Neck Taper and Compatibility

What Does the Surgeon Have to Consider?

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The Neck Taper in Hip Arthroplasty

What does the surgeon have to consider?

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Modular principle for hip arthroplasty

Modern hip arthroplasties are based on a modular construction. This modular construction, particularly the combination of a stem and femoral ball heads of differing neck lengths, is an accepted solution that enables flexible adjustment to the individual situation of patients during surgery.

This modularity enables the surgeon to optimize reconstruction of the original joint anatomy and to achieve the best possible biomechanics for the patient. Modular taper fixation also enables different materials such as metal and ceramics to be joined together. Taper locking has proven itself to be practicable in both its manufacturing process and its application. A further advantage is its high stability, which prevents corrosive phenomena. During revision surgery it is possible to loosen the locked fixation and to replace the femoral ball head in accordance with the manufacturer's instructions.

On the history of taper fixation

The taper fixation between a femoral ball head and a stem, familiar in hip arthroplasty, was developed at the start of the 1970s by the industry partners Sulzer AG (endoprosthesis manufacturer and predecessor of Zimmer, Winterthur, Switzerland) and Feldmühle AG (ceramics manufacturer and predecessor of CeramTec GmbH, Plochingen, Germany).

The aim was to realize reliable and durable fixation between a ceramic femoral ball head and a metal stem. Dörre et al.[1] attached special importance to the force-fit connection (taper locking) between the ceramic femoral ball head and the metal taper: a hip arthroplasty with taper fixation was used in a patient for the first time in 1974. The principle behind this taper fixation was protected in a Swiss patent (No. 1060601).

At the start of the 1990s intense efforts were made to standardize a uniform taper (the Eurotaper) with the International Organization for Standardization (ISO, document ISO/TC150/SC4 N117) but these efforts failed.

There is still no standard for the stem taper. Implant manufacturers continue to use tapers with their own specifications (for example, various 12/14 tapers), which differ in terms of geometry, structure and surface properties (Fig. 1). The intervals between the neck lengths (s, m, l and xl) (Fig. 2) are also not standardized and can vary from manufacturer to manufacturer by several millimeters.

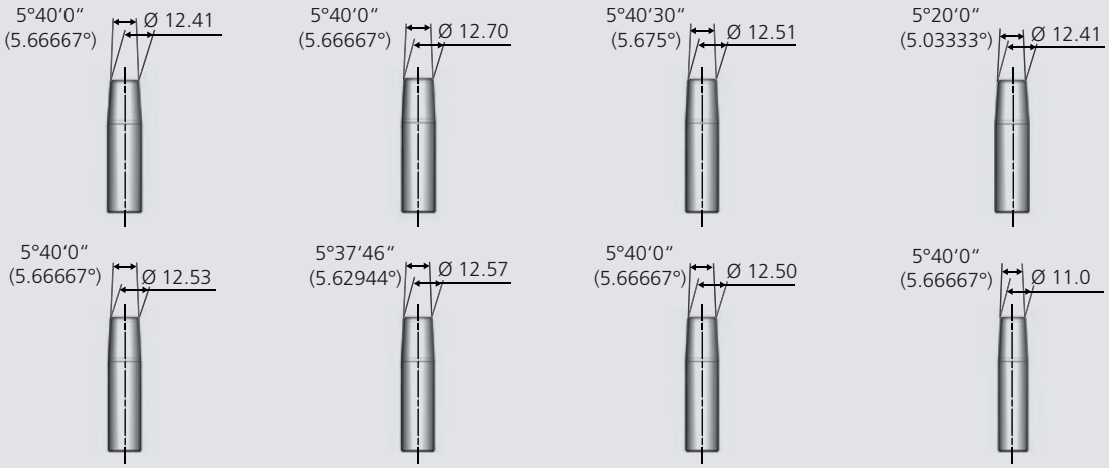


Fig. 1: *Different tapers all of which are designated "12/14"*

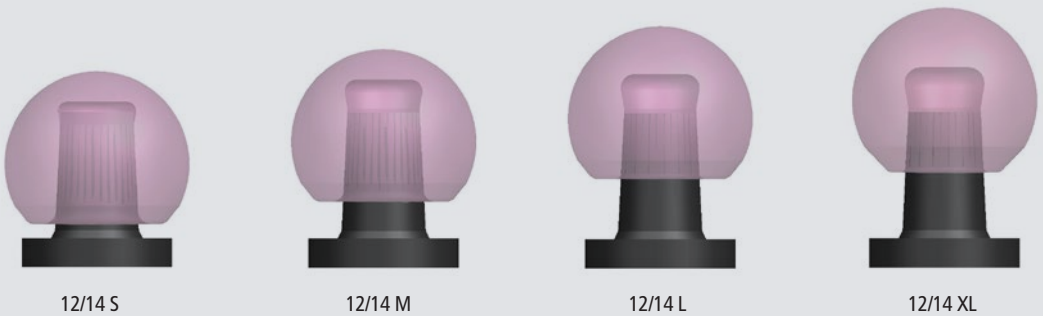
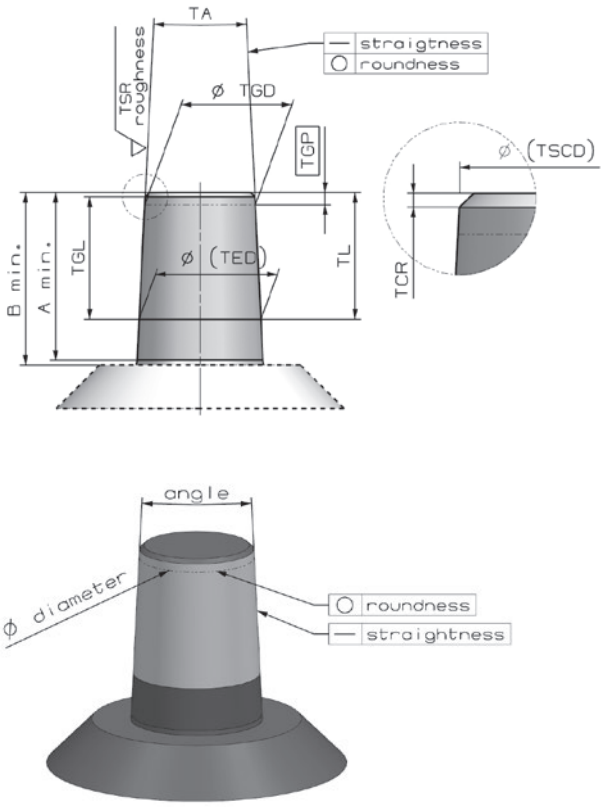


Fig. 2: *Different neck lengths*



Abbreviation	Description
TGP	Taper gage plane
TGD	Taper gage diameter
TA	Taper angle
TL	Taper length
TCR	Taper chamfer/radius
TSR	Taper surface roughness
TS	Taper straightness
TR	Taper roundness
TGL	Taper gage length
TED	Taper end diameter
TSCD	Taper sharp corner dia.

Fig. 3a/3b: *Characteristics of an implant taper*

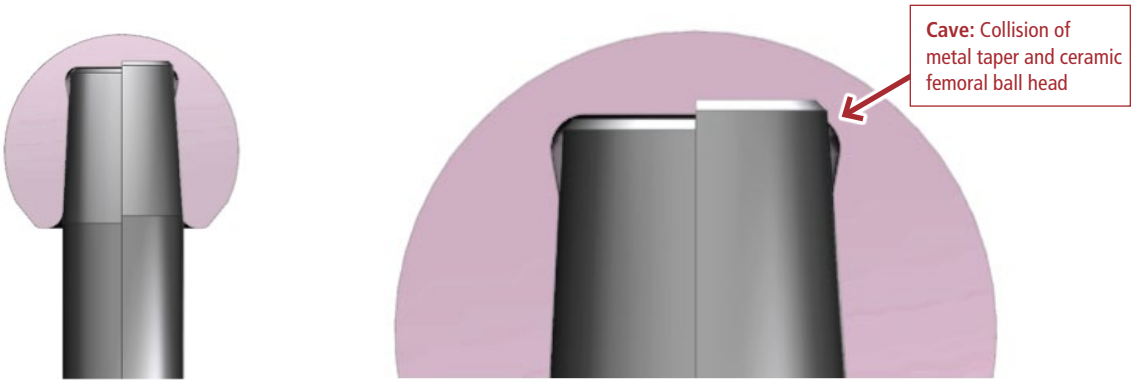


Fig. 4: *Compatibility example: Design difference between two nominally similar 12/14 tapers demonstrated with the fit with a ceramic femoral ball head*

Features of an implant taper

A taper fixation is made up of a stem taper and a taper in the femoral ball head (drill hole). Each of these tapers has characteristic properties (Fig. 3a/3b) such as taper angle, diameter, straightness and roundness and surface properties, which are essential for a precise matching of the components. For secure taper locking, the fit of the taper fixation between the femoral ball head and the stem taper is very important.

Compatibility

It is vital that surgeons combine only those arthroplasty stems and femoral ball heads that the implant manufacturer has declared to be compatible.[2] The implant manufacturers are responsible for the release of the stem taper / femoral ball head combinations and supply the components to the hospitals. The surgeon must comply with the details regarding approved combinations provided by the implant manufacturer in the instructions for use and other written information.

A survey of the New Zealand Orthopaedic Association showed that 23% of the surgeons had implanted mismatched components within the last 5 years. The most of them occured in THA.[3] In case of failure to observe compatibility of individual arthroplasty components (Fig. 4), clinical consequences, e.g. with regard to joint geometry with effects on leg length and soft-tissue tension as well as increased metal wear combined with adverse tissue reactions (pseudotumor) and implant failure ahead of time[4] cannot be ruled out.

A meta-analysis indicates that there are insufficient studies of this issue. Information regarding the mechanical behavior of taper locking with inadequately fitting arthroplasty components may be provided by laboratory investigations.

TAKE HOME MESSAGE

- There is no uniform, standardized stem taper.
- Numerous stem tapers are called "Eurotaper 12/14" but this only represents a general size designation and provides neither an indication about compatibility with arthroplasty components from other manufacturers nor information about the precise manufacturer's specification for a stem taper.
- You must therefore query terms such as **12/14 Eurotaper** or **Standard Taper 12/14!**
- It is essential that you check the compatibility of femoral ball heads and stem tapers!

GLOSSARY

Eurotaper: Not a standard term in hip arthroplasty

Taper: Technical element in the shape of a cone or truncated cone

Taper diameter/conical taper (example 12/14 or 10/12 etc.): Simple characterization of the taper using a rounded and imprecise size definition of the smallest and largest taper diameter with undetermined distance between the two diameter elements

Taper angle: Precise angle of inclination of the cone in its axial direction

Taper diameter: Exact nominal diameter or tested diameter at the defined measurement height on the cone

Femoral ball head minimal definition:
(Example: 32 12/14 M 0 5° 46′ defines a femoral ball head with):

- Ball diameter = 32mm
- Taper diameter:
  start of taper = approx. 12mm
  end of taper = approx. 14mm
- Neck length = M (medium)
- Taper angle = 5° 46'

The implant manufacturer must release the ceramic femoral ball head for use with the particular type of implant.

Straightness: The term describes the straightness of each line on a conical surface in the axial direction.

Roundness: The term describes the roundness of the circumference of any cross-section.

Surface roughness/structure: The term describes the properties and parameters of the surfaces of a technical element.

Acknowledgment

The authors thank Wolfgang Zitzlaff, Tina Mirus und Ines Feistel (Design Dept., CeramTec GmbH) for their energetic and comprehensive support.

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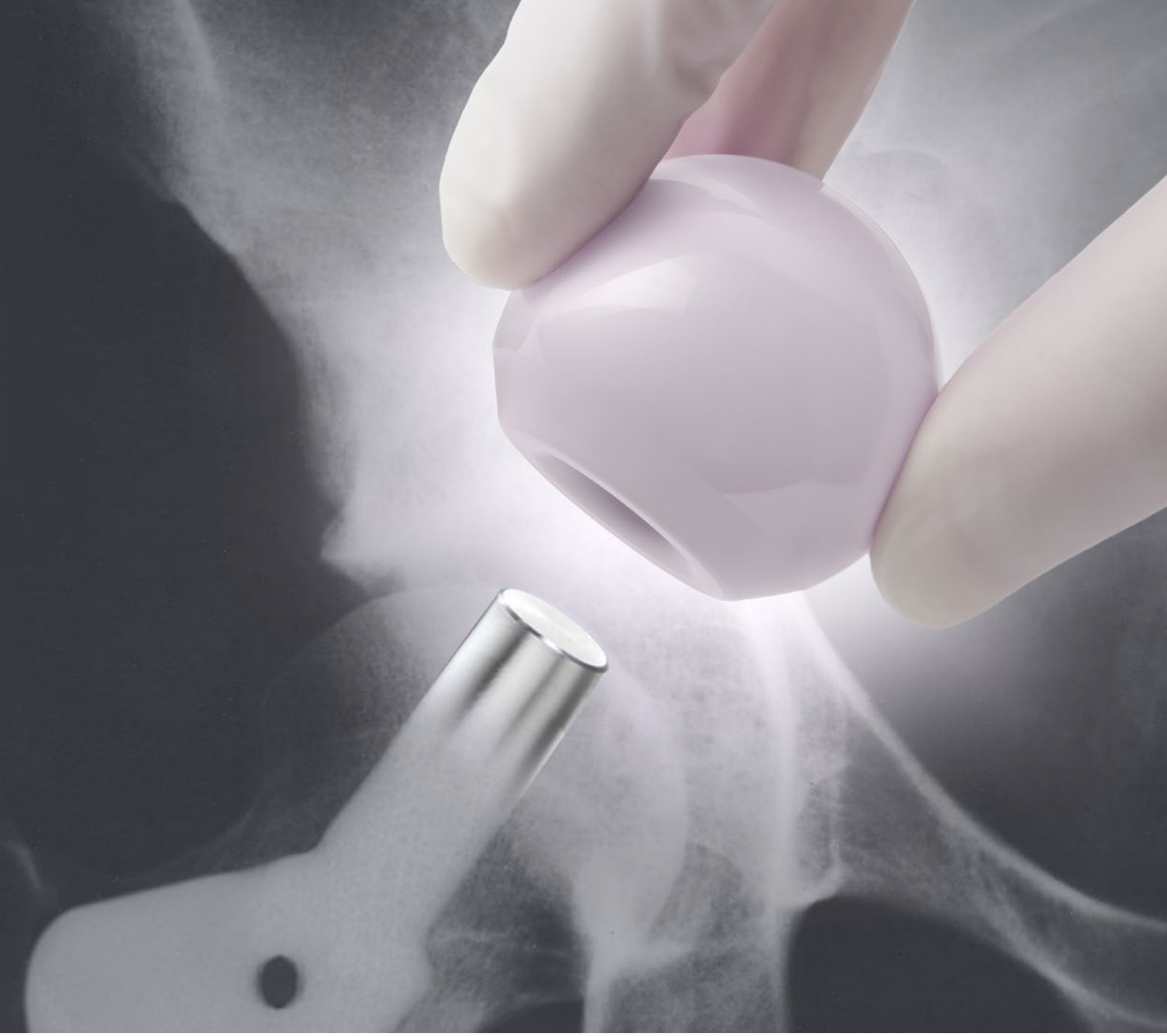

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MT-00149-1708-EN-01 · Printed 8.2017