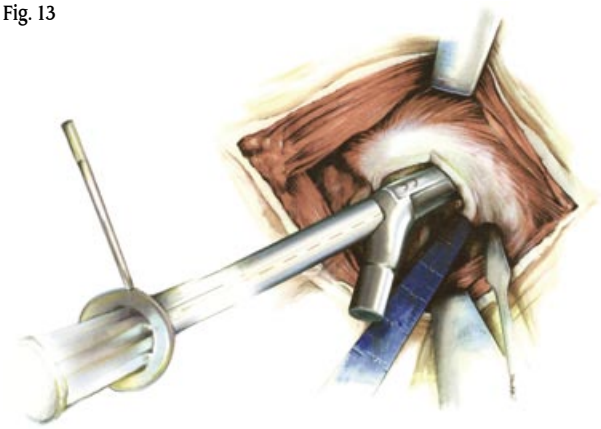
The trial stem is inserted in the femur until it is properly seated. The positioning guide on the handle of the impactor/extractor helps in determining the optimal anteversion. When there is severe pre-existing anteversion, make sure that the prosthesis is placed in the corrected position so that the neck of the prosthesis is not sitting on the rim of the cortex of the femoral neck. If necessary, some bone must be removed with a fine chisel or with the calcar curved rasp until there is a sufficient gap between the neck of the prosthesis and the bone.

Select the head trial size as templated and seat it onto the trial taper.

Next, the hip is reduced. Leg length, offset and range of motion are checked. This procedure is repeated as necessary using different length trial heads until trial placement is satisfactory. The trial stem is removed with hammer taps on the impactor/extractor (Fig 13).

If the trial reduction does not yield the desired result, proceed with the next diameter reamer and repeat the trial step with the appropriately sized trial.

Fig. 13

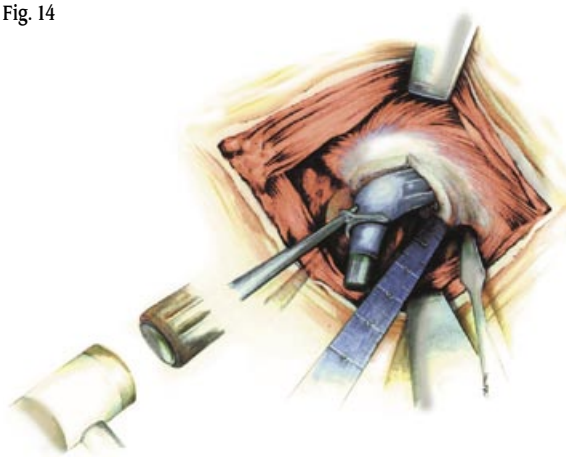


13

The prosthesis is inserted by hand until resistance can be felt. The impactor (75.11.15-01) is used to ensure final seating of the Cone Prosthesis by hammer taps (Fig. 14).

The tip of the impactor is inserted into the impacting hole in the shoulder of the prosthesis so that the fork-shaped flange surrounds the neck of the prosthesis. With this instrument, the prosthesis is rotated into the desired anteversion and impacted into its definitive position. The stability of the fixation can be assessed as follows: at first the prosthesis penetrates somewhat deeper into the medullary cavity with each hammer tap until the required stability is reached and the prosthesis does not move any further with continuing hammer taps. At this time there will be a higher pitch in the tone of the hammer taps. Finally, the depth of the penetration according to the preoperative planning is checked with the use of a tape measure.

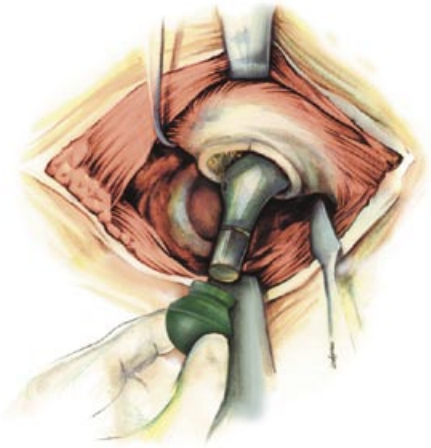
Fig. 14



14

For the final trial reduction, a plastic trial head is seated onto the neck taper (Fig. 15).

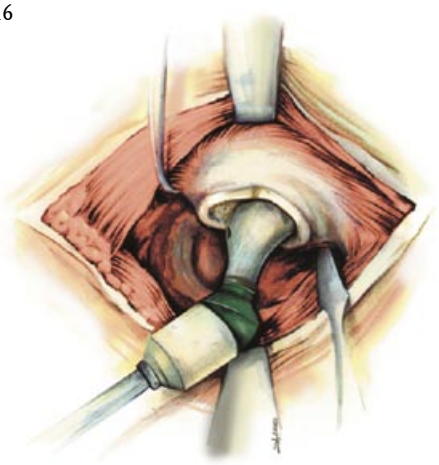
Fig. 15



15

Cautious trial reduction is carried out with the assistance of the nylon-headed impactor. The joint is examined by moving the leg in all directions, especially in flexion/internal rotation. If necessary, the prosthesis is re-implanted with adjusted angle of anteversion and the trial reduction is repeated. Finally, soft tissue tension is checked with longitudinal traction on the extended leg. With this traction, the prosthetic joint may open by a few mm, and if necessary a longer prosthetic head must be selected (Fig. 16). If the leg has been lengthened considerably, the tension of the sciatic nerve should be assessed.

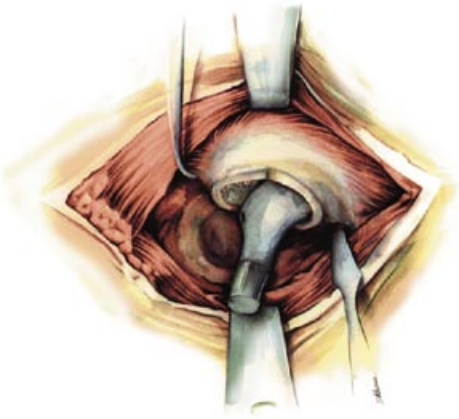
Fig. 16



16

The intermediate spaces remaining between the prosthesis and the bone are tightly filled with the chips of cancellous bone which have been obtained during the dissection (Fig. 17).

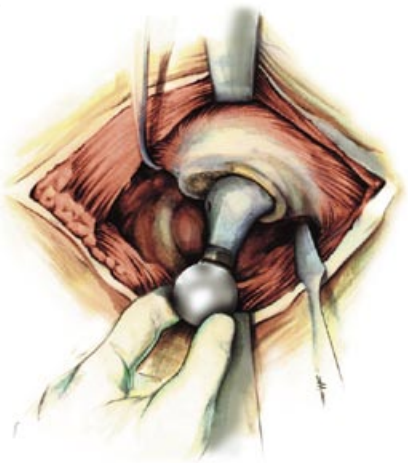
Fig. 17



17

After careful cleaning of the taper, the selected femoral head is mounted with a light rotational movement and rotated further with axial force until it is firmly seated. The ball head is seated with several taps with the nylon-headed impactor (Fig. 18).

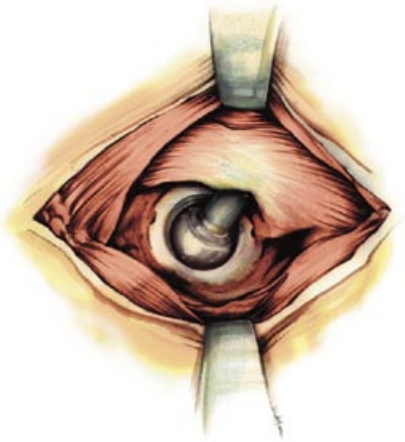
Fig. 18



18

A trial reduction is performed in order to assess the function of the hip. This is then followed with re-fixation of the short external rotators. A redon drain is then inserted and the appropriate closure technique is performed (Fig. 19).

Fig. 19



Postoperative Treatment and Case Examples

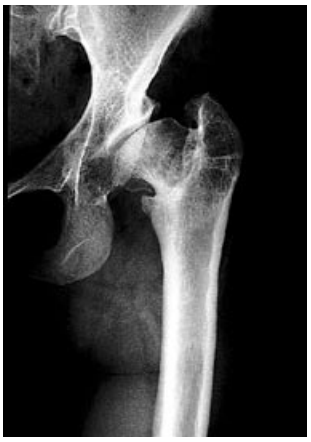
Postoperative treatment is carried out in the same way as has proven successful with other hip prostheses.

Begin the patient's exercise program a few days before the operation during the preoperative investigations and haemodilution. This makes it much easier for the patient because everything is then familiar after the operation. Also begin compression stockings on both legs and breathing exercises a few days prior to the operation.

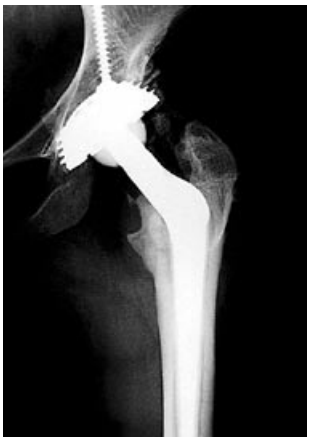
After the operation, the affected leg is laid in a foam splint. Beginning on the first day after the operation, have the patient stand beside his or her bed three times a day. Walking exercises begin on the third postoperative day in the patient's room, and walking to the toilet and in the corridor commence on the fifth day. Partial weight-bearing with 25–30kg with two elbow crutches is checked on the scales. With the leg in elastic suspension, active abduction and extension exercises of the hip are carried out with the patient supine.

Case 1 *

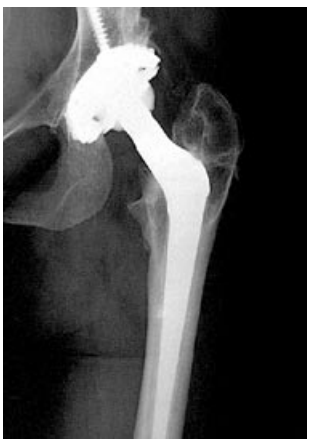
Advanced and very painful dysplastic arthritis of the left hip in a 39 year-old woman.



3 weeks after implantation of an uncemented Cone Prosthesis and a conical screwed-in cup.



7 years after implantation of the prosthesis there is normal pain-free function, and the bone structure is homogeneous with structural adaptation to the mechanical loading.



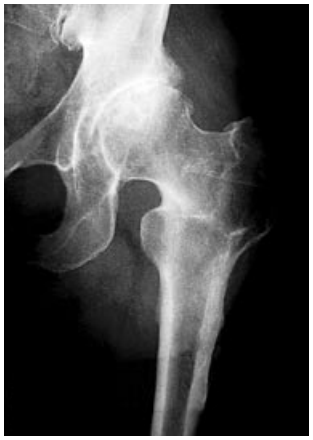
*Results shown here not indicative of all patients' experience with the Cone Prosthesis. Individual results may vary.

Climbing stairs and isometric training of the hip muscles in the lateral and prone positions start on the fifteenth postoperative day. Getting into a car is practiced. The patient is discharged home after 3 weeks with instructions to continue partial weight-bearing and the isometric muscle exercises and to omit passive movement exercises.

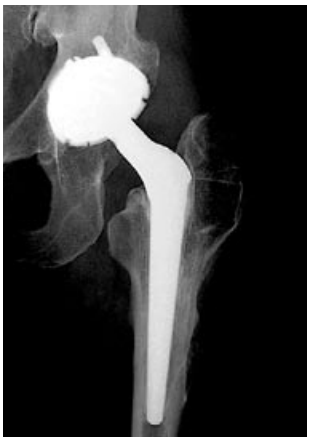
The first follow-up examination takes place three months after the operation. Depending on the X-ray findings, there is usually a gradual transition to full weight-bearing within four weeks. Patients are advised against sport activities for the next few months.

Case 2 *

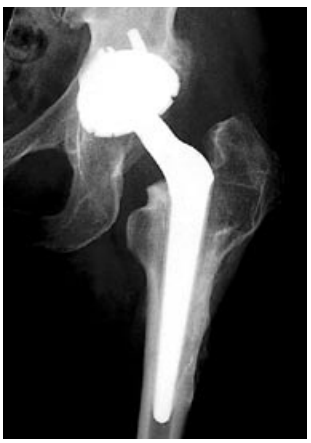
Dysplastic arthritis of the right hip in a 57-year-old woman 15 years after intertrochanteric osteotomy.



3 weeks after implantation of an uncemented Cone Prosthesis and a monobloc primary cup with metal articulation.



5 years after the hip replacement. There is normal, pain-free function and the bone structure in the prosthesis bed is uniform.



*Results shown here not indicative of all patients' experience with the Cone Prosthesis. Individual results may vary.

Ordering Information

CONE PROSTHESIS 12/14 UNCEMENTED

Catalog No.	Description
34.00.09-130	Cone Prosthesis ø 13mm
34.00.09-140	Cone Prosthesis ø 14mm
34.00.09-150	Cone Prosthesis ø 15mm
34.00.09-160	Cone Prosthesis ø 16mm
34.00.09-170	Cone Prosthesis ø 17mm
34.00.09-180	Cone Prosthesis ø 18mm
34.00.09-190	Cone Prosthesis ø 19mm
34.00.09-200	Cone Prosthesis ø 20mm
34.00.09-210	Cone Prosthesis ø 21mm
34.00.09-220	Cone Prosthesis ø 22mm
34.00.09-230	Cone Prosthesis ø 23mm
34.00.09-240	Cone Prosthesis ø 24mm

TRIAL CASE

Catalog No.	Description
01.00369.001	Tray Trial Stems Cone Prosthesis (empty)
01.00029.029	Standard Container Cover, blue
01.00369.113	Trial Stem Cone Prosthesis ø 13mm
01.00369.114	Trial Stem Cone Prosthesis ø 14mm
01.00369.115	Trial Stem Cone Prosthesis ø 15mm
01.00369.116	Trial Stem Cone Prosthesis ø 16mm
01.00369.117	Trial Stem Cone Prosthesis ø 17mm
01.00369.118	Trial Stem Cone Prosthesis ø 18mm
01.00369.119	Trial Stem Cone Prosthesis ø 19mm
01.00369.120	Trial Stem Cone Prosthesis ø 20mm
01.00369.121	Trial Stem Cone Prosthesis ø 21mm
01.00369.122	Trial Stem Cone Prosthesis ø 22mm
01.00369.123	Trial Stem Cone Prosthesis ø 23mm
01.00369.124	Trial Stem Cone Prosthesis ø 24mm
01.00109.808	Impactor
75.85.00	Positioning Bar

INSTRUMENTS

Catalog No.	Description
01.00369.011	Tray (empty)
01.00369.012	Insert (empty)
01.00029.029	Standard container cover, blue
75.11.15-130	Awl Cone Prosthesis ø 13mm
75.11.15-140	Awl Cone Prosthesis ø 14mm
75.11.15-150	Awl Cone Prosthesis ø 15mm
75.11.15-160	Awl Cone Prosthesis ø 16mm
75.11.15-170	Awl Cone Prosthesis ø 17mm
75.11.15-180	Awl Cone Prosthesis ø 18mm
75.11.15-190	Awl Cone Prosthesis ø 19mm
75.11.15-200	Awl Cone Prosthesis ø 20mm
75.11.15-210	Awl Cone Prosthesis ø 21mm
75.11.15-220	Awl Cone Prosthesis ø 22mm
75.11.15-230	Awl Cone Prosthesis ø 23mm
75.11.15-240	Awl Cone Prosthesis ø 24mm
75.11.15-01	Impactor Cone Prosthesis
75.11.00-09	Extractor Cone Prosthesis
75.00.25	Handle with quick coupling
95.00.03	Ruler 20cm
71.00.92	Calcar Rasp
75.11.40-01	Gauge for the medullary cavity
75.01.38	Repositioning Lever
78.00.38-22	Repositioning Top 22
78.00.38-28	Repositioning Top 28
78.00.38-32	Repositioning Top 32
9666-22-000	Head Trial - Size 22mm/Neutral
9666-22-350	Head Trial - Size 22mm/+3.5mm
9666-22-800	Head Trial - Size 22mm/+8mm
9666-26-000	Head Trial - Size 28mm/Neutral
9666-28-004	Head Trial - Size 28mm/-4mm
9666-28-400	Head Trial - Size 28mm/+4mm
9666-28-800	Head Trial - Size 28mm/+8mm
9666-32-000	Head Trial - Size 32mm/Neutral
9666-32-004	Head Trial - Size 32mm/-4mm
9666-32-400	Head Trial - Size 32mm/+4mm
9666-32-800	Head Trial - Size 32mm/+8mm

SALES AIDS

Catalog No.	Description
Demo340009-180	Sample, Size 18
06.01148.000	X-ray template, 15%

LITERATURE

Literature No.	Description
06.00645.012	Wagner H, Wagner M. Cone prosthesis for the hip joint. Reprint from *Arch Orthop Trauma Surg*. 2000; 120: 88–95.
06.00704.012	Castelli CC et al. Radiographic evaluation of the “conus” uncemented stem. Reprint from *Hip International*. Vol. 9 no. 3, 1999; 133–138.
06.00711.012	Kim YY et al. Total hip reconstruction in the anatomically distorted hip – cemented versus hybrid total hip arthroplasty. Reprint from *Arch Orthop Trauma Surg*. 1998; 117: 8–14.
D000234	Wagner H, Wagner M. Conical Stem Fixation for Cementless Hip Prostheses for Primary Implantation and Revision. Reprint from *Endoprosthetic*s. E. W. Morscher 1995; 258-267.

Please refer to package inserts for complete product information, including contraindications, warnings, precautions, and adverse effects.

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