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Original Article

The Polished MS-30 Stem With a Solid Centralizer: A Minimum 10-year Review of Radiological and Clinical Outcomes
拋光 MS-30 假體固體與實心置中器的結合:最少術後十年的造影和臨床結果

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ABSTRACT

Background/Purpose: MS-30 is a triple tapered cemented femoral stem. Before 2005, it was used together with a solid centralizer. We wanted to investigate its effect on the migration behaviour and survivorship of polished stem with a minimum of 10 years.
Methods: Twenty-seven hips in 26 patients were available for follow-up. The mean length of follow-up was 12.1 years. Clinical outcomes were documented with the Harris Hip Score. Radiographs were examined for evidence of aseptic loosening.
Results: The average Harris Hip Score was 74.8. No stem was revised for aseptic loosening. Two stems (7.4%) developed radiolucent lines of more than 2 mm width with osteolysis. The mean subsidence was 0.77 mm. The survival rate at the 10th postoperative year, with aseptic loosening as the end point, was 100%.
Conclusion: The polished MS-30 stem with a solid centralizer has a satisfactory long-term outcome. Its mean subsidence was less than that of other polished tapered stems reported in the literature.

中 文 摘 要

簡介: MS-30是一款三維錐形的骨水泥型假体。在2005年之前它的置中器是實心的。本文探討該置中器對拋光假体的遷移行為和存活率在最少十年術後的影響 。
方法: 我們回顧了26例（27髖），平均隨訪時間為12.1年，臨床結果以 Harris評分記錄，同時記錄了假体在X光片的鬆動跡象。
結果: 平均Harris評分為74.8。沒有假体因無菌性鬆動而需修復。有兩個假体（7.4%）出現大於2mm寬度的透亮線 和骨溶解。假体的平均沉降是0.77毫米。在10年後以無菌性鬆動為終點的存活率為100%。
結論: 拋光MS-30假体固體與實心置中器的結合使用具有滿意的長期結果，其平均沉降小於其他拋光錐形骨水泥型假体在文獻中的沉降。

Introduction

The MS-30 stem (Zimmer Ltd., Winterhur, Switzerland) is a cemented femoral stem for total hip arthroplasty. It is named after its designers, Morscher and Sportorno, and the stainless steel is made of Protasul 30. It has a triple tapered geometry (Figure 1A). Upon subsidence the stem wedges into the cement mantle with the axial loading force transferred as compressive force to restabilise the stem.[1]

When the MS-30 stem was first introduced into the market in 1990, the surface finish was matt. After the inferior results of the matt Exeter Stem were published,[2,3] the polished MS-30 stem was introduced in 1994. At that time the design of the centralizer remained unchanged. The centralizer was solid with a bore coupled to a pin at the stem tip (Figure 1B and C). In a roentgen stereophotogrammetric analysis (RSA) study, a polished MS-30 stem with a solid centralizer was shown to subside less than the stem with a hollow centralizer at 2 years follow-up.[4] In 2005, the centralizer was changed to a hollow design to accommodate stem subsidence.

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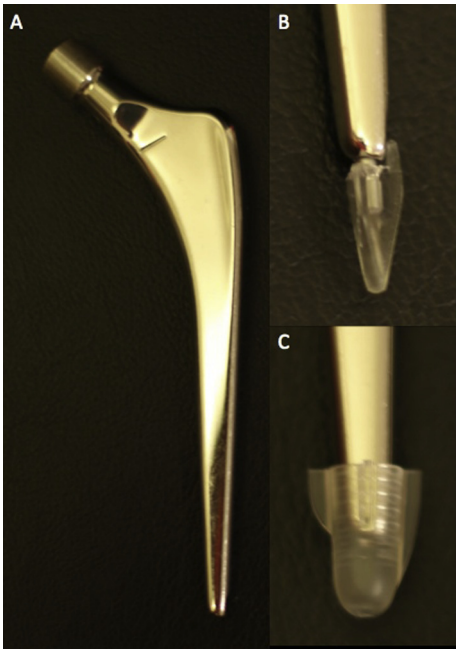

Figure 1. (A) Polished MS-30 stem; (B) solid centralizer; and (C) hollow centralizer.

It has been demonstrated that polished tapered stems continued to migrate at 10 years.[5–7] It is therefore important to know whether the subsidence of the polished MS-30 stem would remain retarded in the long-term and how it would affect its outcome. The aim of this study was to investigate its migration behaviour, radiological, and clinical outcomes with a minimum of 10-years of follow-up.

Methods

Between 1997 and 2003, 47 Chinese patients with 51 hips were operated on. The posterior approach was used. After broaching, the femoral canal was prepared with canal plugging, pulsatile lavage, and hydrogen peroxide gauze packing. Simplex P cement (Stryker Ltd., Mahwah, New Jersey, USA) was used. It was prepared with vacuum mixing then applied with a cement gun with pressurisation. The polished version of the MS-30 stem with a solid centralizer was used in all patients. They were used in conjunction with Original M.E. Muller Low Profile Cup (Zimmer Ltd.) and a 28 mm modular SuloxTM alumina-ceramic femoral head (Zimmer Ltd.).

Cefazolin was given to all patients as a prophylactic antibiotic. Subcutaneous low molecular weight heparin was given as thromboembolism prophylaxis. An abduction pillow was kept on for the first 2 days after the operation. Full weight bearing walking was started on Day 3. A hi-low chair for sitting was required for patients for the first 6 weeks.

Clinical and radiological follow-ups were done at the 6th week, 3rd month, and 6th month after the operation, and then annually. Clinical outcomes were documented with the Harris Hip Score.[8] Anteroposterior and lateral radiographs of both hips were taken. Stem subsidence and alignment change were measured with OsiriX (OsiriX, Geneva, Switzerland).

Radiographs taken 6 weeks after the operation were examined for cementation quality and stem alignment. Cementation quality was graded as described by Barrack et al.[9] Stem alignment was defined as the angle between the stem axis and canal axis. A deviation of >3° was regarded as significant.

Subsequent radiographs were examined for any changes in stem alignment. Subsidence was defined by the distance between the shoulder of prosthesis and the sclerotic line above it.[10] Radiolucent lines were defined as linear radiolucency adjacent to a sclerotic line.[11] Lines >2 mm width were regarded as significant. Osteolysis was defined as a new cystic lesion with endosteal scalloping and/or stem migration, which had not been recorded on the postoperative radiograph taken at 6 weeks.[12] They were recorded in zones as described by Gruen et al.[11] Heterotopic ossification was also recorded and graded according to Brooker et al.[13]

Survivorship was analysed according to Kaplan and Meier.[14] The survival rates for aseptic loosening and for all causes were calculated. The end point was defined by revision or clinical failure.

Results

Clinical results

Of the 47 patients operated on, 16 patients died and five patients were lost to follow-up. The causes of death were not related to the indexed hip operation. Twenty-six patients with 27 hips were available for follow-up. The mean length of follow-up was 12.1 years (10.1–15.2 years).

There were 23 females and three males. The mean age at operation was 69.8 years (59–80 years). The preoperative diagnoses are as shown in Table 1.

The mean Harris Hip Score at the last follow-up was 74.8. The distribution of the overall result is as shown in Table 2. One patient with poor results had irreducible posterior dislocation refusing revision. The remaining patients had fair and poor results due to causes not related to the indexed hip operation.

Radiographic results

From analysis of the postoperative film at 6 weeks, 23 stems (85.2%) attained neutral alignment. Two stems (7.4%) were in valgus and two were in varus (7.4%). Grading of the cement mantle is as shown in Table 3.

The distribution of stem subsidence at the last follow-up is as shown in Table 4. The mean subsidence was 0.77 mm. No stem subsided >3 mm. No stem developed any changes in coronal alignment >3°.

Two stems (7.4%) developed radiolucent lines of >2 mm width with osteolysis. The first case had radiolucent lines at Zone 1, Zone 2, Zone 6, and Zone 7, with osteolyses at Zone 2 and Zone 6. The second case had radiolucent lines at Zone 1, Zone 6, and Zone 7, with osteolysis at Zone 6. Both stems subsided by 2.6 mm. There was no coronal plane migration. Upon review of the radiographs 6 weeks after the operation, all of them had neutral alignment with Grade B cement mantle.

Three patients developed heterotopic ossification. According to Brooker's[13] classification, one (3.7%) was Grade 1 and two (7.4%) were Grade 3.

Table 1
Preoperative diagnoses

	No.	%
Osteoarthritis	11	40.7
Avascular necrosis	10	37.0
Fracture complications	3	11.1
Rheumatoid arthritis	3	11.1

Table 2
Harris Hip Score

	No.	%
Excellent	3	11.1
Good	14	51.9
Fair	6	22.2
Poor	4	14.8

Table 3
Grading of cement mantle

Barrack's classification	No.	%
A	4	14.8
B	20	74.1
C1	2	7.4
C2	1	3.7
D	0	0

Table 4
Stem subsidence

Subsidence (mm)	No.	%
<1.0	18	66.7
1.0–1.9	5	18.5
2.0–2.9	4	14.8
≥3.0	0	0

Complications

One hip developed recurrent posterior dislocation 4 weeks after the operation. The final episode was irreducible by close reduction, but the patient refused revision. One patient developed deep vein thrombosis. There was no infection in this series. No patient was revised for aseptic loosening.

Survival analysis

Taking all causes for revision or clinical failure into account, the 10-year survivorship was 95.7%. If the end point was aseptic loosening, the 10-year survivorship was 100%. Their survival curves are as shown in Figures 2 and 3 respectively.

Discussion

The polished MS-30 stem has an excellent long-term survivorship. In a series of 95 stems followed for an average of 10.2 years, the survival rate was 98.5% with aseptic loosening as the endpoint.[15] In another series of 55 stems followed for an average of 12 years, the survival rate was 100%.[16] The outcome of our series concurs with literature.

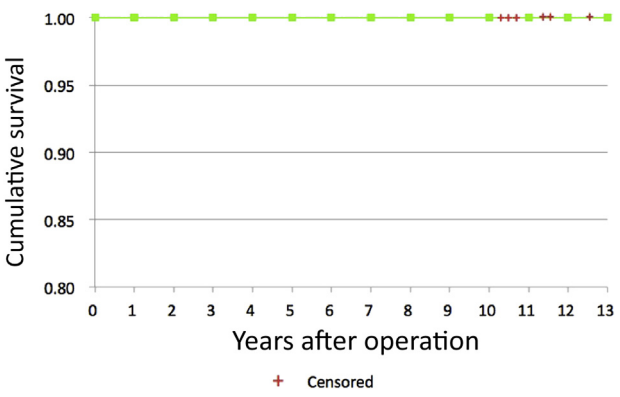

Figure 2. Survivorship with failure for aseptic loosening as the end point.

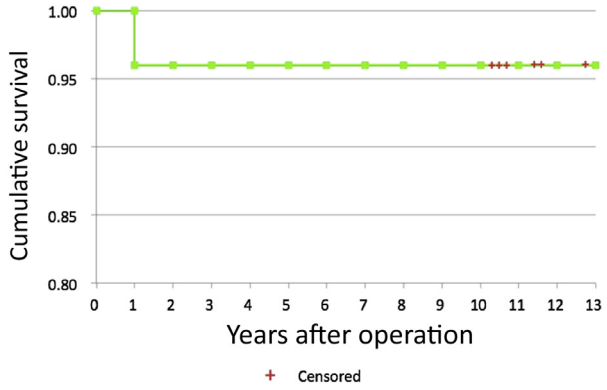

Figure 3. Survivorship with failure for any reason as the end point.

At 2 years after operation, the polished MS-30 stem with a solid centralizer has been shown to subside less compared with a stem with a hollow centralizer in a RSA study.[4] In our series, with a minimal follow-up length of 10 years, the mean subsidence was 0.77 mm. This is less than other polished tapered stems, which were reported to have a mean subsidence of 1.28–2.1mm at 10 years.[5–7] The solid centralizer of the MS-30 stem is fixed to the stem through a pin-bore mechanism. The centralizer, which is made of polymethyl methacrylate, has been shown to bond well with cement.[17] The stem-centralizer coupling together with the cement-centralizer bonding may retard stem subsidence.

The MS-30 stem has a triple-taper geometry and employs the taper-slip principle.[18] Upon axial loading the stem subsides. This generates radial compression force in the cement. It is transferred to the bone as hoop stress, which in turn stabilizes the stem. The stem is fixed through such balance of forces, which is termed force-closed design.[19] Bonding between stem and cement is not necessary. The solid centralizer fixes the stem tip to the cement mantle and actually contradicts the taper-slip principle. However, our series demonstrated favourable long-term results which is comparable to other polished tapered stem.[20,21]

We encountered two cases with radiolucent lines at proximal medial and proximal lateral cement bone interface. This raises the concern of bending cantilever failure as described by Gruen et al,[11] in which the proximal stem lost support while the distal stem remained well-fixed. In the RSA studies of C-stems, which also have a triple tapered geometry,[7,22] there was no significant coronal plane migration. Clinical studies did not reveal increased loosening due to cantilever fatique.[23] The centralizer of the C-stem is hollow to accommodate subsidence. In our series, however, a solid centralizer was used with a triple tapered stem. The distal stem was fixed to a cement mantle with the axial migration limited. The stem may be prone to coronal plane migration due to the mediolateral taper. Further studies with larger sample sizes are warranted to delineate the prevalence and significance of this phenomenon.

The age at operation in our study was older than in other series. It resulted in a high dropout rate due to death or loss of follow-up. Additionally, a higher portion of patients had fair to poor results even though the cause was not related to the indexed operation in majority of the cases. According to the Swedish Hip Registry, the revision rates of stems vary with age.[24] Our older cohort can supplement with other series to give a complete picture on the performance of this stem at different ages.

In conclusion, the polished MS-30 stem with a solid centralizer demonstrated less subsidence than other cemented stems, with

survivorship remaining comparable. Further observation of its radiographic behaviour is recommended.

Conflicts of interest

The authors have no conflicts of interest.

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