Journal of Orthopaedics 19 (2020) 102–105

Contents lists available at ScienceDirect

Journal of Orthopaedics

journal homepage: www.elsevier.com/locate/jor

Original Article

A novel surgical technique to perform total knee arthroplasty in patients with inaccessible femoral medullary canal

Gianluca Castellarin

Department of Orthopaedic Surgery II, Suzzara Hospital, Via G. Cantore 14, 46029, Suzzara, Mantua, Italy

ARTICLE INFO

Keywords:
Total knee arthroplasty
Knee surgery
Surgical instruments
Surgical techniques

ABSTRACT

Not seldom Surgeons have to deal with total knee cases where the femoral intramedullary canal is not accessible due to hardware still in place, long hip stems or diaphyseal mal-unions, so intra-medullary referenced instrumentations cannot be employed. We developed a novel instrument called EMAS (Extra Medullary Alignment System) able to help addressing those cases in a simple and reproducible way avoiding the use of more complex and expensive technologies. We present the results achieved using EMAS on 18 of those difficult cases with a maximum follow-up of 7 years as well as our experience using EMAS in our standard practice.

1. Introduction

Total Knee Replacement procedures have been steadily growing over the last 2 decades.[1] In the US TKA procedures number more than doubled between 1999 and 2008[2] and it will further grow during the next decades.[3] A similar trend can be observed also in Europe and Australia.[4,5,6] This trend can be attributed to population ageing, increase of obesity and of sports injuries.[1,2]

Therefore it's becoming more frequent for surgeons to operate on patients who had certain kind of previous orthopaedic surgeries. In other words to find cases where the femoral medullary canal cannot be used as an alignment reference due to trauma hardware still in place, long hip stems or discontinuities due to traumatic mal-unions. The vast majority of total knee prosthesis today available offers just intramedullary referenced instruments for the femoral component positioning and joint alignment, even if the superiority of this technique Vs the extramedullary referenced one does not seem to be completely proven.[7,8]

A treatment option for the above-described cases could be provided by modern technologies such as patient specific cutting blocks or navigation. Those options however have the disadvantage of being more expensive and complex Vs standard surgical procedures, therefore they might not be accessible to every Surgeon because of cost and/or lack of specific training. Furthermore both patient specific cutting blocks and navigation often require the performance of examinations such as MRI or CT-Scans that might be hard or impossible to make in case of massive metal hardware still in place on the patient limbs. On the other hand hardware removal before performing TKA surgery it's not always possible and it can be risky, being associated with high rate of re-fractures and complications[9,10]

We therefore worked on the development of a TKA instrumentation allowing joint alignment, balancing and femoral component placement in a simple and reproducible way avoiding any femoral canal violation.

2. Materials and methods

2.1. Surgical technique

The EMAS (Extra Medullary Alignment System) is spacer with two extensible paddles (lateral and medial) and a removable frontal tower (Fig. 1)

The spacer with the paddles completely retracted has a 10 mm thickness that is equal to the minimum thickness of a standard total knee tibial component.

The Surgeon is allowed to adjust with a screwdriver the two paddles height by acting on the medial and lateral screw holes available on the front of the instrument.

The EMAS device is completed by a removable tower that has the function of indicating the height difference in mm between the two paddles as well as to act as a holder for the distal femoral cutting block, extramedullary rod and femoral sizing instruments.

After proximal tibia osteotomy, performed employing standard extra or endo-medullary instruments, the EMAS jig is inserted in the articulation with the knee in full extension and with its two paddles completely retracted. The instrument set includes +2 mm; +4 mm; +7 mm and +10 mm shims to be added to the back of the EMAS device in case the bone removed from the proximal tibia was thicker than 10 mm.

E-mail address: gianlucacastellarin@gmail.com.

https://doi.org/10.1016/j.jor.2019.11.043
Received 17 October 2019; Accepted 24 November 2019
Available online 27 November 2019

Fig. 1. The Extramedullary Alignment System device together with its removable frontal tower.

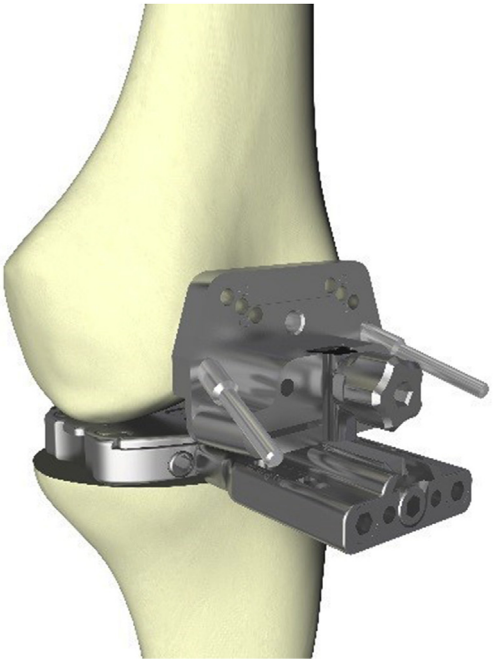

Fig. 2. The EMAS instrument with the distal femoral cutting block.

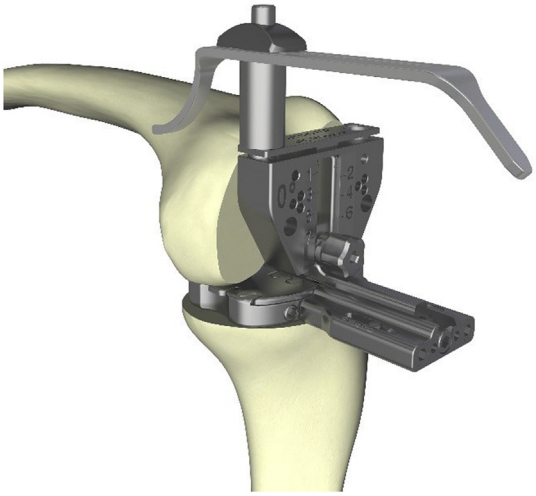

Fig. 3. The EMAS instrument with the femoral sizing jig.

The joint is aligned and balanced by acting on the two paddles thickness, while ligament releases are performed if needed. Joint stability can be assessed also with the patella anatomically reduced, removing the EMAS frontal tower. An extra-medullary road allows surgeons to verify whether the correct leg alignment was reached. After achievement of the right articular stability and axis, a cutting block can be connected to the device to perform the distal femoral resection (Fig. 2). The distal femoral osteotomy is made with the knee in flexion after having secured the cutting block to the bone and EMAS removal. A similar procedure is then followed with the knee at 90° of flexion in order to reach joint stability. Once the joint is balanced in flexion, a sizing instrument, attached to the EMAS frontal tower, will guide the Surgeon to select the 4-in-1 cutting block of the right size and position it with the correct external rotation (Fig. 3). After having performed extensive cadaver trials we found out that 1 mm difference between the two paddles thickness equals one degree of femoral component rotation. The Surgeon anyway will always have the possibility of double check the femoral implant external rotation referring to the Whiteside line or to the line of the epicondyles.

Since 2012 we have been using the EMAS technique for those difficult cases where, due to obstructions and/or deformities, the femoral canal could not be used as a reference for implants alignment. After few years, however we adopted this technique also for our standard TKA practice. To date we used the EMAS technique to complete more than 700 TKA procedures.

2.2. Cases performed

Between January 1st, 2012 and December 31st, 2018, 18 patients with inaccessible femoral canal had their knee replaced because of Osteoarthritis employing the EMAS technique (Table 1).

In ten cases femoral canal was obstructed by metal hardware that was still in place from previous surgeries, while in three cases the patients previously had total hip replacement with a long femoral stem. In the remaining five cases femoral canal was inaccessible because of discontinuities caused by mal-unions (four cases) or by an abnormal congenital diaphyseal curvature (one case). In this cohort ten patients were Female, and eight males. Every patient provided her/his Informed consent to be included in this study. Average patient age was 71.6 years (Min. 60; Max. 84). Pre-op average patients Knee Society Score was 45 (Min.38; Max.60), while average pre-op Oxford score was 16 (Min. 12; Max. 30). All surgeries were performed by the Author employing a standard medial para-patellar approach without using Tourniquet. All patients had their knee replaced with a cemented Mobile Bearing Cruciate Retaining Implant with a medially constrained bearing surface (Genus MB TKA and Lateral Sliding Mobile Insert, Adler Ortho SpA, Cormano, Italy). In none of the cases we replaced the patella. Patients were treated with Tranexamic acid injections prior or during surgery to reduce bleeding.[11] Intra-operative blood loss observed was lower Vs the one we had employing standard Intra-medullary instruments on line with what shown in literature when the femoral canal is not violated.[12] Average surgical time was as well similar to the one with standard intra-medullary instruments. After surgery, Patients underwent our standard post-operative recovery protocol: Patients knees were passively moved immediately post-op, allowed to stand the day after surgery, and then sent to our Physiotherapy department two days after surgery.

3. Discussion

3.1. Clinical results

Immediate Post-Op X-Rays showed good leg and implant alignment for all patients both on the frontal and lateral plans, similar to the one obtained employing standard intramedullary referenced instruments. At the latest follow-up (June 30th, 2019) one patient resulted death due

Table 1
Summary of the cases with inaccessible femoral canal performed with the EMAS technique between 2012 and 2018.

Case #	Gender	Age	Femoral canal inaccessible because of:
1	M	70	Femoral valgus osteotomy performed with a blade plate. Hardware still in place
2	F	84	Femoral shaft fracture treated with an IM locking nail. Hardware still in place.
3	M	81	Femoral mal-union. Severe canal discontinuity. No hardware in place.
4	F	66	Peri-prosthetic hip fracture treated with plate and screws. Hardware still in place
5	F	71	Long revision hip stem invading most of femoral canal.
6	M	65	Distal femoral fracture treated with a distal plate. Hardware still in place.
7	M	80	Femoral and tibial mal-unions. Complete femoral canal discontinuity. No hardware in place.
8	M	74	Femoral Mal-union. Femoral Canal discontinuity. No hardware in place.
9	F	71	Distal femoral fracture treated with plates and screws. Hardware still in place.
10	M	60	Patient with a previous hip replacement.
11	F	68	Per-trochanteric fracture treated with a IM nail. Hardware still in place
12	F	72	Distal femoral fracture treated with plates and screws. Hardware still in place.
13	F	80	Long revision hip stem.
14	M	75	Femoral mal-union. Femoral canal discontinuity. No hardware in place.
15	F	69	Femoral diaphyseal fracture treated with a Kuntcher nail. Hardware still in place.
16	M	67	Failed ACL and PCL reconstruction several screws left in the femur and tibia
17	F	62	Patient with a failed varus femoral osteotomy. Hardware still in Place.
18	F	74	Patient with femoral diaphysis curved on the frontal plan.

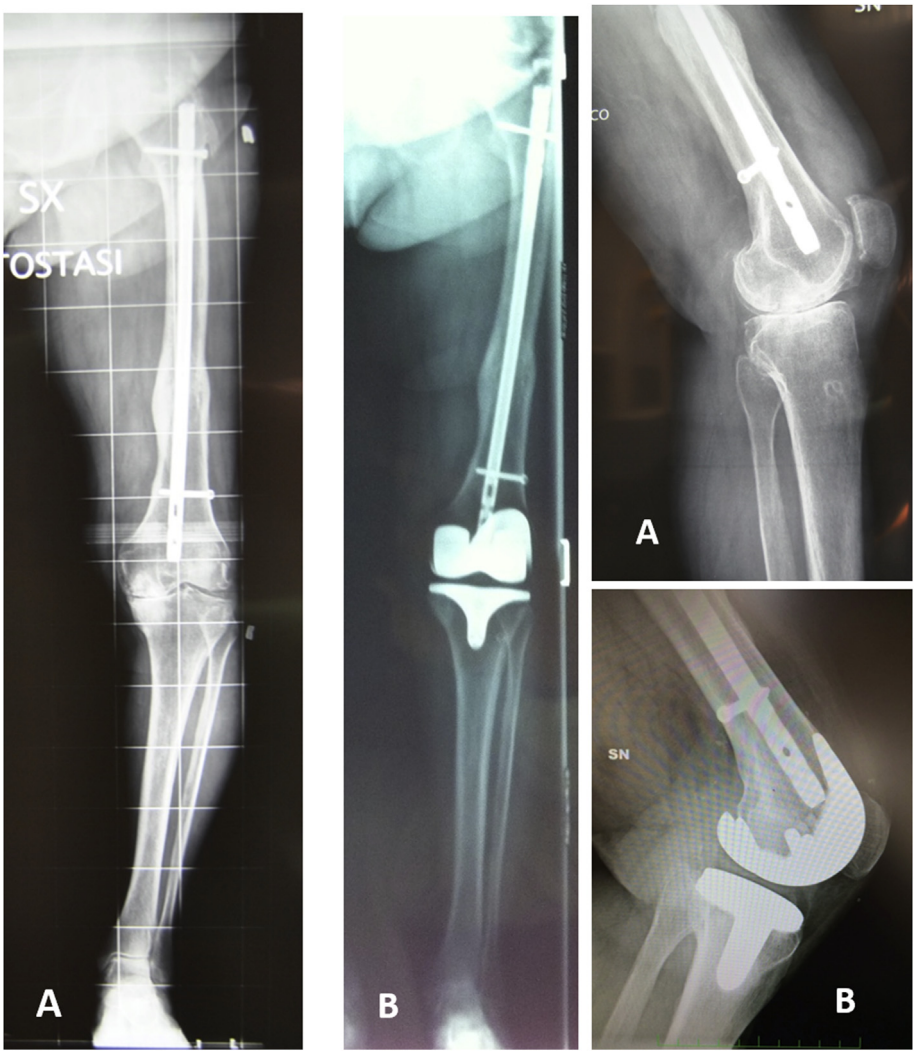

Fig. 4. Patient #2. Inaccessible femoral canal treated with the EMAS technique: 84 years old male Patient with a IM locking nail. A) Pre-Op. X-rays. B) X-Rays at 2 years Follow-up.

to reasons unrelated with the implant. No patient was lost at follow-up, and no components revisions or meaningful implants related complications were reported. Mean follow-up for the group was 3.6 years (Min. 0.5 years; Max. 7 Years). Knee Society mean score at the latest follow-up was 88 (Min. 80; Max. 100), while mean Oxford score was 44 (Min. 38; Max. 48). Mean R.O.M. was 105° (Min. 95°; Max. 110°). At the latest follow-up all patients reported a good level of satisfaction.

Figs. 4 and 5 show examples of the cases treated and of the

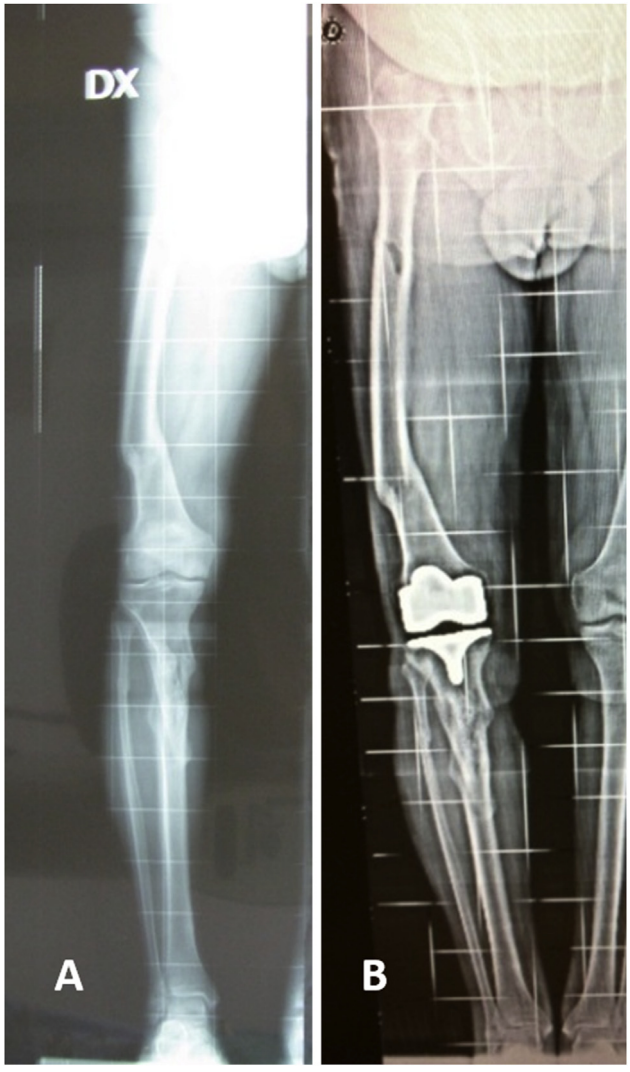

Fig. 5. Patient #7. 80 years old male patient with femoral discontinuity due to malunion. A) Pre-Op. X-ray. B) X-Ray at 4 years Follow-up.

alignment achieved.

As previously stated we are now using the EMAS technique also for our standard TKA practice. To date we used EMAS to position more than 700 TKAs without observing any out of the ordinary complication. We are collecting our clinical data in a centralized database. Clinical results of that larger group of patients will be object of a future publication.

4. Conclusions

We presented a novel surgical instrument and technique designed to provide Surgeons with a simple, inexpensive and reproducible way to address those difficult TKA cases where the femoral canal is inaccessible because of hardware, hip prosthesis or diaphyseal discontinuities this technique did not require longer operative time Vs standard TKA surgery nor a lengthy learning curve. Furthermore this technique lead to a reduction of the intra-operative blood loss and it eliminated some of the complications associated with the use of Intramedullary alignment rods[13,14]

The cohort of 18 patients with inaccessible femoral canal operated using the EMAS technique, here presented, showed encouraging clinical results at a mean 3.6 years follow-up (maximum follow-up was 7 years). We have been so confident in this technique to extend its usage also to our standard TKA practice. In our hands the EMAS technique demonstrated to be reliable and relatively simple to use. Longer follow-up and more comprehensive clinical studies will be needed to confirm our findings.

Declaration of competing interest

I have no Conflict of interest to declare.

References

1. Singh JA. Epidemiology of knee and hip arthroplasty: a systematic review. *Open Orthop J.* 2011;5:80–85.
2. Losina E, Thornhill TS, Rome BN, Wright J, Katz JN. The dramatic increase in total knee replacement utilization rates in the United States cannot Be fully explained by growth in population size and the obesity epidemic. *J Bone Jt. Surg Am.* 2012;94:201–207.
3. Inacio MCS, Paxton EW, Graves SE, Namba RS, Nemes S. Projected increase in total knee arthroplasty in the United States - an alternative projection model. *Osteoarthr Cartil.* 2017 Nov;25(11):1797–1803.
4. Culliford D, Maskell J, Judge A, Cooper C, Prieto-Alhambra D, Arden NK. Future projections of total hip and knee arthroplasty in the UK: results from the UK Clinical Practice Research Datalink. *Osteoarthr Cartil.* 2015 Apr;23(4):594–600.
5. Italian Arthroplasty Registry RIAP. *Annual Report.* 2018; 2018http://riap.iss.it/riap/en/activities/reports/.
6. A.O.A.N.J.R.R.. The Australian orthopaedic association national joint replacement registry. Annual Report https://aoanjrr.sahmri.com/documents/10180/576950/Hip%2C%20Knee%20%26%20Shoulder%20Arthroplasty; 2018.
7. Qian T, Ping S, Gang Z, Hua-Zi X, Hai-Xiao L. Extramedullary versus intramedullary femoral alignment technique in total knee arthroplasty: a meta-analysis of randomized controlled trials. *J Orthop Surg Res.* 2017;12:82.
8. Baldini A, Adravanti P. Less invasive TKA . Extramedullary femoral reference without navigation. *Clin Orthop Relat Res.* 2008;466:2694–2700.
9. Davison BL. Refracture following plate removal in supracondylar-intercondylar femur fractures. *Orthopedics.* 2003;26(2):157–159 Feb.
10. Kovara FM, Strasserb E, Jaindla M, Endlerc G, Oberleitnera G. Complications following implant removal in patients with proximal femur fractures – an observational study over 16 years. *Orthop Traumatol: Surgery & Research.* 2015;101(7):785–789.
11. Fillingham YA, Ramkumar DB, Jevsevar DS, et al. The efficacy of tranexamic acid in total knee arthroplasty: a network meta-analysis. *J Arthroplast.* 2018 Oct;33(10):3090–3098.e1.
12. Kandel L, Vasili C, Kirsh G. Extramedullary femoral alignment instrumentation reduces blood loss after uncemented total knee arthroplasty. *J Knee Surg.* 2006 Oct;19(4):256–258.
13. Caillouette JT, Anzel SH. Fat embolism syndrome following the intramedullary alignment guide in total knee arthroplasty. *Clin Orthop Relat Res.* 1990 Feb (251):198–199.
14. Fahmy NR, Chandler HP, Danylchuk K, Matta EB, Sunder N, Siliski JM. Blood-gas and circulatory changes during total knee replacement. Role of the intramedullary alignment rod. *J Bone Jt. Surg Am.* 1990 Jan;72(1):19–26.