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HIP ARTHROPLASTY

Dual-mobility total hip arthroplasty in patients younger than 55 years old: a systematic review

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Abstract

Total hip arthroplasty (THA) is regarded as one of the most successful and cost-effective orthopedic procedures. However, THA is a surgical procedure with potential intraoperative and postoperative risks. Dislocation is one of the common postoperative complications and remains one of the main indications for THA revision. The purpose of this systematic review was to evaluate the role and the outcomes of dual-mobility implant to prevent dislocation in patients younger than < 55 years in primary THA. In this systematic review, we included observational, prospective, and retrospective studies that evaluated the outcome and the complications of the dual-mobility cup in < 55-year-old patients. After applying exclusion criteria (femoral neck fractures or THA revision, case series, reviews, and meta-analyses), ten articles were included in the study. The overall number of participants in all the studies was 1530. The mean age of the participants was 50 years. The mean follow-up was 11.7 years. A total of 46 patients (2.7%) reported intraprosthetic dislocations, in which the polyethylene liner dissociates from the femoral head, while 4.8% of revision was due to aseptic loosening. The mean revision rate at twelve years was 11%. The mean value of Harris Hip Score increased from 50.9 pre-operatively to 91.6 after surgery. Dual mobility is a valid option for young patients with extended survivorship and low rates of instability and dislocation after primary THA.

Keywords Hip replacement · Dual mobility · Clinical outcomes · Revision rate · Survival rate · Harris Hip Score

Introduction

Total hip arthroplasty (THA) is one of the most successful orthopedic surgical procedures. Each year, over 1 million total hip arthroplasties are performed worldwide. Improving patient quality of life, the demand for THA will grow, and the number of THAs is projected to increase by 174% by 2030 compared to 2005 [1]. Main clinical indications for total hip replacement are osteoarthritis (which accounted for 90% of procedures), femoral neck fractures (5%), avascular necrosis (2%), developmental dysplasia of the hip (DDH) (2%), inflammatory arthritis (1%) and femoro-acetabular

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impingement syndrome (FAIS) [2]. Total hip arthroplasty has excellent mid-term and long-term outcomes. The average age is getting lower, and with advances in implant design, THA has become an excellent option for young adults who need to return to physically demanding activities to improve their quality of life [3, 4]. However, THA is a surgical procedure that could present intraoperative risks. Dislocation is one of the common complications and remains one of the main indications for THA revision [5]. The surgical approach, baseline diagnosis, surgical technique, surgeon confidence, implant lifetime, and patient's compliance with restrictions influence the risk of dislocation. The prevalence of dislocation has ranged from 0.3 to 10% in primary THAs and up to 28% in revision THAs [6]. To reduce the risk of instability, more than 40 years ago, Gilles Bousquet and Andrè Rambert introduced the concept of dual mobility (DM), associating the low friction concept of Charnley with the Big Head principle of Mac Kee Farrar. With the benefit of the damping effect of the polyethylene between both hard materials, the couple of friction with polyethylene/metal or polyethylene/ceramic avoids material break [7]. This type of implant is well known for its low dislocation rate and high mobility range in primary THA. These dual-mobility implants are designed to reduce wear, restore near-normal range of motion, and improve implant stability and range of motion [8, 9]. This DM is usually performed in younger patients who undergo primary total hip replacement, surgical revision, and femoral neck fractures with excellent results. Dual-mobility THA in the hemiplegic and elderly patients provides both efficacy and stability with good functional results [10]. Instead, the main indication in the young patient is related to his high physical performance, to determine a lower risk of complications and avoid subsequent revisions. Therefore, this systematic review aims to determine the outcomes of dual-mobility THA in younger patients < 55 years in primary total hip replacement.

Materials and methods

In this systematic review, we included observational, prospective, and retrospective studies that evaluated the outcome and the complications of the dual-mobility cup in < 55 years old patients. Studies were included if they reported postoperative outcomes, survival, and dislocations rate of the dual-mobility cup in primary THA. We excluded studies that involved femoral neck fractures or THA revision; moreover, case reports, case series, reviews, and meta-analyses were excluded.

Search methods for identification of studies

A systematic literature search was performed using the following databases: Pubmed-Medline, Scopus, and the Cochrane Library. We used the following search strategy "dual"[All Fields] AND ("mobilities"[All Fields] OR "range of motion, articular"[MeSH Terms] OR ("range"[All Fields] AND "motion"[All Fields] AND "articular"[All Fields]) OR "articular range of motion"[All Fields] OR "mobility"[All Fields]) AND "cup"[All Fields] AND ("arthroplasty, replacement, hip"[MeSH Terms] OR ("arthroplasty"[All Fields] AND "replacement"[All Fields] AND "hip"[All Fields]) OR "hip replacement arthroplasty"[All Fields] OR ("total"[All Fields] AND "hip"[All Fields] AND "arthroplasty"[All Fields]) OR "total hip arthroplasty"[All Fields]). The reference list of the articles was screened manually. After duplicates were removed, the abstracts of all relevant studies were independently examined by two review authors (B.Z. and G.F.P.). Any uncertainties or conflicts were reviewed with the third reviewer to eliminate potential inaccuracies. Two reviewers (B.Z. and G.F.P.) evaluated the articles to identify which ones should be included in the review.

Data collection, analysis, and outcomes

Data extraction was independently produced by two reviewers (B.Z. and G.F.P.). We extracted the following study characteristics: authors, year of publication, type of study, number of patients, number of hips, mean follow-up and lost at follow-up, mean age, diagnosis, surgical information as the type of cup, stem, fixation, bearing, and surgical approach, complications, and revision rate. Revision rate is reported as prosthetic implant or component revision rate due to complications or failure. Instead, implant survivorship represents prosthetic implant survival rate during the follow-up. Finally, outcomes included clinical scores such as Harris Hip Score (HHS), visual analog scale (VAS), return to activity, and implant survivorship.

Methodological quality assessment

Two reviewers (B.Z. and G.F.P.) used the Methodological Index for Non-randomized Studies (MINORS) score to assess the quality of the included non-randomized studies.

Results

Results of the search

The literature search identified 1556 articles. Of these, 1437 articles were screened based on title and abstract after 82 duplicates were removed. Then 41 articles were read in full text, and 31 of these were excluded for the following reasons: evaluating femoral neck fracture ($n = 12$), patients aged more than 55 years ($n = 8$), patients with associated neurological disorders or comorbidities ($n = 7$), and case reports ($n = 4$). Finally, we included in this review ten articles, which were four prospective studies and six retrospective studies (Fig. 1).

Demographic data

The overall number of participants in all the studies was 1530. Hips number included in the study was 1662. The mean age of the participants was 50 years (41–55 years). The most common diagnosis was primary osteoarthritis, with an

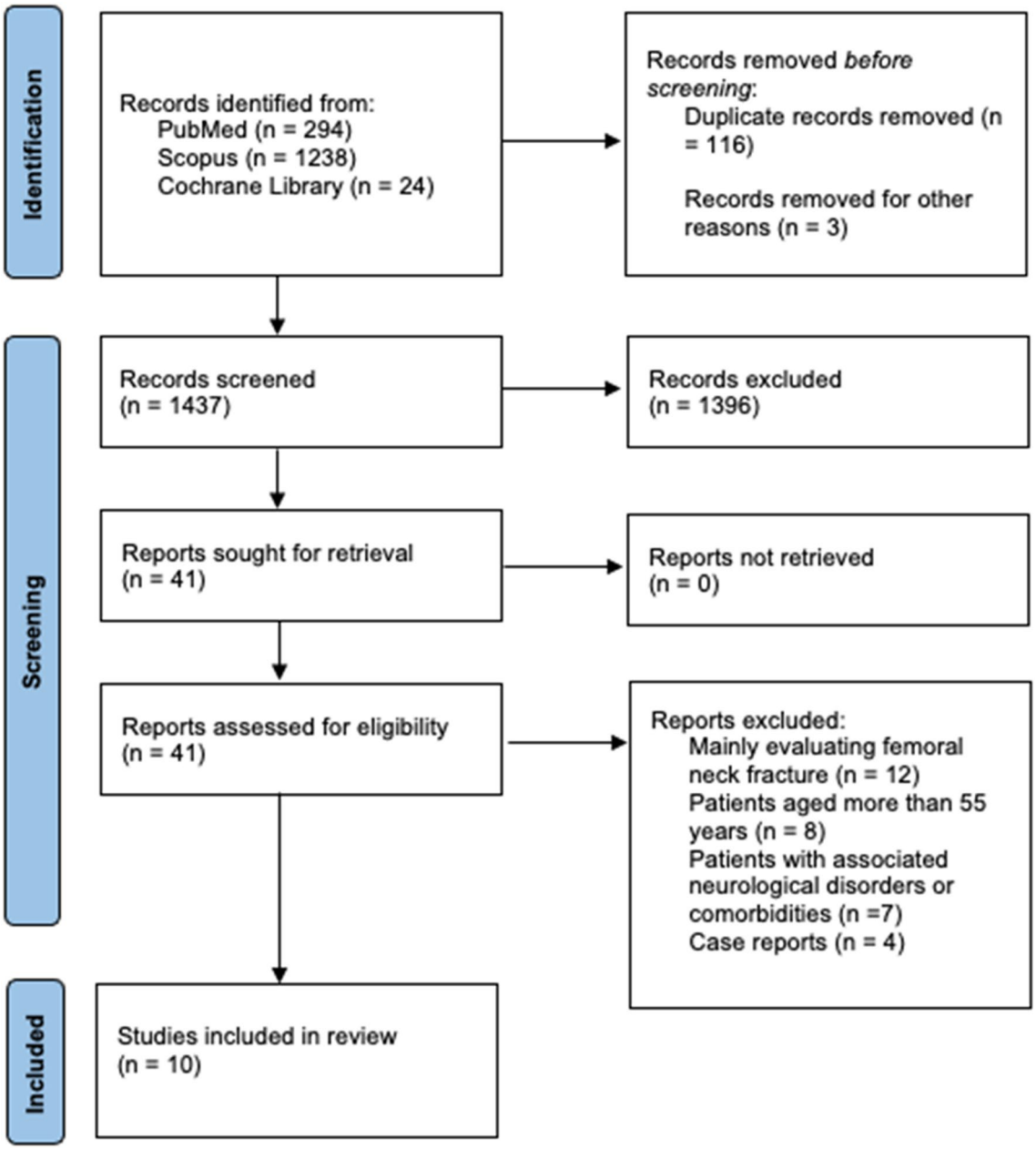

Fig. 1 PRISMA 2020 flow diagram

incidence of 57.69%. The second common diagnosis was hip dysplasia, with an incidence of 16.1%. Other diagnoses included in the study were osteonecrosis of the femoral head (ONFH) and rheumatoid arthritis. The mean follow-up was 11.7 years, ranging from 2 to 25.3 years. All demographic data are compiled in Table 1.

Surgical data

Seven studies had reported a predominance of posterolateral surgical approach, while in the remaining three studies, the surgical approach was not reported (Table 2). Several types of bearing were reported in the studies. Five studies combined metal–polyethylene bearing; 2 studies combined ceramic–polyethylene bearing, while the remaining three studies used both combinations. Concerning the stem fixation, cemented and uncemented femoral stems were included.

Outcomes and complications

Of 1662 hips, only 25 have experienced early complications, including periprosthetic fracture, femoral fractures, femoral unscrewing, and PJI. Only two studies reported no intraoperative complications, while in the other studies, the most frequent early complications, within 1.5 years, were periprosthetic fractures and periprosthetic joint infections (PJI) (Table 3). The mean revision rate was 11%. A total of 46 patients reported intraprosthetic dislocations (IPD), while other revision cases were due to aseptic

Table 1 Demographic data

Author	Year	Type of study	LOE	N. patients	N. hips	Mean age at surgery	Diagnosis	Follow-up	Lost at follow-up
Assi et al. [17]	2018	RS	III	26	30	54.9 y	ONFH	51 m	/
Boyer et al. [16]	2011	RS	III	205	240	55 y	OA (67%), dysplasia (12%), ONFH (11%), RA (3%), pseudoarthrosis (4%), hip arthrodesis (3%)	22 y	12 lost, 99 died
Epinette et al. [21]	2016	PS	II	321	321	48 y	OA (75.8%), ONFH (17.2%), dysplasia (5.9%), RA (1.1%)	2.7 y	1 died
Martz et al. [8]	2016	RS	III	31	40	44 y	ONFH	116.8 m	11 deceased
Nam et al. [22]	2019	PS	II	43	43	52.6 y	OA, ONFH	24 m	/
Neri et al. [12]	2016	RS	III	174	212	53 y	OA (74%), ONFH (12%), dysplasia (11%), inflammatory arthritis, post-traumatic (3%)	25.3 y	12 lost, 76 deceased
Philippot et al. [13]	2008	PS	II	384	384	55 y	OA (50.1%), dysplasia (23.7%), ONFH (12.6%), post-traumatic (2%), secondary OA (11.1%)	15.3 y	6 lost, 92 deceased
Philippot et al. [14]	2017	RS	III	114	137	41 y	dysplasia (27%), post-traumatic (24%), ONFH (23%), epiphysiolysis (12%), sequelae of osteochondritis (9%), OA (4%), neurogenic osteoma (1%)	21.9 y	7 lost, 11 deceased
Puch et al. [23]	2016	PS	II	105	119	49.9 y	OA (54.3%), dysplasia (25%), ONFH (12.9%), other (7.8%)	11 y	8 lost, 4 deceased
Rowan et al. [24]	2017	RS	III	127	136	48.5 y	OA (77.9%), dysplasia (8.1%), ONFH (7.4%), inflammatory arthritis (2.2%), post-traumatic (2.2%), protrusio acetabuli (1.5%), osteogenesis imperfecta (0.74%)	3.2 y	/

Retrospective Study, *PS* Prospective Study, *LOE* Level of Evidence, *N* number, *y* years, *m* months, Osteonecrosis of the Femoral Head, *OA* Osteoarthritis, *RA* Rheumatoid Arthritis

Table 2 Surgical data

Author	Surgical approach	Cup	Stem	Fixation	Bearing
Assi [17]	PL	Avantage (90%), Quattro (7%), HNG (3%)	N.R	Press-Fit cup cemented stem	Ceramic–Polyethylene
Boyer [16]	PL (83%), direct lateral (17%)	Novae® Serf	PF® Serf	Press-fit and tripodal fixation cup, uncemented screwed stem	Metal–Polyethylene
Epinette [21]	N.R	Stryker ADM® (54.2%), MDM® (45.8%)	Modular / monoblock stem	Press-Fit cup, cemented (18%) and uncemented stem (82%)	Ceramic–Polyethylene (HLXPE)
Martz [8]	PL (85%), lateral (15%)	Novae Sunfit® or Novae® Serf	Cementless stem hydroxyapatite coated (Symetric®), cemented stem (PF Protek®)	Press-fit cup, cemented (40%) and uncemented (60%) stem	Metal–Polyethylene (UHMWPE) (72.5%), Ceramic–Polyethylene (27.5%)
Nam [22]	PL	MDM® Stryker	Accolade Stryker	Press-fit cup, uncemented tapered stem	Ceramic–Polyethylene (67.5%), Metal–Polyethylene (32.5%)
Neri [12]	PL	Novae® Serf	PF® Serf	Press-fit cup with screw and pegs, stainless steel conical, screwed stem	Metal–Polyethylene (UHMWPE)
Philippot [13]	N.R	Novae® titanium Serf and Novae® stainless steel Serf	PF® stainless steel threaded and PRO titanium threaded Serf	Press-fit cup with screw and pegs, uncemented screwed stem	Metal–Polyethylene
Philippot [14]	N.R	Novae® Serf	PF® Serf and PROFIL® Serf, both screwed	Press-fit cup with two pegs and screw screwed stem	Metal–Polyethylene (UHMWPE)
Puch [23]	PL (72%), Hardinge lateral (28%)	2nd generation DMC	CORAIL Depuy (56.3%), TARGOS Lepine (41.2%)	Press-fit cup, uncemented stem	Metal–Polyethylene (UHMWPE)
Rowan [24]	PL	Stryker ADM® (81.6%), MDM® (18.4%)	Securfit V40 taper, Securfit C-taper, Rejuvenate modular, SROM modular, Novation	Press-fit cup, uncemented stem	Ceramic–Polyethylene (HLXPE) (54.5%), Metal–Polyethylene (45.5%)

PL Posterolateral approach, *DLA* Direct lateral approach, *N.R.* not reported, *UHMWPE* Ultra-high-molecular-weight polyethylene

Table 3 Outcomes and complications

Author	Early complications	Revision rate %	Revision etiology	HHS Pre	HHS Post	Survivorship
Assi [17]	1 periprosthetic fracture	0	N.R	N.R	98.7 ± 2.7	100%
Boyer [16]	5 femoral fractures (2%)	17.2	20 Aseptic loosening (8.3%), 2 septic loosening (0.8%), 10 retentive failure (4.1%), 5 liner wear (2%), 5 stem loosening (2%)	65 ± 10.3	92 ± 8.4	73.9%
Epinette [21]	1 periprosthetic fracture	3.7	2 impingement acetabular components (0.6%), 8 ARMD (2.5%), 1 aseptic loosening (0.3%), 1 sepsis (0.3%)	N.R	93.60 ± 8.48	99.7% overall, 97.51% for revision
Martz [8]	1 early PJI, 1 heterotopic ossification, 1 LLLD	0	N.R	50.8 ± 15.5	95.7 ± 6.9	65% overall, 100% for revision
Nam [22]	no intraoperative complications	0	N.R	54.1 ± 20.5	91.2 ± 10.8	100%
Neri [12]	2 PJI (0.94%)	21.22	17 aseptic loosening (8.02%), 10 IPD (4.71%), 9 polyethylene wear (4.24%), 7 periprosthetic fracture (3.3%)	51.1	83.6	90.6%
Philippot [13]	9 femoral unscrewing, 1 femoral mobilization	11.5	13 aseptic loosening, (3.3%), 14 IPD (3.6%), 7 polyethylene wear (1.8%)	N.R	N.R	95.9%
Philippot [14]	1 femoral stem fracture (0.79%), 1 PJI (0.79%)	32.1	20 cup aseptic loosening (14.7%), 15 IPD (10.9%), 6 polyethylene wear, 3 femoral aseptic loosening (2.25%)	48.30	85.1	77%
Puch [23]	1 PJI (0.8%)	4	2 stem loosening (1.6%), 2 cup loosening (1.6%)	39.5	98.0	96.1%
Rowan [24]	no intraoperative complications	19.8	1 periprosthetic fracture, 2 stem aseptic loosening, 24 ARMD	47.7 ± 14.4	87.2 ± 16.6	N.R

PJI Periprosthetic Joint Infection, *LLLD* Lower leg length discrepancy, *N.R.* not reported, *IPD* intraprosthetic dislocation, *ARMD* Adverse Reaction to Metal Debris, *HHS* Harris Hip Score

loosening. Harris Hip Score was reported in 9 studies. The main value of HHS increased from 50.9 pre-operatively to 91.6 after surgery. VAS score was not evaluated in these studies. All studies reported a high survival rate range, ranging from 73.9% to 100%, with an average of 88.7%. Rates of return to activity and sport were not mentioned in the studies.

Methodological evaluation

This systematic review involved only non-comparative studies. Therefore, only the first eight items of the MINORS score were adopted to assess the methodological quality. The mean value of the included studies is 13.2 (Table 4).

Discussion

THA is an extremely successful operation, but dislocation remains one of the leading causes of failure with considerable negative consequences on the patients' quality of life [11]. The primary aim of this review was to evaluate the efficiency and the outcomes of dual-mobility THA in younger patients < 55 years in primary total hip replacement.

Considering the studies included in our review, we observed an extremely low rate of complications. The mean revision rate was 11% (3.7–32.1%). The mean survival rate was 88.7% ranged from 73.9% to 100%. Dislocations have been described only in 3 studies. Neri et al. [12] showed ten revisions for IPD (4.71%), while Philippot et al. [13] reported 14 revisions for IPD (3.6%) after 8.9 years. In

Table 4 MINORS score

Author	Stated aim	Inclusion of patients	Collection of data	Endpoints appropriate to the aim	Unbiased assessment of the study endpoint	Follow-up	Loss to follow-up less than 5%	Prospective calculation of the study size	Total
Assi [17]	2	2	2	2	2	1	2	0	13
Boyer [16]	2	2	2	2	0	2	2	2	14
Epinette [21]	2	2	2	2	0	1	2	2	13
Martz [8]	2	2	2	2	0	2	2	1	13
Nam [22]	2	2	2	2	0	1	2	2	13
Neri [12]	2	2	2	2	0	2	1	2	13
Philippot [13]	2	2	2	2	0	2	2	2	14
Philippot [14]	2	2	2	2	0	2	1	2	13
Puch [23]	2	2	2	2	0	2	1	2	13
Rowan [24]	2	2	2	1	1	1	2	2	13

another study [14], the same research group reported a rate of 10.9% for IPD. In these cases, IPDs were caused by wear of the liner's retention collar, resulting in loss of the liner's retaining ability. The factors influencing instability are related to the patient's condition and technical factors [15].

On the other hand, most of the studies included showed excellent survivorship with no episode of dislocation in young patients treated with DM THA. All clinical scores improved significantly at the final follow-up. Outcomes evaluated in these studies showed excellent results. HHS had an increase of about 45%. Nine studies showed a high range of survival rates. Survivorship ranged from 73.9% at an average follow-up of 22 years, as described by Boyer et al. [16], to 100%, as shown by Assi et al. [17], with a mean follow-up of 51 months. DM THA showed excellent clinical and radiological results with very few complications and has demonstrated to be a decisive treatment to avoid dislocation, the leading cause of revision.

Similar to our results, Walker et al. [18] found that THA had an excellent response to symptoms, improving functional ratings in patients aged 30 or less, regardless of implant choice or fixation technique. They demonstrated significant HHS findings and a revision rate comparable to the older population. Darrith et al. [1] analyzed 24 studies of dual-mobility primary THAs with 10,783 THAs with an average follow-up of 8.5 years. They found that the DM THA is a viable alternative to standard implants with good overall survivorship and a low dislocation rate of 0.46 percent (41 hips).

In a study by Jørgensen et al. [19], the clinical outcomes at 5 years of follow-up of 44 patients who underwent THA with anatomic DM monoblock have been observed. The authors proved good survival rates for the implants in patients with different ages, showing good clinical outcomes, low polyethylene wear rate and well monoblock cup fixation.

Gardner et al. [20] in their study analyzed the pooled estimates of all-cause survival rate following THA DM, evaluating estimates of unadjusted dislocation rate and revision due to instability, fracture and infection. The pooled survival estimate at 10 years was 96.3% from registry data and 95.7% from case series. The revision estimate for THA DM was 0.8% for instability, 0.4% for infection and 0.3%, for fracture.

Limitations

The limitations of this study are linked to the small number of studies, the presence of different clinical and radiological outcomes, the heterogeneity of the sample populations, the different types of implants and surgical approaches, and the poor evaluation of return to activity and sport.

Moreover, the included studies involved only a group of patients who underwent THA DM. Therefore, there was no possibility to compare these patients' survival rates and clinical outcomes with other kinds of THA or different surgeries to evaluate the effectiveness of THA DM in young adults. As the sample comprises young patients, an assessment of return to physical activity and sports would be helpful to obtain strong evidence on the performance and effectiveness of THA DM.

Conclusion

Dual-mobility THAs are a valid option for young patients with extended survivorship and low rates of instability after primary THA. The rate of complications is relatively low, while the survival rate of the implant is increased, and the revision surgery is no longer difficult. Therefore, this study demonstrated the efficacy and longevity of THA DM in

patients younger than 55 years old, concerning low complication rate and high survival rate.

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Declarations

Conflict of interest The authors declare no conflict of interest.

Ethical approval Not applicable.

Informed consent Not applicable.

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