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Is Dual Mobility Total Hip Arthroplasty Surgery More Aggressive than Hemiarthroplasty when Treating Femoral Neck Fracture in the Elderly? A Multicentric Retrospective Study on 302 Hips

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Abstract

Introduction: Bipolar hemiarthroplasty (BHA) and total hip arthroplasty (THA) are validated treatments for displaced femoral neck fractures (DFNFs). BHA seldomly needs conversion to THA, but the latter has higher dislocation rate in FNFs. Dual Mobility THA offers a reduced dislocation rate and eliminates the risk of conversion. This study looks for differences between BHA and DMTHA in terms of surgical time, blood loss and transfusion, dislocation rate, mortality, and thromboembolic events. **Material and Methods:** All patients were ≥75yo. Recorded data included use of anticoagulant/antiplatelet drugs, ASA, operative time, intra-operative complications, pre/post-operative hemoglobin values, transfusions, hospitalization time, DVT/PE, glomerular filtration rate, Charlson Comorbidity Index (CCI), dislocation at 60 days, and mortality at 30 days and 6 months. A secondary analysis compared the subgroups in different age range (75–85 and ≥ 86yo). **Results:** In the cohort of 302 DFNF (93 BHA and 209 DMTHA) differences in mean age, CCI, and ASA score were significant. Once divided by age, the subgroups resulted comparable in terms of age and CCI, with no significant difference. A significant difference in surgical times showed DMTHA being an average 12 minutes longer than BHA. Significant was the ΔHB in the DMTHA subgroup which resulted lower compared to the BHA one. Difference in mean number of post-operative transfusion were not statistically significant. **Conclusions:** From our data, DMTHA did not lead to an increase in mortality, morbidity, bleeding, or dislocation rate when compared to BHA and could be considered as treatment of choice for DFNFs especially in healthy and active patients.

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Introduction

Despite being an extremely common and resource consuming injury for national health services, most appropriate treatment for displaced femoral neck fractures (DFNFs) in the elderly is still a matter of debate between bipolar hemiarthroplasty (BHA) and total hip arthroplasty (THA).[1-5] In case of DFNFs in active patients or on pre-existing hip osteoarthritis, THA represents the best performing choice, despite its higher initial costs and dislocation rate.[6,7] Bipolar hemiarthroplasty is traditionally considered a valid alternative for fragile, low demanding patients or those with cognitive disorders thanks to reduced blood loss, lower initial cost, and lower dislocation rate.[8] However, it has been established that BHA can lead to acetabular erosion with the need of conversion to THA, increasing the final cost of implants.[9] Moreover, given the increased operative and post-operative risks of elderly patients, eliminating the likeness of a BHA to THA conversion must be considered when deciding between those implants. A systematic review on the topic by Lewis et al.[10] reported that THA has better results in terms of mortality, reoperation, adverse outcomes, function, and quality of life, and it is a better choice overall for displaced femoral neck fractures under 80 years old, despite a higher dislocation rate. Recently, improvements to dual mobility THA (DMTHA), such as higher resistance crosslinked PE[11] and update to neck design, corrected the issues affecting early implants and encouraged a wider use.[12-15] These implants, used in France since 1974,[16] aim to improve range of motion (ROM) and reduce dislocation rate compared to fixed bearing THA. Considering the characteristics of BHA and single bearing THA, DMTHA might represent the best compromise for the treatment of femoral neck fracture in elderly but active patients.[17] The aim of the present retrospective multicentric comparative study was to assess surgical time, blood loss and transfusion, dislocation rate, mortality, and thromboembolic complications of 2 groups of patients with displaced femoral neck fracture treated with bipolar hemiarthroplasty and dual mobility total hip arthroplasty.

Materials and Methods

In the setting of a retrospective comparative study involving the regional trauma center and 2 general hospitals, we collected data on 302 DFNF treated surgically with BHA or DMTHA, either cemented or press-fit, between January 2018 and September 2019. Exclusion criteria included: less than 6 months of follow-up, patients younger than 75 years old, pathological femoral neck fractures, revision surgery, polytrauma patients needing additional procedures, rheumatic patients, patients with prior congenital hip dysplasia, Legg-Calve-Perthes disease, epiphysiolysis, or aseptic necrosis of the femoral head. The research has been approved by our local Institutional Review Board (ID1825 n.90/2021).

All surgical procedures were performed by posterolateral approach. Implant type decision was based on surgeon preference and on his considerations about patient condition and functional request. All patient received preoperative antibiotic prophylaxis. For hemiarthroplasty, the implants included cemented CCA stem with Bipolar head (Mathys Ltd), cemented MS-30 stem (Zimmer Biomet) and SL (cemented and uncemented) stem with Spheri-Lock head (LimaCorporate). Dual mobility THA implants included cemented PolarCup with PolarStem (Smith&-Nephew), cemented Avantage cup with Taperloc stem (Biomet Inc), cemented Novae Stick cup with Hype stem (Serf), cemented Apta Fix stem (Adler Ortho), cemented Exeter and ABG stems (Stryker Corporation), press-fit Trident cup, ABG stem, Accolade stem (Stryker Corporation), press-fit Novae cup with Hype stem (Serf), and press-fit Apta stem (Adler Ortho).

As a standard practice, patients were encouraged to sit on the bed the first day post-operatively. When the patient's condition allowed for it, walking was resumed on day 2 with the help of aids.

Data collection was performed by consulting clinical records and, when needed, by phone contact. Recorded data included the use of anticoagulant/antiplatelet drugs, American Society of Anesthesiology (ASA) score, operative time, complications during surgery, pre- and post-operative hemoglobin values (ΔHb), intra-operative blood transfusion, post-operative blood transfusion (from the hours right after surgery to post-operative day 7), pre- and post-operative hospitalization days (considering admission as day 0), temperature > 38°C from post-operative day 3 up to discharge, pre- and post-operative estimated glomerular filtration rate (ΔeGFR) and result of Charlson Comorbidity Index (CCI).

Complications were also recorded. Intra-operative complications included iatrogenic acetabular or femoral fractures. Post-operative complications included deep venous thrombosis (DVT) or pulmonary embolism (PE) within 30 days from surgery and hip dislocation within 60 days from surgery. Primary outcome was survival of the

patient, which was verified at 30 days and 6 months from surgery.

In case of patients transferred to other departments due to post-operative complications, the discharge date from the receiving department was retrieved in order to avoid bias in hospitalization days. Pre-operative Hb value was intended as the last one before surgery. In those cases requiring pre-operative blood transfusion, sampling had always been performed in the time between transfusion and surgery. Post-operative Hb value was intended as the first one available after surgery. Time from pre-operative blood sampling to surgery and from surgery to post-operative blood sampling varied and were not recorded. Intra-operative blood transfusions were recorded with the sole purpose of excluding such patients from the ΔHb value analysis. GFR was calculated with the CKD-EPI equation.

Statistical analysis was performed with Microsoft Excel (Redmond, Washington, U.S.). Patients were divided in 2 subgroups, respectively, including patients treated by DMTHA and BHA. A secondary analysis was performed to compare the same subgroups in 2 different age range (from 75 to 85 and ≥ 86 years old). Continuous variables were expressed as mean ± standard deviation. Categorical variables were expressed as number and percentage. Comparison between the BHA and DMTHA subgroups values was performed with paired-samples t-test in case of continuous variables (Student's t-test for data with equal variance and Welch's t-test in case of data with unequal variance), while differences between categorical variables were evaluated with Chi-Square test. Differences were considered significant with $p < 0,05$.

Results

The cohort included 302 cases of DFNF on 300 patients (86 males, 214 females, mean age 85,5 years old). Overall, 209 cases were treated by DMTHA (Subgroup 1) and 93 by BHA (Subgroup 2). Mean age difference between subgroups was statistically significant with patients in the BHA subgroup being on average 2.2 years older. Mean CCI and ASA score also resulted in higher values in the BHA subgroup, with a statistically significant difference. Subgroups were comparable in terms of gender and anticoagulant/antiaggregant therapy intake, as no statistically significant difference emerged. There was a statistically significant difference in surgical times with DMTHA procedure being an average 12 minutes longer than BHA. There were 4 (2%) intra-operative complications among the DMTHAs (1 acetabular fracture during impaction, 2 acetabular over-reaming and 1 failed stem cementation) compared to 1 (1,1%, a femoral shaft fracture) in the BHA, but this difference was not statistically significant. There was a significant difference in post-operative temperature, with a higher T > 38°C occurrence in the BHA subgroup. After exclusion of 62 patients that transfused intra-operatively, ΔHB in the DMTHA subgroup resulted 1,1 ± 1,1 g/dl compared to 1,7 ± 1,2 g/dl in the BHA one. This difference was statistically significant with p = .0007. Difference in mean number of post-operative transfusion and mean ΔeGFR in each subgroup were not statistically significant as well. There was a 4% occurrence of DVT/PE in the DMTHA subgroup against 8% among the BHAs, but this difference was not statistically significant. Regarding hospitalization days, the DMTHA subgroup had longer mean pre-operative stay (2,8 ± 2 days) compared to the BHA (1,9 ± 1,3 days) but also shorter mean post-operative stay (11,2 ± 6 days compared to 13,2 ± 6,2 days), both being statistically significant differences. However, when considering total hospitalization days, the difference was not statistically significant. There was a small difference in dislocation rates between subgroups (1,9% in DMTHA compared to 2,2% in BHA) which turned out not statistically significant. Both subgroups saw 4 cases not surviving up to the 30th post-operative day, respectively, 1,9% of patients among DMTHAs and 4,5% among BHA, however, this difference was not statistically significant. When considering survival at 6 months post-op, there were 21 (10%) deaths in the DMTHA subgroup compared to 15 (16%) in the BHA one, again this difference was not statistically significant. Detailed results are summarized in Table 1 and Table 2.

Age 75–85 Years Old

The present group included 145 cases, respectively, 116 DMTHA and 29 BHA. Differences in age, gender, CCI, and anticoagulant/antiaggregant therapy intake were not statistically significand between subgroups. Mean ASA score turned out higher in the BHA subgroup, with a statistically significant difference. Surgical time for DMTHA was, on average, 15 minutes longer than in the BHA subgroup, with significant $p < 0,05$. There was 1 (0,9%, 1 acetabular fracture during impaction) intra-operative complication in the DMTHA subgroup and none among the BHAs, however, this difference did not result statistically significant. There was no statistically significant difference in the occurrence post-operative T > 38°C. After exclusion of 28 patients that transfused intra-operatively, ΔHB in the DMTHA subgroup resulted 1,2 ± 1,1 g/dl compared to 1,7 ± 1,3 g/dl in the BHA one. This difference was statistically significant with p = .037. Difference in mean ΔeGFR was not statistically significant between subgroups. There was also no significant difference in the mean number of post-operative transfusion employed in each subgroup. Regarding DVT/PE, there was a 2,6% occurrence in the DMTHA subgroup against 6,9% among the BHAs, however, such difference was not statistically significant. There was no statistically

Table 1. Data Results for Continuous Variables in the Total Cohort, in the 75–85 Years Old and in the ≥86 Years Old Range.

	Total Cohort			Age 75–85			Age ≥86		
	THA	Hemi	*P*-value	THA	Hemi	*P*-value	THA	Hemi	*P*-value
Age (years)	84,78	87,03	.00088	80,54	81,62	.09762	90,21	89,48	.13329
CC index	4,82	5,34	.0019	4,65	5,21	.07822	5,08	5,41	.08124
Pre-op stay (days)	2,85	1,89	.000023	2,65	2	.05681	3,03	1,84	.000074
Post-op stay (days)	11,15	13,24	.00566	11,41	12,96	.29085	11,29	13,375	.04142
Total stay (days)	14	15,25	.1088	14,7	15,31	.4042	14,33	15,21	.39396
Operative time (min)	78,58	66,26	.0000033	80,12	65,24	.000574	84,09	66,73	.000025
ASA score	2,55	3,07	$4{,}8114 \times 10^{-11}$	2,51	2,96	.000157	2,61	3,125	$6{,}5454 \times 10^{-7}$
Pre/post-op ΔHB (g/dl)	1,12	1,67	.00074	1,15	1,72	.03668	1,08	1,65	.008335
Pre/Post-op ΔeGFR (ml/min)	2,74	1,77	.57606	1,34	1,63	.91463	4,52	1,84	.21481
Intra-op transfusions (units)	.27	.26	.83809	.24	.27	.76251	.32	.375	.60,146
Post-op Transfusions (units)	1,11	.956	.31755	1,09	1,03	.82092	1,19	.92	.14562

THA = total hip arthroplasty. Hemi = hemiarthroplasty; CC = Charlson Comorbidity; ASA = American Society of Anesthesiology; eGFR = estimated glomerular filtration rate; HB = hemoglobin values

Table 2. Data Results for Categorical Variables in the Total Cohort. Hemi = hemiarthroplasty; OAT/NOACs = oral anticoagulant therapy/new oral anticoagulants; DVP-PE = deep venous thrombosis - pulmonary embolism.

	Total Cohort		
	Total hip arthroplasty	Hemi	*P*-value
Gender	26% M/74% F	33% M/67% F	.2122
Post-op t >38°C	4%	12%	.0152
OAT/NOACs	16%	10%	.15645
Antiplatelet drugs	32%	28%	.42755
Intra-op complications	2%	1%	.59802
DVT-PE at 30 days	4%	8%	.17195
Dislocation at 60 days	2%	2%	.89177
Mortality at 30 days	2%	4%	.23303
Mortality at 6 months	10%	16%	.13216

Table 3. Data Results for Categorical Variables in the 75–85 Years Old Range. Hemi = hemiarthroplasty; OAT/NOACs = oral anticoagulant therapy/new oral anticoagulants; DVP-PE = deep venous thrombosis - pulmonary embolism.

	Age 75-85		
	Total hip arthroplasty	Hemi	*P*-value
Gender	26% M/74% F	38% M/62% F	.19675
Post-op t > 38°c	5%	7%	.71605
OAT/NOACs	12%	10%	.79629
Antiplatelet drugs	28%	17%	.21964
Intra-op complications	1%	0%	.61586
DVT-PE at 30 days	3%	7%	.25519
Dislocation at 60 days	1%	3%	.28549
Mortality at 30 days	2%	0%	.47644
Mortality at 6 months	3%	14%	.02908

significant difference between subgroups in pre-operative, post-operative and total hospitalization days. Dislocation rate was lower in Subgroup 1 (0,9% in DMTHA and 3,5% in BHA) but this difference was also not significant. Among the DMTHA subgroup, 2 (1,7%) cases had not survived up to the 30th post-operative day. On the other hand, all cases in the BHA subgroup survived, however, this difference was not significant. At 6 months post-op, both subgroups saw 4 cases not surviving, respectively, 3,4% in the DMTHA subgroup compared to 13,8% in the BHA one. This difference was statistically significant with p = .029. Detailed results are summarized in Table 1 and Table 3.

Age ≥ 86 Years Old

The present group included 93 DMTHA and 64 BHA, for a total of 157 cases. Subgroups were comparable in terms of age, gender, CCI, and anticoagulant/antiaggregant therapy as there were no statistically significant differences.

Again, mean ASA score resulted higher in the BHA subgroup with a statistically significant difference. As with the 75–85 age range, average surgical time was longer (17 minutes) in DMTHA subgroup. There were 3 (3%) intra-operative complications (2 acetabular over-reaming and 1 failed stem cementation) in the DMTHA subgroup and 1 (1,6%, a femoral shaft fracture) among BHAs, again such difference was not statistically significant. There was a statistically significant difference in post-operative T > 38°C, occurring in 9 BHA patients (14,1%) compared to 3 (3,2%) in the DMTHA subgroup. Excluding 34 patients that transfused intra-operatively, ΔHb resulted slightly higher in the BHA subgroup than in the DMTHA one (respectively 1,6 ± 1,1 and 1,1 ± 1,2 g/dl), a statistically significant difference with p = .008. Mean ΔeGFR showed no statistically significant difference between subgroups. The BHA subgroup received a mean of 0,9 ± 1 blood units up to post-operative day 7, opposed to a mean of 1,2 ± 1,2 blood units of the DMTHA subgroup, however, this difference was not statistically significant. Occurrence of DVT/PE was 5,4% among DMTHAs and 7,8% in the BHA group, however, such difference was not statistically significant. As with the general cohort, the DMTHA subgroup had statistically significantly longer mean pre-operative

Table 4. Data Results for Categorical Variables in the ≥86 Years Old Range. Hemi = hemiarthroplasty; OAT/NOACs = oral anticoagulant therapy/new oral anticoagulants; DVP-PE = deep venous thrombosis - pulmonary embolism.

	Age ≥86		
	Total hip arthroplasty	Hemi	*P*-value
Gender	27% M/73% F	31% M/69% F	.55197
Post-op t > 38°c	3%	14%	.01202
OAT/NOACs	21%	9%	.06284
Antiplatelet drugs	38%	33%	.53539
Intra-op complications	3%	1%	.51573
DVT-PE at 30 days	5%	8%	.53906
Dislocation at 60 days	3%	2%	.51572
Mortality at 30 days	2%	6%	.18798
Mortality at 6 months	18%	17%	.86056

stay (3 ± 2,2 days) compared to the BHA (1,8 ± 1 days) and shorter mean post-operative stay (11,2 ± 6,7 days compared to 13,4 ± 6,2 days). Again, the difference was not statistically significant when considering total hospitalization days. Dislocation rate was doubled in the DMTHA subgroup (3,2%) compared to the BHA subgroup (1,6%), however, this difference was not significant. There were, respectively, 2 (2,2%) and 4 (6,3%) deaths before 30th post-operative day in the DMTHA and BHA subgroups, although with no statistically significant difference. Both subgroups saw a relevant increase in death at 6 months with 17 (18,3%) cases among DMTHA and 11 (17,2%) cases with BHA, not a statistically significant difference. Detailed results are summarized in Table 1 and Table 4.

Discussion

Despite DFNFs frequency, the most appropriate treatment in elderly is still debated. Patients in poor general condition usually undergo hemiarthroplasty, but the choice is characterized by an intrinsic risk of conversion to THA, meaning a second surgery for the patients, higher overall cost for NHS and possibly more complications. On the other hand, total hip arthroplasty has longer operative time, higher blood loss and risk of complications, higher initial cost, and risk of dislocations.[18] With the adoption of DMTHA the risk of dislocation is supposedly eliminated,[18,19] favoring the use of total hip arthroplasty when the patient can sustain the procedure. The subgroups among the overall cohort were not comparable due to a statistically significant difference in term of age, CCI, and ASA score. Despite being a limit in the general group analysis, this heterogeneity was expectable, and it is likely due to the clinical practice of treating older/more fragile patients with hemiarthroplasty. Indeed, once the cohort was divided by age, there were no statistically significant differences in terms of age and CCI between subgroups (difference in ASA score remained). As reported in the results section, THA required longer surgery time compared to HA.[20,21] However, the longer operative time did not seem to have an influence on blood loss. On the other hand, from our results, we reported that ΔHb was higher in the BHA subgroup than in the DMTHA. This finding was confirmed in general and subgroup ages of results. Such data goes against previous reports in literature[20,21] and authors' previsions, however, in our experience DMTHA did not lead to significantly higher bleeding compared to BHA. It must be noted that since most procedures were performed in a regimen of urgency, blood sampling did not follow a precise schedule, possibly influencing the reliability of the ΔHb calculation. However, the initial finding on ΔHb difference is further reinforced by the absence of a statistically significant difference in post-operative blood transfusion between the 2 procedures, a detail previously reported by similar studies.[22–25] Finally, our data showed no difference in intake of anticoagulants/antiaggregant therapy between the 2 groups, which could otherwise mislead blood loss results. Regarding hospitalization time, in our experience fractures treated with DMTHA had a longer pre-operative waiting time but a shorter post-operative stay when compared to those treated by BHA, this finding being statistically significant in both the general cohort and the ≥ 86 age group. A cautious interpretation for BHA shorter pre-operative wait could be based on the lower surgical experience required. Moreover, BHA is less time demanding and therefore more suitable to be performed in strict times. When considering intra-operative complication, the choice of procedure seems to have no influence on their likeness as there were no significant differences in the present study. The authors were unable to compare this result with similar findings in literature. The present data also showed no difference in the occurrence of DVT/PE between the 2 procedures, in accordance with previously published studies.[19,22] Furthermore, considering 6 months of follow-up, we reported comparable dislocation rate between BHA and

DMTHA.[18,22,26] Finally, in the 75–85 age group, a higher mortality at 6 months of follow-up was reported among BHAs. As previously mentioned, this might be due to preferring BHA for more fragile patients. More significantly, in the general cohort and in the ≥ 86 age range, DMTHA did not lead to higher mortality at 6 months compared to BHA, which was also reported in literature with even longer follow-up.[17,22,26] As always, the present study has limitations. Firstly, the retrospective design of the research determined an intrinsic selection bias. Factors during follow-up period cannot be controlled and the number of patients could be underpowered to demonstrate statistical differences. Moreover, we reported baseline differences of patients between the 2 groups. However, once the cohort was divided by age, there were no statistically significant differences in terms of age and CCI between subgroups.

Conclusions

In light of our results, the use of THA with dual mobility cuff did not seem to increase mortality, morbidity, or dislocation rate when compared to BHA for the treatment of DFNFs. Moreover, DMTHA did not lead to significantly higher bleeding compared to BHA. Therefore, when expertise and surgical time are available, DMTHA could be considered as primary treatment modality for DFNFs. Considering the design of the present study, further randomized controlled trial (RCT) are mandatory to make comparison between DMTHA and BHA in the treatment of DFNFs especially in healthy and active patients.

Declaration of Conflicting Interests

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Ethical Approval

This research has been approved by our local IRB.

Informed Consent

All patients had signed informed consent for publication upon admission.

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