JISRF CLASSIFICATION SYSTEM FOR SHORT STEM UNCEMENTED THA

By:

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Abstract: The aim of this paper is to review the influx of short stems for total hip arthroplasty. Not all short stems are created equal concerning fixation points for implant stability and length of engagement of the device in the proximal femur. Some devices are stabilized in the head, neck, metaphysis and metaphysis and diaphysis. Depending on stabilization and engagement area different short stems can have different indications, contraindications and clinical outcomes. As a result of our findings JISRF developed a classification system based on implant stabilization point and overall stem length.

Key Words: short stems, head stabilized, neck stabilized, metaphyseal stabilized, metaphyseal diaphyseal stabilized.

Introduction:

The use of short stems is growing. Initial short and mid-term follow up studies of a number of these stems suggest that stable, durable fixation and excellent clinical outcomes can be achieved. As a result, a very large number of short stem designs are available. However, there does not exist a classification system[1] for uncemented short stem implants that would allow comparisons of clinical and radiographic results. The purpose of this presentation is to propose a classification system based upon the length of the stem and the method by which the stem seeks to achieve stability.

A number of advantages have been argued to justify the design and clinical usage of short stems[1,2,3]: Elimination of femoral proximal-distal mismatch, tissue preservation (hard & soft), facilitation of less invasive surgical exposures, less invasive surgical violation into the femoral canal, less violation into the trochanteric bed, improved proximal bone remodeling, less intraoperative blood loss, less postoperative rehabilitation, less instrumentation and less inventory cost[4,5].

All of these advantages are worthwhile if they can be proven to be significant benefits to the clinical outcome and increased survivorship of the device. The real question is can these shorter length devices obtain strong and long-lasting stability of the implant without diaphyseal anchoring?[10]

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☆Orthopaedics New England, http://www.OrthoNewEngland.com
** Signature Orthopaedics Australia, http://signatureortho.com.au
❖ Advanced Orthopaedics & Sports Medicine Institute http://www.aosmi.com
○ L.A. Orthopaedic Institute, www.laoi.org

➢A variety of short stems are available

We would challenge anyone to name these devices and what are their primary stabilizations points of engagement. They all have some type of stem but to what purpose? Some could be a challenge to explant if necessary.

Methods:
25 femoral components described as having "short stems" were evaluated. The range of lengths for each stem type and the method of achieving initial implant stability was determined. The optimum radiographic position of each of these implants and the proposed type of bone remodeling associated with this placement in the proximal femur was evaluated.

Some of these devices are not available in the U. S. and some are new to their clinical experience. As a result this paper makes no assumption as to clinical performance or benefits to certain product feature. This is intended to point out certain trends for hip reconstruction and provide as base for development of the ***"JISRF Short Stem Classification System".***

Trends:
Conservative approaches to hip development (devices and surgical approaches) are the main focus in total hip arthroplasty at the moment[6,7].

The recent MoM concerns have reduced current alternate bearing development[8]. The focus is high on improved polyethylene material matting with improved ceramic heads.

Recent reports with certain convention style stems have raised concerns over the use of modularity at this neck stem junction. Neck stem modular tapers are being used in six of the twenty-five devices we reviewed with success. It is important to remember not all modularity is created equal. Application of modularity in certain design styles like neck sparing have significantly reduced stresses at the modular neck stem junction compared to both conventional monoblock and modular designs[9,14].

The European experience with certain styles of conservative designs are years ahead of the U.S. experience. So it is reasonable to look towards Europe for both trends and early to mid-term clinical results.

JISRF Classification System on Short Stems

Head Stabilization

Hip Resurfacing

The procedure is bone-conserving on the femoral side because most of the joint is retained. The femoral head is shaped to accept a low-wear metal sphere that has a small stem for positioning purposes. This sphere matches the patient's anatomy, meaning there is a lower risk of dislocation, a broad range of movement and excellent stability. The acetabular socket is then fitted with a corresponding metal cup.

Currently MoM bearings are under attack and the overall usage of these devices are on the decline.

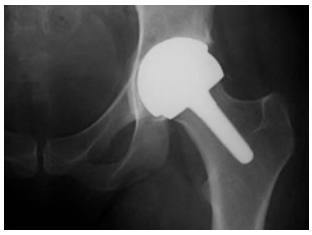
Onlay Hip Replacement

Developed and implanted in China this design shapes the head neck into a shape that allows for a onlay implant to fit over the outer cortex. It has fixed pins to the implant to aid in placement and initial stability. There is a central lag screw that engages the femoral implant and provides additional stability. The outer contour of the implant is custom made for each patient. The limited series of eight implants has had limited follow up of eight years with encouraging results.

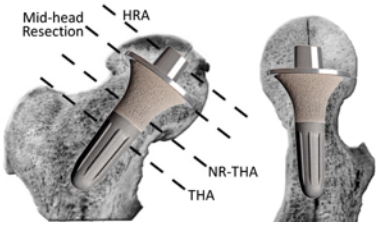
Subclass of Head Stabilization

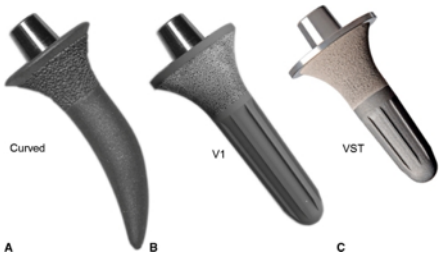
Mid Head Stabilization

The BMHR (Birmingham Mid Head Resection) is an alternative, bone-conserving hip device for young and active patients who are unsuitable for a BHR.



The conical stem engages lower down the femoral head as compared to a standard hip resurfacing. The femoral head is of the same material as the Birmingham Hip Resurfacing femoral component and the acetabular component is the same for both.





Different styles of the Mid-Head Designs. The VST is the current design.

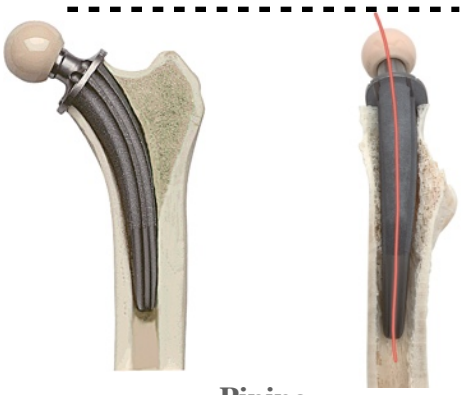
Neck Stabilization

This is one of the fastest growing market segments for short stems. Historically femoral neck retention was advocated by Freeman[13], Townley, Whiteside and Pipino. Only Pipino advocated a short curved neck sparing stem. Freeman, Townley and Whiteside all advocated saving the neck with the use of standard length stems that engaged the neck, metaphysis and diaphysis.

Pipino has dedicated the past thirty years to the idea of ***Tissue Sparing Total Hip Arthroplasty.*** As we have seen with other orthopaedic devices after 15-30 thirty years a device or technique becomes an overnight success: 1956 self-tapping bone screw state of the art in the 1970s, 1950s Richards Sliding Hip Screw state of the art in 1970s, 1960s Head-neck modularity state of the art in 1980s, 1970s Modular Acetabular Components state of the art in 1980s. 1970s Anterior Single and Dual MIS incision ***(K. Keggi)*** fastest growing surgical approach to the hip in 2000.

Curved Short Neck Sparing Stems

Pipino
c.c. stem implanted 1983-1996
Howmedica Biodynamic™ Stem



Pipino
CFP Titanium stem design 1996- Current
Waldemar Link

C.F.P.® Prosthesis Stem
Minimal bone resection by preservation of the femoral neck and proximal cancellous substance. Part of the circumflex artery branch-outs are preserved thereby maintaining vascular supply of the femoral neck after resection of the femoral head. Stem shape and Surgical Technique allow uncemented implantation with up to 87% prosthesis-to-bone contact. Anatomical stem and built-in physiological anteversion. Two stem curvatures ensure secure support of the stem at the medial cortex. Collar allows reintroduction of physiological loads into the femur

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The Muscle Sparing Approach Hip Stem (MSA™)

GlobalOrthopaedic Technology

The first MSA™ was implanted as a custom in December 2007 in Sydney Australia by Dr. Ian Woodgate. Since then GOT has introduced the stem on a limited basis to evaluate its clinical performance.

The design approach was build off the Pipino experience with specific novel features to address the concerns that were observed with the CFP style stem.

Goals: to improve proximal load transfer while creating a bone and tissue sparing stem.

The stem should be simple in design, amenable to reproducible technique and provide for fine tuning of joint mechanics while stimulating and maintaining compressive loads at the medial calcar.

In theory neck retaining devices provide for:

- Bone and/or tissue conservation
- Restoration of joint mechanics
- Minimal blood loss
- Potential reduction in rehabilitation
- Easily convertible to traditional THA in case of revision
- Simple reproducible surgical technique
- Opportunity to have bearing femoral head diameter and material as best indicated
- The selection of any standard surgical approach to the hip
- The prosthesis is compatible with large head technology

Clinical observations to-date have been very encouraging. There have been no reports of problems associated with the modular neck. No fractures, no fretting corrosion, no pseudo tumors and no reported on going hip pain.

Part of the TSI™ Study Group
www.jisrf.org

Licensed Technology from:

CDD
Concept, Design & Development, LLC

The Apex ARC™: Hip Reconstruction Implant by Omnilife Science™

The Apex ARC hip system provides surgeons with the bone conserving benefits of hip resurfacing without the disadvantages of metal-on-metal articulation, a steep learning curve and limited indications.

Unlike hip resurfacing, the Apex ARC offers:

- Universal Technique: Can be used with any common orthopedic surgical approach, including direct anterior and MIS:
- Bearing Options: Offers surgeons multiple bearing surface options.
- Acetabular Access: Does not significantly impede preparation of the acetabulum.
- Range of Application: Can be used on a wide range of patients in terms of gender, anatomy, deformity and disease Modular Pairing: Provides the surgeon with intra-operative versatility to restore joint mechanics by the use of modular necks and heads.
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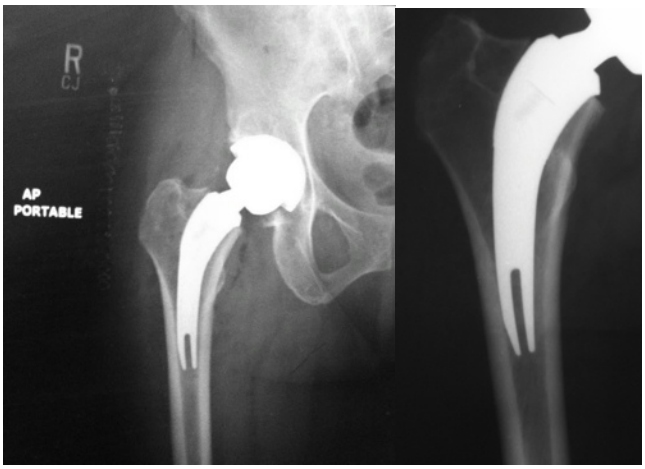
The first ARC™ stem was implanted in April 2010 and introduced with a controlled group of experienced surgeons. This stem is also monitored by the JISRF TSI™ Study Group that has reported its findings at over +30 CME meetings. www.jisrf.org

The system features c.c. modular necks so intropeative can be taken to check leg length, offset and version.

Stem fit is achieved in the femoral neck not the metaphysis or diaphysis of the femur.



Radiograph demonstrates that the curve of the stem hugs the medial curve of the femur and the proximal conical flair engages the medial calcar.

Part of the TSI™ Study Group
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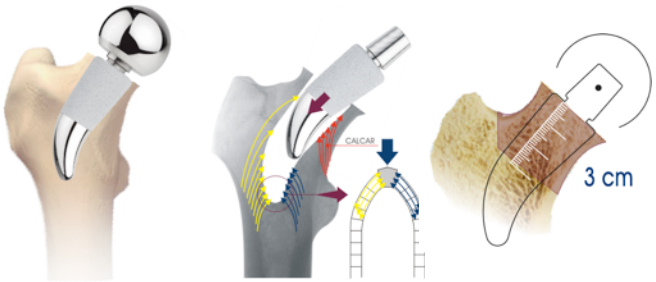
JUST is an Italian project developed by Permedica, Manufacturing in cooperation with Dr. Andrea Camera, Director of the complex Structure of Prosthetic Surgery-Santa Corona Hospital, Pietra Ligue (Sv).

The JUST stem is designed to fit into the trabecular bone system of the femoral neck. There is no information readily available on this device.



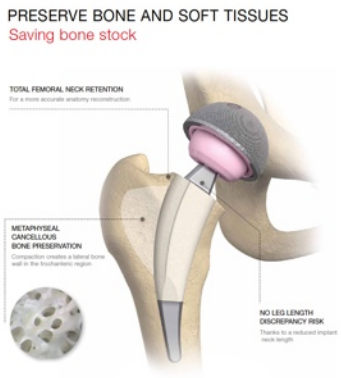
Promise Neck Preserving Stem

The Promise stem fills the need for a primary prosthesis preserving the femoral neck and the bone stock in the proximal region.
This conservative approach is particularly appropriate for young patients, where bone stock preservation offers wider possibilities for eventual future revision surgeries with traditional femoral stems.

THE COLLO-MIS STEM

The COLLO-MIS stem was designed to save bone tissue and ensure a rapid functional recovery.
By sparing the femoral neck without the risk of unequal leg length and compressing the cancellous bone, an anatomically accurate reconstruction is ensured while also saving as much of the patient's bone stock as possible.
The stem geometry and double macroporous coating provide for immediate stability and the restoration of the biomechanical balance required for optimal osteointegration.

The freedom to choose the preferred soft tissue-sparing approach and generation tribological couplings with materials and diameters combine to hasten the patient's functional recovery.



"Faster rehabilitation to an optimal primary fixation and a minimally invasive surgical technique"
M. Krieger, MD
Gelenkzentrum
Rhein-Main, Wiesbaden
Germany

Corin MiniHip™

Bone Conserving Hip Replacement

Design features

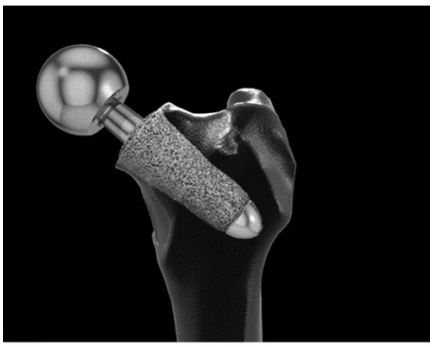
- Short stem conserving bone for a less invasive procedure
- Biocompatible titanium alloy
- Choice of high performance articulations
- Polished slim neck increasing the potential range of motion8
- Minimized neck resection for preservation of the femoral neck
- Fins to enhance rotational stability
- Medial curve following medial calcar radius for an anatomical bone conserving fit
- Bi-Coat™ for initial and long-term stable fixation9
- Polished distally to minimize proximal stress shielding
- Seven sizes with growing neck length for an anatomical fit

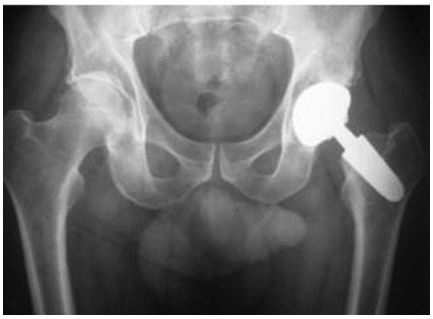
Neck Stabilized (Plugs)

Silent stem by DePuy

The 'Silent™ Hip' is designed for the young and active patient with arthritis of the hip. It is a relatively new procedure that has many potential advantages over standard hip replacements and resurfacing hip replacements.

The Silent hip is a tapered press-fit, textured implant designed to sit in the femoral neck without contacting the lateral cortex. It was launched in 2009 and remains in clinical trials.





CUT Femoral Neck Prosthesis by Orthodynamics

The CUT femoral neck endoprosthesis is a short stem device with a modular dual cone proximal component that allows the selection of different offsets and versions once the stem has been implanted. The implant is made from CoCrMo alloy and has a macroporous structure. The stem is curved at the tip, to sit against the lateral cortex of the femur.

The results of this implant have been variable. Steens et al quote a 5 year survival rate of 98% at an average of 6.6 years, but reported technical issues with this implant include valgus/varus malalignment,

with undersized components tending to drift into valgus, and occasional revision required because of lack of offset (2). Other authors have reported much lower survival; Ender et al reported a 5 year survival of 89%, and Ishaque et al reported 8 year survival of 49.6%

The TSI™ Neck Plug is part of a larger conservative comprehensive stem system.

Primoris™ Neck Replacement from Biomet

Why a femoral neck preservation?

- Maintain blood supply of the proximal femur and thus supporting the preservation of these load bearing bone structures (Pipino et.al., 2006).
- The bone structure of the femoral neck is extremely stable so ideal for anchorage of an implant
- Retention of bone stock makes revision easy
- Natural joint mechanism is retained

Indications:

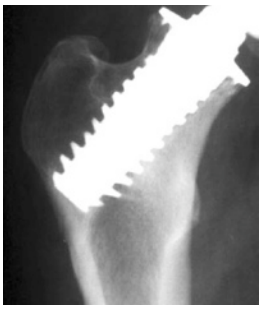
- Alternative to standard primary THR
- Young active patients
- Patient with significant joint disease
  - Osteoarthritis or
- Patients with existing implants in-situ

Development team:

Dr Poul Nielsen (Aalborg University Hospital, Denmark)
Mr Johan Witt (University College of London)
Dr Gordon Blunn (Institute of Orthopedics and Musculoskeletal Science, Stanmore Hospital)
Mr Richard Carrington (Stanmore Hospital)
Mr Tim Briggs (Stanmore Hospital)

Currently under investigation.

The Spiron Threaded Neck Plug HA coating



The Spiron cementless femoral neck prosthesis is based on the idea of proximal force transmission. The concept of osseous anchorages has been proven successful various times. The prosthesis is a conical, self-cutting screw that is inserted without cement into the prepared subcapital implant bearing. It is produced from a corundum blasted titanium-vanadium alloy and is covered with a second-generation calcium phosphate coating. The coating and the form of the thread increase the implant's surface and help to optimize osseointegration.

Metaphyseal Stabilization

There is a long history of using short metaphyseal stems that include anatomical, straight, and tapered style stems. Variable results have been seen often depended on surgical technique, bone quality and patient related activities.

Currently in this market segment the tapered style stems appears to be the dominate design style.

Biomet Microplasty™ style stems:

Taperlock® Microplasty
Balance® Microplasty

The Taperloc® microplastyTM Hip System is the next dimension in the evolution of Biomet's flat tapered wedge design philosophy. the taperloc® microplastyTM Hip builds on the strong clinical heritage of the proven taperloc® Hip System and incorporates new design features to address the growing demand for bone conserving and minimally invasive options in total hip arthroplasty.

The Balance® microplastyTM stem was introduced in 2007 and incorporates the design philosophy of the standard Balance® stem featuring an anatomic fit and fill geometry and bi-planar taper in a reduced length. it utilizes a bone conserving, tissue sparing design for minimally invasive total hip arthroplasty. its reduced length may avoid the need for a custom implant for cases in which existing hardware may prevent the use of a standard length stem.

ACCOLADE II from Stryker

Femoral Hip System is a femoral stem that is intended for cementless, press-fit application. The proximal region of the stem is coated with PureFix HA over a commercially pure titanium plasma spray substrate. The Morphometric Wedge — an evolution of the tapered wedge — is characterized by its variable, size-specific medial curvature. The total system includes:

• 12 body sizes ranging from size 0 to size 11 • Two anatomic offset options for each size

The stem is designed for use with Stryker V40 femoral heads and their compatible acetabular components.

The ACCOLADE II Hip System includes a broach-only instrumentation platform that accommodates all surgical approaches and has been streamlined for surgical efficiency.

Surgical Technique Developers:

Dr. Richard Rothman
Dr. Dermot Collopy
Dr. David Jacofsky
Dr. Frank Kolisek
Dr. Art Malkani

Tri-Lock Bone Preservation Stem by DePuy

The original Tri-Lock® was introduced in 1981. This implant was the first proximally coated tapered-wedge hip stem available to orthopaedic surgeons and their patients. Since its introduction, Tri-Lock has demonstrated 98% survivorship.

The reduced lateral shoulder, thin geometry and optimized length of the Tri-Lock Bone Preservation Stem minimize the amount of bone removed from the patient. These same features, along with approach enabling instrumentation, allow the surgeon to perform minimally invasive technique.

Metha® Short Hip Stem by Aesculap

Low neck cut / metaphyseal stability

The Metha® short cementless hip prosthesis stem is anchored directly within the closed ring of the femoral neck and metaphysis. Metha® preserves valuable muscle and bone structures and leads to a high primary loading stability and natural femoral antetorsion.

The prosthesis concept allows implantation via the base of the femoral neck.

Note: They did have some fatigue problems with their first modular neck made of titanium alloy. Now made of c.c.

Often the stem is proud of the neck resection.

Aida® Short Stem
Developed in 2008 by Implantcast, Lüeburger Schanze - Buxtehude, Germany

The Aida® hip system includes cementless short stem implants of 9 sizes each with two different offsets (standard and lateralized). The implants are made of implantan® $TiAl_6V_4$-titanium alloy with a proximal dual coating of cpTi (pure titanium) and HA.

AJS® hip system includes a complete variety of cementless and cemented hip stems for the primary treatment of the hip joint. The AJS stem accommodates to the anatomy of the proximal femur of European patients.

The AJS® hip system was developed in co-operation with Jürgen Schmitz, Evang. Krankenhaus, Dinslaken.

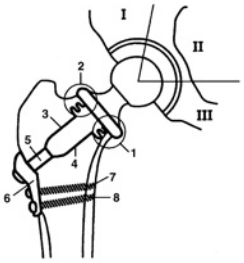
PEGASUS MODULAR

is a straight short press-fit stem designed to fit the metaphyseal area of the proximal femur, allowing minimally invasive approach and saving bone stock.

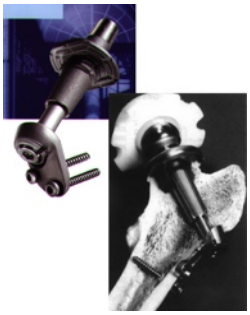
A trochanteric wing, deployed intraoperatively, locks hard against the cortical wall of the greater trochanter to assure total primary implant fixation.

The neck modularity allows a choice of the best option for correct biomechanical restoration.

Thurst Plate



The Thrust plate prosthesis (TPP) (Zimmer Winterthur, Switzerland) is an implant for cementless fixation at the metaphysis of the proximal femur. For reasons of diaphyseal bone preservation, this implant is preferred by some orthopedic surgeons especially in younger patients who most certainly will have a revision arthroplasty later on in their lifetime. At this time, the untouched diaphyseal bone provides advantages for the fixation of a subsequent stemmed femoral implant.



Mid-term results by Fink et.al. concluded:[12]

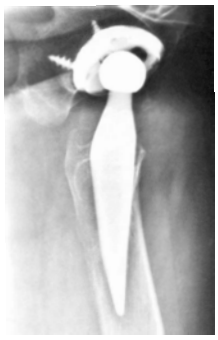
1. Higher failure and infection rate as compared with standard cementless THA.
2. Possibility of pain associated with soft tissue problems over the fishplate.
3. Stress shielding under the thrust plate

This was not an alternative to stemmed THA.

Mayo® Conservative Stem by Zimmer

The MAYO Conservative Hip Prosthesis was designed to significantly reduce bone loss compared to a standard porous primary stem. Thus, leaving more bone stock if a revision procedure is needed.

Developed in conjunction with
Bernard F. Morrey, M.D.
Professor and Chairman
Department of Orthopaedic Surgery
Mayo Clinic
Rochester, MN



Fitmore® Hip Stem by Zimmer

Preserves natural bone in the greater trochanter
• Different medial curvatures to help restore patient's anatomy
• Trapezoidal cross-section offers proven primary fixation

Nanos by Smith & Nephew

The NANOS femoral neck prosthesis was developed to create a system with metaphyseal anchorage and load distribution. The implant requires only minimal bone resection. The cancellous bone around the metaphysis and the greater trochanter are retained to ensure load distribution and transfer. This upholds the principle of the "second line of defense" for this prosthesis concept.

Ten sizes designed to complement each other and a clearly arranged set of instruments make it easier for the surgeon to intraoperatively determine and select the suitable implant. The NANOS femoral neck prosthesis has been developed based on clinical experience of various "short stem prostheses" and is the third generation of this type of prosthesis.

Note: The Nanos can save neck but it achieves its primary stabilization by metaphyseal fixation.

Summary

JISRF has developed a classification system to help identify, differentiate and catalog short stemmed total hip implants by primary stabilization contact points.

Not all short stems generate the same radiographic findings and or clinical results. It is also important to appreciate the specific design and appropriate surgical technique for a given design.

We believe this classification system helps to clarify some of the design principles and clinical findings.

JISRF Classification System for Short Stems

1. **Head Stabilized**
2. **Neck Stabilized**
3. **Metaphyseal Stabilized**
4. **Conventional (Metaphyseal/Diaphyseal) Stabilized**

Of course there will be subcategories off of these main six categories. Examples: Neck plugs versus short curved neck stems. However the primary stabilization point, will be the same overall category.

This classification will help differentiate when reporting on the design and clinical findings of short stem total hip arthroplasty.

ARC™ Stem / Microplasty Taper
Neck Stabilized / Metaphyseal Stabilized

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Notes

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