

Primary total hip replacement

Primary total hip replacement

Over 95 /uni00A0 000 primary THRs are performed annually in the UK (National Joint Registry , UK). The success rate for THR is very high and the evidence supports the results being more than encouraging. In the modern era, with evidence-based technique and selection of prosthesis, over 95% of patients will have a well-functioning THR at 10 years after surgery . In the best series, 85% will still be functioning at 20 years, although some are still in place because the patient may have increasing comorbidities, preventing revision of the THR. Following surgery , pain is reduced and there is improvement in mobility and sleep, as well as social and sexual function. Nevertheless, with the ever-increasing number of patients with joint replacements, the number of patients whose replacement has failed and come to the point of revision, or even re-revision, is rising. Principles and design of hip replacements Joint replacement should be biocompatible and made of inert materials. It should be well fixed to the host tissue and the design should incorporate features that allow a good range of movement and stability . The bearing surfaces should produce low friction and minimise the amount of wear particles produced which in turn prevents early loosening. The material released from the bearing surface should be non-toxic. The procedure should remove the minimum amount of the patient's bone so that revision is possible, and it should create a biomechanically stable joint. Finally , any implanted joint should ideally outlive the patient and be cost-effective. Materials for the femoral component Implants available currently are made of cobalt chrome alloy , stainless steel or titanium. Metal implants are able to withstand high loads, are relatively inert and can be manufactured easily . However, they do pose problems in terms of ion release if they are used as bearing surfaces. Also, corrosion can be a cause for concern if two dissimilar metals are used. Bearing surfaces The design described by Charnley in 1961 revolutionised THR and became a gold standard by using a bearing surface of metal on high-density polyethylene. This is described as a hard-on-soft bearing surface and has a low coefficient of friction, which in turn produces lower wear of the polyethylene Sir John Charnley , 1911-1982, Professor, Wrightington Hospital, UK, pioneer in hip replacement design, particularly the concept of low-friction arthroplasty . Features of an ideal joint replacement /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF component, resulting in longer survival of the prosthesis. Hence the phrase low-friction arthroplasty was given to this implant. High-density polyethylene has good shock-absorbing properties but does wear slowly over the years, producing small particles that can stimulate an inflammatory response in the joint, which then leads to osteolysis and aseptic loosening of the implants. The activated macrophages resorb bone and may also stimulate osteoclasts to do the same. There has therefore been a move towards using bearing surfaces with a lower wear rate, such as ceramic on ceramic. With metal-on-metal bearing surfaces, although the wear rate is lower, the wear - particles are smaller (nano rather than micro) and can lead to an adverse reaction, particularly in the soft tissues, resulting in failure. There is increasing evidence

that these implants are less forgiving than conventional metal-on-polyethylene THRs, appearing to require more precise implant positioning. Ceramic femoral head bearings on polyethylene cups are low friction, but ceramic femoral heads on ceramic acetabular cups - have the lowest friction of all. However, ceramic-on-ceramic bearings are expensive to manufacture, and are another example of hard-on-hard bearings and produce small-sized wear particles. A summary of the advantages and disadvantages of each bearing surface is provided in Table 39.6 . Fixation of implants Artificial joints must be securely fixed to the bone on each side of the joint so that the implant does not work loose. This can be achieved with the help of cement or biological interdigitation between the prosthesis and bone (Table 39.7). Traditionally , hip replacements were fixed into a bed of polymethylmethacrylate (PMMA) cement (Figure 39.8). The cement acts as a grout (spacer) and not as a glue between the implant and the bone. In the majority of cases, it gives an excellent outcome as shown by data in several national joint registries. However, it can cause potential problems: cement pressurisation can result in release of cement and marrow contents into the patient's blood stream. This can cause a drop in blood pressure. Improvements in cementing techniques allow for no gaps in the cement mantle between the femoral component and the bone. In spite of all the measures taken, occasionally there may be small areas in the cement mantle without cement.

Biocompatible Well fixed to the host tissue, stable and allowing a good range of movement
 Bearing surfaces should be designed to minimise friction and have improved wear characteristics
 Material released from the bearings should be non-toxic
 Remove the minimum amount of bone
 Produce mechanical stability
 Should ideally outlive the patient

On the other hand, this problem can be obviated by using an uncemented prosthesis in which biological fixation can be achieved by providing a rough surface on the prosthesis for bone to grow into the porous surface of the prosthesis or by coating the surface of the prosthesis with hydroxyapatite, an osteoconductive agent, to encourage bone to bond to the prosthesis (Figure 39.9). These uncemented devices have also shown good long-term outcomes, although they can be associated with higher implant costs, increased risk of intraoperative fracture and difficulty in removing them if revision surgery is required in the future.

Type of bearing	Advantages
Metal on polyethylene	Proven efficacy; easy to manufacture; cheap
Ceramic on polyethylene	Lower wear rate
Metal on metal	Lower wear rate
Ceramic on ceramic	Newer delta ceramics have the lowest wear rate

UHMWPE, ultra-high-molecular-weight polyethylene.

TABLE 39.7	Fixation of implants.	Method of fixation	Component	Advantages
Cemented	Femur	Implant does not need to fit cavity exactly; well-proven results	Acetabulum	Cheap, can be used in osteoporotic bone
Uncemented	Femur	No cement required; fixation more secure; dynamic and biological fixation	Acetabulum	Good fixation into acetabulum; can be augmented with screws to secure fixation

Primary total hip replacement

Over 95 000 primary THRs are performed annually in the UK (National Joint Registry , UK). The success rate for THR is very high and the evidence supports the results being more than encouraging. In the modern era, with evidence-based technique and selection of prosthesis, over 95% of patients will have a well-functioning THR at 10 years after surgery . In the best series, 85%

will still be functioning at 20 years, although some are still in place because the patient may have increasing comorbidities, preventing revision of the THR. Following surgery, pain is reduced and there is improvement in mobility and sleep, as well as social and sexual function. Nevertheless, with the ever-increasing number of patients with joint replacements, the number of patients whose replacement has failed and come to the point of revision, or even re-revision, is rising.

Principles and design of hip replacements

Joint replacement should be biocompatible and made of inert materials. It should be well fixed to the host tissue and the design should incorporate features that allow a good range of movement and stability. The bearing surfaces should produce low friction and minimise the amount of wear particles produced which in turn prevents early loosening. The material released from the bearing surface should be non-toxic. The procedure should remove the minimum amount of the patient's bone so that revision is possible, and it should create a biomechanically stable joint. Finally, any implanted joint should ideally outlive the patient and be cost-effective.

Materials for the femoral component

Implants available currently are made of cobalt chrome alloy, stainless steel or titanium. Metal implants are able to withstand high loads, are relatively inert and can be manufactured easily. However, they do pose problems in terms of ion release if they are used as bearing surfaces. Also, corrosion can be a cause for concern if two dissimilar metals are used.

Bearing surfaces

The design described by Charnley in 1961 revolutionised THR and became a gold standard by using a bearing surface of metal on high-density polyethylene. This is described as a hard-on-soft bearing surface and has a low coefficient of friction, which in turn produces lower wear of the polyethylene.

Sir John Charnley, 1911-1982, Professor, Wrightington Hospital, UK, pioneer in hip replacement design, particularly the concept of low-friction arthroplasty.

Features of an ideal joint replacement

Component, resulting in longer survival of the prosthesis. Hence the phrase low-friction arthroplasty was given to this implant.

High-density polyethylene has good shock-absorbing properties but does wear slowly over the years, producing small particles that can stimulate an inflammatory response in the joint, which then leads to osteolysis and aseptic loosening of the implants. The activated macrophages resorb bone and may also stimulate osteoclasts to do the same. There has therefore been a move towards using bearing surfaces with a lower wear rate, such as ceramic on ceramic. With metal-on-metal bearing surfaces, although the wear rate is lower, the wear particles are smaller (nano rather than micro) and can lead to an adverse reaction, particularly in the soft tissues, resulting in failure. There is increasing evidence that these implants are less forgiving than conventional metal-on-polyethylene THRs, appearing to require more precise implant positioning.

Ceramic femoral head bearings on polyethylene cups are low friction, but ceramic femoral heads on ceramic acetabular cups - have the lowest friction of all. However, ceramic-on-ceramic bearings are expensive to manufacture, and are another example of hard-on-hard bearings and produce small-sized wear particles. A summary of the advantages and disadvantages of each bearing surface is provided in Table 39.6.

Fixation of implants

Artificial joints must be securely fixed to the bone on each side of the joint so that the implant does not work loose. This can be achieved with the help of cement or biological interdigitation between the prosthesis and bone (Table 39.7). Traditionally, hip replacements were fixed into a bed of polymethylmethacrylate (PMMA) cement (Figure 39.8). The cement acts as a grout (spacer) and not as a glue between the implant and the bone. In the majority of cases, it gives an excellent outcome as shown by data in several national joint registries. However, it can cause potential problems: cement pressurisation can result in release of cement and marrow contents into the patient's blood stream. This can cause a drop in blood pressure. Improvements in cementing techniques allow for no gaps in the cement mantle between the femoral component and the bone.

In spite of all the measures taken, occasionally there may be small areas in the cement mantle without cement.

Biocompatible Well fixed to the host tissue, stable and allowing a good range of movement
Bearing surfaces should be designed to minimise friction and have improved wear characteristics
Material released from the bearings should be non-toxic Remove the minimum amount of bone
Produce mechanical stability Should ideally outlive the patient

On the other hand, this problem can be obviated by using an uncemented prosthesis in which biological fixation can be achieved by providing a rough surface on the prosthesis for bone to grow into the porous surface of the prosthesis or by coating the surface of the prosthesis with hydroxyapatite, an osteoconductive agent, to encourage bone to bond to the prosthesis (Figure 39.9). These uncemented devices have also shown good long-term outcomes, although they can be associated with higher implant costs, increased risk of intraoperative fracture and difficulty in removing them if revision surgery is required in the future.

Type of bearing Advantages Metal on polyethylene Proven efficacy; easy to manufacture; cheap
Ceramic on polyethylene Lower wear rate Metal on metal Lower wear rate Ceramic on ceramic
Newer delta ceramics have the lowest wear rate UHMWPE, ultra-high-molecular-weight polyethylene. TABLE 39.7 Fixation of implants. Method of fixation Component Advantages
Cemented Femur Implant does not need to fit cavity exactly; well-proven results Acetabulum
Cheap, can be used in osteoporotic bone Uncemented Femur No cement required; fixation more secure; dynamic and biological fixation Acetabulum Good fixation into acetabulum; can be augmented with screws to secure fixation

Primary total hip replacement

Over 95 000 primary THRs are performed annually in the UK (National Joint Registry , UK). The success rate for THR is very high and the evidence supports the results being more than encouraging. In the modern era, with evidence-based technique and selection of prosthesis, over 95% of patients will have a well-functioning THR at 10 years after surgery . In the best series, 85% will still be functioning at 20 years, although some are still in place because the patient may have increasing comorbidities, preventing revision of the THR. Following surgery , pain is reduced and there is improvement in mobility and sleep, as well as social and sexual function. Nevertheless, with the ever-increasing number of patients with joint replacements, the number of patients whose replacement has failed and come to the point of revision, or even re-revision, is rising. Principles and design of hip replacements Joint replacement should be biocompatible and made of inert materials. It should be well fixed to the host tissue and the design should incorporate features that allow a good range of movement and stability . The bearing surfaces should produce low friction and minimise the amount of wear particles produced which in turn prevents early loosening. The material released from the bearing surface should be non-toxic. The procedure should remove the minimum amount of the patient's bone so that revision is possible, and it should create a biomechanically stable joint. Finally , any implanted joint should ideally outlive the patient and be cost-effective. Materials for the femoral component Implants available currently are made of cobalt chrome alloy , stainless steel or titanium. Metal implants are able to withstand high loads, are relatively inert and can be manufactured easily . However, they do pose problems in terms of

ion release if they are used as bearing surfaces. Also, corrosion can be a cause for concern if two dissimilar metals are used. Bearing surfaces The design described by Charnley in 1961 revolutionised THR and became a gold standard by using a bearing surface of metal on high-density polyethylene. This is described as a hard-on-soft bearing surface and has a low coefficient of friction, which in turn produces lower wear of the polyethylene Sir John Charnley, 1911–1982, Professor, Wrightington Hospital, UK, pioneer in hip replacement design, particularly the concept of low-friction arthroplasty. Features of an ideal joint replacement component, resulting in longer survival of the prosthesis. Hence the phrase low-friction arthroplasty was given to this implant. High-density polyethylene has good shock-absorbing properties but does wear slowly over the years, producing small particles that can stimulate an inflammatory response in the joint, which then leads to osteolysis and aseptic loosening of the implants. The activated macrophages resorb bone and may also stimulate osteoclasts to do the same. There has therefore been a move towards using bearing surfaces with a lower wear rate, such as ceramic on ceramic. With metal-on-metal bearing surfaces, although the wear rate is lower, the wear particles are smaller (nano rather than micro) and can lead to an adverse reaction, particularly in the soft tissues, resulting in failure. There is increasing evidence that these implants are less forgiving than conventional metal-on-polyethylene THRs, appearing to require more precise implant positioning. Ceramic femoral head bearings on polyethylene cups are low friction, but ceramic femoral heads on ceramic acetabular cups - have the lowest friction of all. However, ceramic-on-ceramic bearings are expensive to manufacture, and are another example of hard-on-hard bearings and produce small-sized wear particles. A summary of the advantages and disadvantages of each bearing surface is provided in Table 39.6. Fixation of implants Artificial joints must be securely fixed to the bone on each side of the joint so that the implant does not work loose. This can be achieved with the help of cement or biological interdigitation between the prosthesis and bone (Table 39.7). Traditionally, hip replacements were fixed into a bed of polymethylmethacrylate (PMMA) cement (Figure 39.8). The cement acts as a grout (spacer) and not as a glue between the implant and the bone. In the majority of cases, it gives an excellent outcome as shown by data in several national joint registries. However, it can cause potential problems: cement pressurisation can result in release of cement and marrow contents into the patient's blood stream. This can cause a drop in blood pressure. Improvements in cementing techniques allow for no gaps in the cement mantle between the femoral component and the bone. In spite of all the measures taken, occasionally there may be small areas in the cement mantle without cement.

Biocompatible Well fixed to the host tissue, stable and allowing a good range of movement
Bearing surfaces should be designed to minimise friction and have improved wear characteristics
Material released from the bearings should be non-toxic
Remove the minimum amount of bone
Produce mechanical stability
Should ideally outlive the patient

On the other hand, this problem can be obviated by using an uncemented prosthesis in which biological fixation can be achieved by providing a rough surface on the prosthesis for bone to grow into the porous surface of the prosthesis or by coating the surface of the prosthesis with hydroxyapatite, an osteoconductive agent, to encourage bone to bond to the prosthesis (Figure 39.9). These uncemented devices have also shown good long-term outcomes, although they can be associated with higher implant costs, increased risk of intraoperative fracture and difficulty in removing them if revision surgery is required in the future.

Type of bearing Advantages Metal on polyethylene Proven efficacy; easy to manufacture; cheap
Ceramic on polyethylene Lower wear rate Metal on metal Lower wear rate Ceramic on ceramic
Newer delta ceramics have the lowest wear rate UHMWPE, ultra-high-molecular-weight
polyethylene. TABLE 39.7 Fixation of implants. Method of fixation Component Advantages
Cemented Femur Implant does not need to fit cavity exactly; well-proven results Acetabulum
Cheap, can be used in osteoporotic bone Uncemented Femur No cement required; fixation more
secure; dynamic and biological fixation Acetabulum Good fixation into acetabulum; can be
augmented with screws to secure fixation

Revision #1

Created 2025-12-31 15:15:46 UTC by Omar Ayman

Updated 2025-12-31 15:15:46 UTC by Omar Ayman