

The reverse sleeve in total hip arthroplasty for patients with trochanter valgus deformity: surgical technique and case series

Xiangpeng Kong

Chinese PLA General Hospital

Wei Chai

Chinese PLA General Hospital

Minzhi Yang

Nankai University

Alvin Ong

Rothman Orthopaedic Institute

Jiying Chen

Chinese PLA General Hospital

Yan Wang

Chinese PLA General Hospital

Yonggang Zhou (✉ zhouyg301@sina.com)

Chinese PLA General Hospital <https://orcid.org/0000-0001-6020-998X>

Research article

Keywords: cementless modular stem, reverse sleeve, total hip arthroplasty, trochanter valgus deformity

Posted Date: October 11th, 2019

DOI: <https://doi.org/10.21203/rs.2.15961/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published on February 24th, 2020. See the published version at <https://doi.org/10.1186/s12891-020-3145-4>.

Abstract

Background: Trochanter valgus deformity (TVD) is a rare condition of total hip arthroplasty (THA). The femoral osteotomy might be required to correct the deformity to implant the femoral stem in severe TVD. In this study, we described one unpublished technique of reverse sleeve of S-ROM to get through the complex situation. The aim of this study was to summarize the technical challenges of this special sleeve-implanting method and evaluate its effectiveness and safety.

Methods: From January 2006 to December 2014, the patients who had the reverse sleeve to solve the TVD in THA were enrolled. Their demographics, perioperative and postoperative information were recorded. To explore its indication, we measured and analyzed the ratio of greater trochanter/lesser trochanter (G/L ratio) and trochanter valgus angle (TVA).

Results: Twelve patients (1 male and 11 female, average age 42.30 ± 10.23) who had the complete clinical data were analyzed. The survivorship of femoral prosthesis were 100% with mean follow-up of 6 years. No other complications were found, except for two patients with intraoperative fracture of femur. The Harris hip score (HHS) increased from preoperative 34.31 ± 14.43 to postoperative 84.12 ± 11.33 . All patients' G/L ratio were larger than 1.50.

Conclusions: The reverse sleeve of S-ROM was a simple and reliable method for patients with severe TVD, which brought satisfying clinical outcomes in mid-term follow-up. When G/L ratio is larger than 1.50, surgeons should consider this special surgical technique. **Keywords:** cementless modular stem; reverse sleeve; total hip arthroplasty; trochanter valgus deformity.

Background

Trochanter valgus deformity (TVD) is an uncommon type of proximal femoral deformity [1,2]. Before ceramics and high crosslinked polyethylene being used in orthopedic surgery, total hip arthroplasty (THA) in young patients had a high rate of failure [3]. To delay THA, trochanter valgus osteotomy (TVO) used to be one useful treatment for developmental dysplasia of the hip (DDH) and osteonecrosis of the femoral head (ONFH) [4]. However, when these patients had severe hip arthritis, they have no choice but to receive THA. The significant angled femoral cavity would complicate the femoral preparation and stem implantation [5,6]. THA with concurrent femoral osteotomy is a demanding procedure technically. Lewallen et al reported 32% patients underwent reoperation at 4.6 years after THA and femoral osteotomy [5]. TVO was the leading cause of trochanter valgus deformity, followed by malunion of fracture and congenital factors.

Few studies on THA in patients who had trochanter valgus deformity have been published [1,2]. Iwase et al reported that the failure rate of cementless stem was 22.5% at 4 years after conversion THA and concluded that cemented stems were preferable for THA in patients with previous femoral valgus osteotomy [1]. However, another Japanese surgeon in 2017 reported 100% survivorship of the femoral

component and suggested that modular femoral components should be used when undertaking total hip replacement in patients with previous femoral valgus osteotomy [2].

Appropriate choice of femoral prosthesis could simplify surgical procedures and improve clinical results. The S-ROM femoral component (DePuy Orthopaedics, Warsaw, Indiana) is a cementless, modular and cylindrical prosthesis, which was specially designed for proximal femoral deformity [7]. Modularity at the stem-sleeve junction allows the surgeon to decide the anteversion of the femoral stem independent of sleeve, which could best fit and fill the proximal femur.

In this study, we described one technique of reverse sleeve in THA for patients with TVD. Although this technique has been discussed in some meetings before, no previous studies ever specially described it. The reverse sleeve could take advantage of, rather than correct the deformity, which could improve the efficiency and reduce trauma greatly. The aim of this study was to summarize the technical challenges of this special sleeve-implanting method and evaluate its effectiveness and safety.

Patients And Methods

The study was approved by the institutional review board. From January 2006 to December 2014, the patients who had reverse sleeve in THA were included in our institute's joint registry system. The patients who hadn't have regular follow-up and complete information were excluded.

All patients had severe hip arthritis and TVD, which means metaphyseal level valgus deformity [8]. The modular S-ROM prosthesis consists of the sleeve and stem. The sleeve is porouscoated or hydroxyapatite (HA)-coated and is designed to convert shear and hoop stresses to compressive forces at the sleeve-bone interface. The titanium alloy stem is polished distally; it also has several options of neck length and offset proximally [7]. The sleeve achieves bone ingrowth in the metaphysis and the stem can be freely rotated to accommodate any deformity or asymmetry in the proximal femur [9].

The angle between sleeve's sloop and stem is 30 degree, which is designed to adapt the medial cortex of proximal femur, so the sleeve's triangle was placed to the lesser trochanter commonly. In this study, we placed the sleeve reversely, which means its triangle points to the greater trochanter. Up to now, no other study has described this special sleeve-implanting method and analyzed its clinical outcome systematically.

Surgical technique

All surgeries were performed by two senior surgeons through posterolateral approach.

- After the femoral head being dislocated, the femoral head and neck was resect along with the intertrochanteric crest (Figure 1.A).
- The entry of proximal femur was important to the orientation of stem. The accurate entry can obtain the proper stem alignment and decrease the incidence of periprosthetic fracture. According to the preoperative templating, the site of entry was recognized (Figure 1.B). Then the smallest reamer was

used to find the right medullary cavity with the aid of intraoperative fluoroscopy (Figure 1.C). Then the distal reamer size was increased sequentially until it touched the cortical bone. The depth of reaming was appropriate when its mark aligned with the tip of greater trochanter. More attention should be paid to the orientation of reamer to avoid the protrusion.

- According to the size of distal reamer, the proximal reamer was used to prepare the proximal femur (Figure 1.D). When the medial cortex of femur is unable to support the sleeve, we placed the sleeve reversely. Because there was no instrument to managing sleeve sloop in the greater trochanter side, the surgeon handled the sloop manually (Figure 1.E). The medial cortical bone should be resurfaced to prevent impingement (Figure 1.F). In order to avoid subsidence of sleeve and stem, we adopted the larger sleeve as far as possible (Figure 1.GH).
- The stem was adjusted in proper anteversion. When the hip stability and leg length was satisfying, the surgeon implanted the real prosthesis and finished the surgery (Figure 1.IJKL).
- For the patients who had residual plate and screw, fractures of the greater trochanter should be watched out. In some cases, wires were pre-bundled around the trochanter and removed after reduction.

Postoperative follow-up and measurement.

The patients were followed up at 4 and 12 months after surgery, and then checked every 2–3 year.

We analyzed the perioperative and postoperative complications, Harris hip score (HHS) and radiologic results in the last follow-up. Complications were defined as neurovascular impairment, dislocation, prosthetic loosening, periprosthetic femoral fractures, periprosthetic infection and reoperation for any reasons.

Postoperative radiologic measurement: measuring the angle between the axis of stem and femur to evaluate the stem alignment. The angle of varus stem was showed as positive and the valgus stem was showed as negative.

The midpoints of medullary cavity between the proximal femur (2cm below the lessor trochanter) and middle femur (10cm below the lessor trochanter) were connected as the femoral axis. The distance from the peak of greater trochanter to the femoral axis (GF_1) and the distance from the peak of lessor trochanter to the femoral axis (GF_2) were measured. G/L ratio = GF_1 / LF_2 . Trochanter valgus angle (TVA) was defined as the angle between the femoral axis and the intertrochanteric crest (Figure 2).

Statistical analysis

Statistical analysis was performed using SPSS 21.0 statistical software (Inc, Chicago, US). All data were quantitative expressed as $x \pm s$ (maximum and minimum, median, interquartile range). The test level value p is taken as 0.05 on both sides. The intraclass correlation coefficient (ICC) was used to determine variations in different measurements: 0.81 to 1.00, nearly perfect reliability; 0.61 to 0.80, strong reliability; 0.41 to 0.60, moderate reliability; 0.21 to 0.40, fair reliability; and 0 to 0.20, poor reliability.

Results

12 patients (11 women and 1 man) were enrolled in this study. Their basic information was showed in Table 1. the primary diagnoses of these 12 patients were DDH (9, 75%), ankylosing spondylitis (1, 8.3%), ONFH (1, 8.3%) and proximal femoral fractures (1, 8.3%). The reasons for TVO were osteotomy (10, 83.33%), suppurative joint sequela (1, 8.3%), malunion of fracture (1, 8.3%).

All patients obtained the neutral alignment of femoral stem ($<3^\circ$). There were no neurovascular impairment, dislocation, prosthetic loosening, periprosthetic femoral fractures, periprosthetic infection or reoperation for any reasons until the last follow-up.

One patient had a small split near the lesser trochanter and was treated with a cerclage wire. Another patient had fracture in the bottom of the greater trochanter when we removed the previous plate. Frozen cortical strut allograft and titanium cable were used to immobilize the trochanter. The fractures in the two patients were healed within postoperative 4 months. There were no other complications in the 12 patients until the last follow-up.

In the patients who had reverse sleeve, all G/L ratios were larger than 1.50. The G/L ratio can be regard as a good indicator for reverse sleeve. We should take reverse sleeve into consideration if G/L ratio was larger than 1.50.

The radiologic measurement was done by 2 independent observers (KXP and YMZ). Each observer made the measurements again after 2 weeks without knowing the first values. The intra-observer and inter-observer agreements were found to have nearly perfect reliability for all of the measurements (ICC >0.81).

The typical cases were showed in Figure 3–8.

Discussion

In the past, various hip-preserving surgeries were performed for the young patients with hip dysplasia or ONFH [2,10–12]. When these patients developed arthritis, the residual deformity would bring more challenge to the following THA [13]. Deformity of proximal femur would undoubtedly increase the difficulty of operation. The surgical strategy of THA varies along with the severity and position of deformity [8]. As one uncommon type of femoral deformity, the severe valgus deformity of trochanter is critical for the prosthetic morphology and surgical technique.

In the past, if the traditional tapered stem cannot bypass the abnormal femoral cavity, the deformity would be corrected by osteotomy. The corrective osteotomy has several shortcomings. Firstly, concurrent arthroplasty and femoral osteotomy is a technically demanding procedure. The long-term clinical outcome was significantly inferior to common THA. Secondly, additional fixation and special prosthesis were needed to achieve satisfying initial stability. And these procedures would increase the operation time and economic cost. Some surgeons suggested that customized prosthesis may provide one effective

solution for severe femoral deformity [14–16]. However, the demanding technology and economic cost of customized prosthesis limits its wide application.

If one mass-produced prosthesis could not only adapt to the valgus deformity of proximal femur, but also match the shape of the distal femur, the operation would be much simpler. Thus, we described the technique and present our experience of adopting reverse sleeve in patients with severe TVD. In the meanwhile, we summarized the advantages and disadvantages of this special sleeve-implanting method to evaluate its effectiveness and safety.

According to the design of S-ROM, the angle between sleeve and femoral stem can be adjusted arbitrarily, but the angle is usually seldom beyond 90 degree in clinical practise. The method of reverse sleeve (180 degree) described in this study have never been reported in previous study.

In this study, no aseptic loosening or revision of femoral stem were found in the case series with a mean follow up of 6 years. All patients obtained the significant increase of HHS. The significant improvement of function and less complication indicated the safety and effectiveness of reverse sleeve in patients who had severe TVD. Thanks to the reverse sleeve, the high revision rate of complex osteotomy or cemented THA were avoided. In the meanwhile, the sleeve decrease the risk of subsidence, which cannot be ignored in the fully-coated cylindrical stem and cone [17–18].

Although the method have has yielded satisfying clinical results, we should also consider its disadvantages. Firstly, since the varus greater trochanter is not corrected, the increased joint offset would increase the risk of greater trochanteric bursitis. Two patients reported lateral thigh pain after surgery, which was probably related to the bursitis. Secondly, the manual work of implanting sleeve and malformed medullary cavity would lead to the proximal femoral fractures. So we bundled the wires around the trochanter before implanting and only one patient had a small split near the lesser trochanter. Thirdly, the leg length might be influenced by the residual deformity. While the equal leg length could be achieved by the proper neck length and femoral head.

The clear indication of this special sleeve-implanting method was also important. The medial support and the lateral cover are two essential aspects of the technique, once the medial cortex of proximal femur is destroyed, the opportunity for reverse sleeve is lost. We can make basic predictions though measuring the G/L ratio and TVA. Both the differences of G/L ratio and TVA between two groups were significant, which indicated that their anatomy of proximal femur were characteristic. The G/L ratio can be seen one good indicator for reverse sleeve. We should take reverse sleeve into consideration if G/L ratio was larger than 1.50.

This study has several limitations. Firstly, this study was one retrospective case series with no control group. No comparison to other prostheses or other surgical procedures reduces the convincing power of the study. Secondly, because hip arthritis combining with trochanter valgus deformity were relative rare, the sample size was small. In the future, larger sample size and longer follow-up will be performed to evaluate the effectiveness and safety of the reverse sleeve. Thirdly, The study was conducted over a long

period of time, and changes in surgical personnel and related technical details could affect the final evaluation.

Conclusion

The reverse sleeve of S-ROM was a simple and reliable method for patients with severe trochanter valgus deformity, which brought satisfying clinical outcomes in mid-term follow-up. When G/L ratio is larger than 1.50, the surgeon should consider this special surgical technique.

List Of Abbreviations

Trochanter valgus deformity: TVD; Total hip arthroplasty: THA; Greater trochanter/lesser trochanter: G/L ratio; Developmental dysplasia of hip: DDH; Osteonecrosis of the femoral head: ONFH; Harris hip score: HHS; Trochanter valgus angle: TVA; Transtrochanteric valgus osteotomy: TVO; Greater trochanter to the femoral axis: GF_1 ; Lesser trochanter to the femoral axis: GF_2 ; Interclass correlation coefficient: ICC.

Declarations

Ethics approval and consent to participate: The medical ethics committee of Chinese PLA General Hospital approved the study "The reverse sleeve in total hip arthroplasty for Patients with trochanter valgus deformity: surgical technique and case series". All procedures were conducted in compliance with the guidelines of the Declaration of Helsinki. The patients were informed consent prior to their participation in the study.

• *Consent for publication:* We have obtained consent for publication.

• *Availability of data and material:* All data generated or analyzed during this study are included in this published article.

• *Competing interests* The authors declare that they have no competing interests.

• *Funding:* None.

• *Author Contributions:* All authors have made substantial contributions to: (1) the conception and design of the study, acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted. Xiangpeng Kong and Wei Chai contributed equally to this work and were co-first authors. Yan Wang and Yonggang Zhou: primarily responsible for oversight of the research project, including all data acquisition and analysis, and manuscript preparation and approval. Yan Wang and Yonggang Zhou contributed equally to this work and were co-corresponding authors. Jiying Chen, Minzhi Yang, Alvin Ong.: helped perform the analysis with constructive discussions. All authors have read and approved the final submitted manuscript.

•*Acknowledgement:* Not applicable.

References

1. Iwase T, Hasegawa Y, Iwasada S et al. Total hip arthroplasty after failed intertrochanteric valgus osteotomy for advanced osteoarthritis. [J]. Clin. Orthop. Relat. Res., 1999, undefined: 175–81.
2. Suzuki K, Kawachi S, Matsubara M et al. Cementless total hip replacement after previous intertrochanteric valgus osteotomy for advanced osteoarthritis. [J]. J Bone Joint Surg Br, 2007, 89: 1155–7.
3. Torchia M E, Klassen R A, Bianco A J, Total hip arthroplasty with cement in patients less than twenty years old. Long-term results. [J]. J Bone Joint Surg Am, 1996, 78: 995–1003.
4. Jingushi S, Sugioka Y, Noguchi Y et al. Transtrochanteric valgus osteotomy for the treatment of osteoarthritis of the hip secondary to acetabular dysplasia. [J]. J Bone Joint Surg Br, 2002, 84: 535–9.
5. Papagelopoulos P J, Trousdale R T, Lewallen D G, Total hip arthroplasty with femoral osteotomy for proximal femoral deformity. [J]. Clin. Orthop. Relat. Res., 1996, undefined: 151–62.
6. Ohishi Masanobu, Nakashima Yasuharu, Yamamoto Takuaki et al. Cementless total hip arthroplasty for patients previously treated with femoral osteotomy for hip dysplasia: the incidence of periprosthetic fracture. [J]. Int Orthop, 2016, 40:
7. Biant L C, Bruce W J M, Assini J B et al. The anatomically difficult primary total hip replacement: medium- to long-term results using a cementless modular stem. [J]. J Bone Joint Surg Br, 2008, 90: 430–5.
8. Berry D J, Total hip arthroplasty in patients with proximal femoral deformity. [J]. Clin. Orthop. Relat. Res., 1999, undefined: 262–72.
9. Le David, Smith Karen, Tanzer Dylan et al. Modular femoral sleeve and stem implant provides long-term total hip survivorship. [J]. Clin. Orthop. Relat. Res., 2011, 469: 508–13.
10. Bartoníček Jan, Vávra Jaroslav, Valgus intertrochanteric osteotomy for coxa vara of Bucholz-Ogden Types II and III in patients older than 30 years. [J]. Arch Orthop Trauma Surg, 2011, 131: 1211–7.
11. Zweifel Jochen, Hönle Wolfgang, Schuh Alexander, Long-term results of intertrochanteric varus osteotomy for dysplastic osteoarthritis of the hip. [J]. Int Orthop, 2011, 35: 9–12.
12. Sugioka Y, Hotokebuchi T, Tsutsui H, Transtrochanteric anterior rotational osteotomy for idiopathic and steroid-induced necrosis of the femoral head. Indications and long-term results. [J]. Clin. Orthop. Relat. Res., 1992, undefined: 111–20.

- 13.Park Chan-Woo,Lim Seung-Jae,Park Youn-Soo,Modular Stems: Advantages and Current Role in Primary Total Hip Arthroplasty.[J].Hip Pelvis, 2018, 30: 147–155.
- 14.Wettstein Michael,Mouhsine Elyazid,Argenson Jean-Noël et al. Three-dimensional computed cementless custom femoral stems in young patients: midterm followup.[J].Clin. Orthop. Relat. Res., 2005, undefined: 169–75.
- 15.Flecher X,Argenson J N,Parratte S et al. [Custom cementless stem for osteoarthritis following developmental hip dysplasia].[J].Rev Chir Orthop Reparatrice Appar Mot, 2006, 92: 332–42.16.
- 16.Flecher X,Parratte S,Aubaniac J M et al. Cementless total hip arthroplasty using custom stem and reinforcement ring in hip osteoarthritis following developmental dysplasia.[J].Hip Int, 2007, null: S120–7.
- 17.Schuh Alexander,Schraml Annemarie,Hohenberger Gerd,Long-term results of the Wagner cone prosthesis.[J].Int Orthop, 2009, 33: 53–8.
- 18.Zhen Ping,Liu Jun,Lu Hao et al. Developmental hip dysplasia treated by total hip arthroplasty using a cementless Wagner cone stem in young adult patients with a small physique.[J].BMC Musculoskelet Disord, 2017, 18: 192.

Tables

Table 1. The basic information of patients with reverse sleeve.

Patients	data
Gender (male:female)	1:11
Age (years)	42.30±10.23 (30-66, 45, 15)
BMI (kg/m ²)	22.99±2.34 (19.10-30.10, 24.10, 7.88)
Follow up (years)	5.96±3.29 (2-13, 7, 7)
Deformity duration (years)	12.10±8.29 (2-27, 16, 15)
Operating time (minutes)	109.15±27.43 (71-167, 115, 57)
Preoperative Harris score	34.31±14.43 (17-62, 32, 19)
Postoperative Harris score	84.12±11.33 (67-98, 88, 21)
Intraoperative complication (%)	2 (16.67)

Table 2. The comparison of G/L ratio and TVA in two groups.

Patients	Reverse sleeve (12 hips)
G/L ratio	2.58±0.95 (1.50-4.43, 2.60, 2.11)
TVA (°)	144.50±9.66 (128-156, 142, 20)
