Tips for Cemented THR

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Tips for Cemented THR

• Tips….. more pertinent to *Cemented* THR

• Tips….. for long term success

• Only tips, not a sequence of doing 
  *cemented* THR
It has become very clear over the past decade that it is the **quality of the cementing** which affects the outcome significantly, .......no less than implant choice.

With increased depth of cement penetration, the strength of the cement-bone interface, is enhanced.

Cement is an implant !!
On the use of bone cements
Four different phases are distinguished:

**Setting phase**
- chain growth finished,
- no movability,
- cement hardened,
- high temperature

**Working phase**
- reduced movability,
- increase of viscosity
- heat generation;

**Waiting phase**
- cement less liquid,
- less movable;

**Mixing phase**
- wetting and polymerization,
- cement relatively liquid (low viscous),
COMPARISON OF PHASES IN OVERALL SETTING TIME\textsuperscript{2}
OVERALL SET TIME (IN MINUTES) AT 65°F
Anaesthesia and Positioning

- Hypotensive anaesthesia with spinal or epidural injection

- Systolic blood pressure (<80–90 mmHg) at the time of cement application

- Surgeon shall himself position the patient
Acetabulum

- Adequate exposure,
- Meticulous bone bed preparation,
- Thorough cleansing with pulsatile lavage,
- Sustained cement pressurization,
- And accurate implant positioning,

Will ensure long term success of a cemented acetabular component.
Exposure and Access to the Acetabulum

- Three retractors are positioned to allow adequate access to the socket
Identify True Floor of Acetabulam
Rim Osteophytes

• Preserve rim osteophytes until the cup has been cemented……. for improved cement containment.

• However, partially remove very large osteophytes to facilitate access to the socket.
Reaming - Medial

Principle: Deepen the socket sufficiently to contain the cup under the acetabular roof.

☞ The first small reamer (usually 40–44 mm) is placed horizontally and directed medially until the true floor is reached.
Reaming- Enlarging the socket

Next reamers are directed superiorly

No attempt is made to totally remove the eburnated roof sclerosis.

Partial preservation of the subchondral bone plate will leave the structural support intact.
Final Reamer

• The final reamer size relates to the anterior posterior diameter of the acetabulum.

• As a rule of thumb, the largest and final reamer size should only exceed the Anteroposterior diameter by 2–4 mm.

• Keep on feeling the Anterior and Posterior wall
Anchoring Holes

Use Currette / Special guarded drill / a flexible drill.

Traditional large holes made in the pubis and ischium….No more preferred
Pulsed Lavage – Must, Copious and thorough
Bone Bed Cleansing - $\text{H}_2\text{O}_2$

- Stops the bleeding and ooze from interstices
- Renders any remnant soft tissue strands visible (white).
Cup Size and Trial Acetabular

Cup Size: At least 4 mm smaller in diameter than the largest reamer used, is chosen to ensure a minimum (pure) circumferential cement mantle thickness of 2 mm.

Shall be able to rotate “Trial” with two fingers

Have a trial of “trial acetabular cup” before actual.
Cement Application
Acetabular Cement Pressurization
Prevent Inferior Blob
Acetabular Component

- The acetabular component is positioned in the high viscosity, late phase of cement polymerisation.

- The cup should not be regarded as a pressuriser.
Acetabular Component

- This prevents thin cement mantles in superior dome.
Avoid bottoming
Remove all acetabular rim osteophytes flush to the component rim to reduce the risk of femoro-acetabular Impingement leading to dislocation.
The goals

• Achieve a circumferential cement mantle, free of defects, with a minimum 2-mm thickness,

• Place a femoral component, centered in the cement mantle in neutral alignment.

• Optimize the implant-cement, and cement-bone interface,

Following are the tips……
Femoral Neck Osteotomy

• The exact osteotomy level is not critical for Collarless PT stem

• A relatively high neck cut - Increases Rotational stem stability
- Exact choice of the point of entry
- opening of the intramedullary canal

...are of crucial importance !!!!

for later stem alignment.
Entry point is Postero-Lateral.
If it is difficult to advance the initial Canal finder, then most likely the point of entry is Incorrect !!!!
This problem is more common in obese patients and in particular when using an Anterior or Anterolateral approach, as there is a tendency for all instruments to be pushed forwards, i.e. anterior by the soft tissues.
Preserved anterior cancellous bone and Posterior position of the canal finder are good intraoperative signs for correct technique.
Direct pressure laterally and posteriorly on the broach handle.
Try and aim for preservation of at least 3 mm cancellous bone medially and anteriorly.
Use $\text{H}_2\text{O}_2$

- Movie of $\text{H}_2\text{O}_2$
Cement Restrictor

- Shall be 2 cm distal to the tip of stem

- Do not forget put the trial stem again to avoid surprises with actual stem
Pulsed Lavage

Meticulous pulsatile bone lavage until the irrigation fluid is clear and the Cancellous bone appears white
Cement Mixing and Loading

• Choose the cement carefully and be aware of duration of different phases

• Pre-chill the bone cement in fridge for 2-3 hours to have more working time

• Do not rely on an unexperienced assistant for mixing and loading cement

• Do not mix the cement vigorously

• Preferably use gun for cementation
If available, use vacuum-mixing of cement
Working times for manual mixing (not pre-chilled bone cement)

Room temperature (°C)

- Mixing
- Waiting
- Application
- Setting

Time (min)

Palacos R
Working times for vacuum mixing (pre-chilled bone cement)

Palacos R
Cement Injection

- Apply Cement Distal to proximal.
- The long nozzle should not be immersed in the cement.
- The cement should automatically drive out the cement nozzle and gun from the canal.
- This manoeuvre is best done (virtually) one-handed.
When centralizers are used, do not insert too late, as the centralizer will otherwise disrupt the cement and can cause voids and laminations.

The entry point remains lateral and posterior as outlined for canal

Stem introducer should give rotational control, but should not have a rigid fixation to the stem
Apply slight posterior pressure to direct the stem tip anteriorly to achieve good component alignment.

Insert slowly feeling the counter pressure of the polymerising cement; this provides good additional cement pressurization.

Inserted slowly in line with the longitudinal axis of the femur using sustained manual pressure.

Do not hammer the stem.
• As a positive intraoperative feedback for good technique, bone-marrow extrusion should be apparent at the exposed proximal femoral cortex.

• Seal the Implant-cement and Cement-bone interface at the cut surface of Femur.
The overall composite cement mantle at the medial calcar shall be at least 5 mm thick.
Cementing technique should maintain a pressure above the bleeding pressure in the femoral canal, without leading to embolisation and cardiovascular instability.
Low Viscosity Cements

- Zimmer® Osteobond
Medium Viscosity Cements

- DePuy® SmartSet® MV Endurance™
- Simplex™ P.
- Simplex™ P with Tobramycin
- Simplex™ P SpeedSet™
High Viscosity Cements

- Palacos® R,
- DePuy®1 (CMW®),
- DePuy® SmartSet® HV, and
- Biomet® Cobalt™. High viscosity
High Viscosity Cements

- Become doughy too quickly

- Can be difficult to mix hindering the release of entrapped air. This may increase porosity and consequently reduce fatigue strength.

- Using a vacuum mixer to reduce porosity, and “pressurizing” may improve the fatigue strength

- High viscosity cements cannot be pressurized as easily as medium viscosity cements.
Greater Intrusion Depth Leads to Improved Fixation and Greater Shear Strength
The low viscosity dough might not withstand the bleeding pressure....

→ blood entrapment within the cement, representing potential areas of weakness

→ increased fracture risk.
This phenomenon is the main problem when applying low viscosity cements with their short application phase too early.

Medium or high viscosity cements in this regard seem to be more user-friendly and forgiving, resulting in better long-term performance.
ISO 5833 requirement

..that a graphical representation of the effect of Temperature on the length of the phases in Cement curing, prepared from experimental data, on the particular brand of cement, be provided.
Thank You
Many manufacturers of bone cement claim that all bone cements are alike

- And are attempting to sell bone cement as a commodity product. They are minimizing the fact that bone cement is an orthopaedic implant and the long-term performance of bone cement is critical to the longevity of the orthopaedic procedure performed.
Each broach is designed to accommodate the implant and provide an adequate cement mantle. The final broach will provide optimal metaphyseal fit as well as rotational stability. Neutral alignment and the appropriate anteversion of the broach will optimize metaphyseal fit.
If stability and leg lengths are satisfactory, the broach is removed, and loose cancellous bone is removed with a curette. Reaming of the femoral canal should not be performed, as this will remove stable cancellous bone and create a smooth endosteal surface that decreases the shear strength of the bone cement interface.
The femoral canal must next be plugged with bone cement bone block, or a commercially available plastic plug to improve cement pressurization down the be placed 2 to 3 cm distal to the level of canal, leading to better cement intrusion. The plug should the femoral component in order to provide an adequate distal cement mantle as well as support for the femoral implant.
The final steps in femoral canal preparation involve a pressurized lavage system. Marrow, fat, and blood removal has a twofold purpose: (a) to improve cement intrusion into the cancellous bone and (b) to decrease the risk of fat embolism.
Majkowski et al. (117) quantified the difference in shear strength at the Bone cement interface in bone that was not prepared by pressure lavage versus bone that was. Unprepared bone produced Cement intrusion of 0.2 mm, with an interface shear strength of 1.9 MPa. Brushing of the bone increased cement intrusion to between 0.6 and 1.4 mm, with shear strength ranging between 1.5 and 9.9 MPa. With pressurized lavage mean cement penetration increased to between 4.8 and 7.9 mm, with shear strength increases to between 26.5 and 36.1 MPa.

Adrenaline-soaked and/or dry sponges, alone with suction, are next applied in order to dry sponges, along with suction, are next applied in order to dry the canal. Other measures, such as spinal anesthesia and the use of hydrogen peroxide and iced saline, have been shown to decrease bleeding from the cancellous bone (9). Any blood oozing from the cancellous bone can decrease interfascial shear strength by up to 50% (116).

Laboratory studies have demonstrated that centrifugation decreases the pore size in cement to between 200 and 400 pm in diameter (18) (Fig. 62-5). This porosity reduction has yielded a 24% increase in ultimate tensile strength in standard test specimens and a 136% increase in tension-compression fatigue strength. The fatigue life of the cement was reported to increase nearly 100-fold with centrifugation (41).

Note: ISO 5833 requirement

»It is suggested that a graphical representation of the effect of temperature on the length of the phases in cement curing, prepared from experimental data on the particular brand of cement, be provided.«
Show Graphs
The design of the mixing vessel and spatula as well as the mixing speed and number of strokes per minute also influence the homogeneity of the dough. The longer and the more vigorously it is mixed the more porous it becomes.
Nevertheless, the viscosity at the beginning of the application phase must not be too low. Otherwise the inserted dough might not withstand the bleeding pressure in the femur with the consequence of blood entrapment within the cement representing potential areas of weakness with increased fracture risk. This phenomenon is the main problem when applying low viscosity cements with their short application phase too early. Medium or high viscosity cements in this regard seem to be more user-friendly and forgiving resulting in better long-term performance [1, 9].
The polymerization shrinkage of acrylic bone cements is about 3–5%. Pre-chilling as well as the application of vacuum mixing reduce the cement porosity and improve the mechanics of the cured cement. Such mixing systems
Universal agreement does not exist regarding the benefits of porosity reduction via centrifugation or vacuum mixing in cemented total hip replacement. Though in vitro studies have identified the increase in fatigue strength with centrifugation or vacuum mixing, the clinical significance of porosity reduction was questioned in the face of surface irregularities (42). Rimnac et al. (152) suggested that the existing cracks and surface imperfections may supersede any benefits from porosity reduction.

Cement viscosity has also been examined to determine its clinical role in cemented total hip arthroplasty. Clinical studies examining cement viscosity have sparse. The largest series is based on the Norwegian Total joint Registry (54). Our of 17,323 primary Charnley total hip replacements, there was a significantly increased rate of revision of femoral components for loosening with low-viscosity cement. The 10-year survivorship for low-viscosity cement was 83% versus 92% to 97% for high-viscosity cement. The authors stated that this particular low-viscosity cement is no longer used due to such poor results. Other studies with smaller numbers have not identified a difference between high and low-viscosity cement (64,129).

The cement is injected in a retrograde fashion to avoid air pockets that get trapped between the plug and the cement in order to produce a uniform cement mantle (fig. 62-7). The long nozzle should not be immersed in the cement mantle during cement injection, as this can create voids in the cement mantle. Once the canal has been filled with cement, the cement mantle should be pressurized (Fig. 62-8).
Cement pressurization increases intrusion into the cancellous bone, which has shown to increase the interfascial shear strength between the bone and cement (6,130). Et al (149) related pressurization to intrusion depth in bovine trabecular bone model. A cement pressure of 20Ps produced a cement intrusion of 8 mm for LVC, 2.2 mm for Simplex-P cement, and 1.5mm for Palacos cement. Cement intrusion occurs more reliably in the metaphyseal bone, which contains more cancellous bone, rather than the smoother endosteal surfaces in diaphyseal bone.

Dayton et al. (44) examined in vitro the amount of cement intrusion visualized radiographically with early or late-stage PMMA. The authors inserted implants into cadaveric femora with the PMMA in the earlier stages of polymerization versus the later stages. Radiographs demonstrated an increased incidence of radiolucencies in zones 2 and 6 when implants were inserted in the earlier stages of polymerization. Increased trends of radiolucencies were also evident in zones 1 and 7. The recommendation was to insert the implant during the late phase of polymerization in order to obtain higher cement intrusion and improved interfascial stresses.

Stem centralization helps in centering the stem within the canal to ensure a more uniform cement mantle and to avoid thin Cement mantles or mantles defects.
Multiple studies have demonstrated the effectiveness of stem centralizers for producing a uniform cement mantle.
Star et al. (164) reported that failure of cemented femoral components was associated with thin cement mantles in Gruen zones 5 and 6. Of note, while varus positioning has historically been associated with higher mechanical failure rates in cemented stems, this study suggests that excessive valgus positioning also causes thinner cement mantles, which may predispose them to premature loosening.

There has been no consensus regarding the optimal cement mantle thickness to maximize resistance to fatigue failure. Long term studies have identified cement mantle thicknesses between 2 and 5 mm in the calcar region as producing the best clinical outcomes (52).

Finite-element analysis studies have shown that the highest stress concentrations in the cement mantle occur around the tip of the stem and the proximal medial calcar region (7.73,74). Thin distal-medical cement mantles have been found to lead to femoral component mechanical loosening (164)

Failure due to aseptic loosening is far less common with cemented femoral components than cemented acetabular components. In the proximal femur, cement interdigitation into the cancellous bone provides a stable fixation that prevents wear particle migration through the cement-bone interfaces. In contrast, acetabular fixation with cement interdigitation does not occur in the subchondral bone of the periphery of the acetabulum. Joint pressure will force wear particles to migrate toward the lower-resistance pathway of the acetabulum interfaces. Second, the geometries differ. The mouth of the acetabulum is much larger than the mouth of the femur, which makes it more accessible to invasion by wear particles. When these granulomatous lesions do form, similar sized lesions will have a more profound effect on acetabulum fixation stability than femoral stability.
Iwaki et al. (88) reviewed 185 cemented THAs to determine the significance of early radiolucent lines. Following serial radiographs the authors concluded the following: (a) With no migration or radiolucent lines at 2 years, there will be no lytic lesions at 5 years or aseptic loosening at 10 years. (b) With minimal migration or nonprogressive radiolucent lines, lytic lesions may develop by 5 years, but aseptic loosening is unlikely at 10 years. (c) With progressive radiolucent lines, lytic lesions are likely to develop by 5 years and aseptic loosening likely to develop by 10 years.
Numerous studies have suggested that varus implant position is associated with a higher risk of aseptic loosening (11,33,52,58,107,138,156,165,167).

Loosening of the femoral component requiring revision surgery was correlated with varus implant position in 50% of cases and inadequate cement mantle in 34%. Similar results were reported by Ebranzadeh et al. (52), with increases rates of aseptic loosening with implant position in greater than 5 of varus. In addition outcomes were improved with less than 2mm of proximal-medial cancellous bone and a cement mantle between 2 and 5 mm.

Anthony et al. (3) reported on four cases of focal osteolysis with stable cemented implants. At revision surgery, cement mantle defects were identified at the site of these osteolytic lesions (Fig. 62-17). The authors suggested that cement mantle defects provide a channel for joint fluid contents to access the endosteal surface.
In general, cemented implants are placed into three categories: polished (less than 10 microinches), matte (20 to 30), and grit blasted (70 to 100 microinches).
Gardiner and Hozack (68) reported on 17 failed at a mean of 37 months. The authors postulated that the improved cement-metal bonds transferred the stresses to the cement-bone interfaces, which led to early failure. Numerous authors have reported their experience with roughened cemented femoral implants, and the results have been mixed.

Preoperative planning is recommended. Ideally a lateral radiograph should be available to appreciate the femoral anatomy. A stem size should be pre-selected using Templates to guarantee a minimum cement mantle of 5 mm at the medial calcar and 2–3 mm more distally.

Identification of the piriformis fossa and strict posterior canal preparation are of critical importance to minimise the risk of thin cement mantles in the lateral plane (which cannot be seen on a.p. films!). Careful canal preparation should be implemented to preserve strong cancellous bone (a rim of anterior and medial cancellous bone will improve overall stem alignment). Pulsatile lavage is mandatory to clean implant bed and facilitate cement interdigitation.
It is recommended to use a well-documented bone cement pre-loaded with AB. Vacuum mixing seems beneficial. Cement is applied at medium viscosity in a retrograde manner via a gun. Sustained pressurisation of at least 2–3 min via proximal seal is of utmost importance to resist bleeding pressure and to achieve optimal cement penetration. Femoral stem insertion is done slowly against the increasing cement viscosity. It is the surgeon at the time of stem implantation who will determine the long-term success. 36 Part I · Approaches and Operative Steps 2  ▸ Fig. 2.36a–c. Postoperative radiographs demonstrating the effect of good cementing technique with a »white out« Barrack A cement grading. Note an adequate cement mantle thickness in all a.p. and lat. Gruen zones and in particular in zone 7 at the medial calcar.
Song et al found that the insertion of the prosthetic stem produced the highest pressures and suggested that prior impaction of the cement is probably unnecessary, but it is accepted that sustained pressurisation helps to control cement of low or reduced viscosity and encourages penetration against any opposing blood pressure. The timing of the insertion of the prosthesis, with delay until the viscosity has risen, is necessary to prevent the cement being squeezed back out of the Medullary canal.
It has become very clear over the past decade that it is the quality of the cementing technique which determines the outcome significantly more than implant choice. With increased depth of cement penetration the strength of the cement-bone interface is enhanced.
The use of pulsatile lavage is considered of paramount importance to achieve excellent cement penetration and also to reduce the risk of fat embolism. Its use should be considered mandatory in cemented total hip arthroplasty.
Acetabular Cysts

In cases with radiologically evident cysts, these must be found and removed.

Smaller cysts can be simply curetted, but the pericystic sclerotic wall must always be removed to gain access to the adjacent cancellous honeycombs. A gauge is better than a drill doing this.

Large cysts leave a significant defect, which should then be grafted using the cancellous bone from the femoral neck and head.
Composite Beam versus Polished Taper fixation.

With a tapered, collarless, polished femoral stem, the end result of stem movement (subsidence), creep and stress relaxation is to increase the compressive stress in the cement and at the cementbone interface which leads to long-term stability of the total replacement hip joint.
Box chisel entry

- Can start with nibbler or box chisel.
- I prefer inverted