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## Dual mobility prosthesis in Hip Arthroplasty

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**Abstract**---Background: With the increase in the number of total hip arthroplasty performed in the next decades to reduce or prevent medical and mechanical complications such as post operative THA instability Dual mobility was introduced as an alternative to standard sockets to reduce the risk of THA dislocation post operatively.(1) Aim of the work: to evaluate the hip joint function and stability after dual mobility total hip replacement using standard evaluation methods in 20 cases of hip problems. Patients and Methods: This study included 20 patients; 9 males and 11 females with a mean age  $55.1 \pm 14.1$ . All cases were identified to have one or more risk factor for dislocation after hip arthroplasty, 8 cases had previous hip surgeries, (4 hemiarthroplasties, 2 previous THR and 2 internal fixation surgeries) and 12 cases had no previous hip surgeries. From the 20 cases 1 case was operated through posterior approach and 19 through lateral approach. Results: There were 2 complications in 2 cases, limb length

discrepancy (2 cm longer in the operated side) and superficial infection, all of which are attributed to technical and patient's factors rather than implant factor. There was no single case of prosthetic dislocation at the last follow up, which means that dual mobility total hip arthroplasty succeeded to address the indication for which it was invented. Conclusion: The main concern in this study was the low number of cases and short follow up period. However, it represents a step forward for better understanding and analysis of this relatively new implant.

**Keywords**---Dual Mobility prosthesis, Hip Arthroplasty, Hemiarthroplasties.

## **Introduction**

Total hip arthroplasty is considered one of the most successful surgical procedures in orthopaedics (Austin et al., 2012). Using dual mobility cups give a promising result but should be used in highly demand patient with caution due to accelerating wear and intra prothetic dislocation (Guyen et al., 2009). The reported incidence of instability after primary and revision total hip arthroplasty equal 7% and 25% respectively (Patel et al., 2007). Instability after total hip arthroplasty is due to many risk factor which may be patient related factors e.g gender, age, abductor deficiency or surgical factors e.g. approach, component malposition and femoral head diameter (Prudhon et al., 2013).

Instability after primary and revision total hip arthroplasty is considered a burden cost on health insurance so many modification should be done to minimize Readmission and revision surgery e.g surgical Modification e.g. anterior surgical approach, increased offset, restoration of abductor tension and using a larger femoral head to decrease the risk of instability after total hip arthroplasty (Schairer et al., 2014).

The dual mobility concept is not without problems. Two primary concerns with dual mobility cups remain wear and intraprosthetic dislocation. Dual mobility implants not only have thinner polyethylene liners, but potentially accelerated wear by the two articulating surfaces. There is further concern over potential higher wear rates on the convex surface of a polyethylene bearing (Philippot et al., 2009).

## **Aim of the Work**

The aim of this work is to evaluate the hip joint function and stability after dual mobility total hip replacement using standard evaluation methods in 20 cases of hip problems.

## **Patients and Methods**

This is a prospective study performed on 20 patients having different indications for THR. These patients underwent THR between February 2015 and February 2019.

### *Age:*

The main age was 55.1±14.1 Sex of patients in the studied group was 9 males and 11 females.

### *Preoperative assessment:*

All the 20 patients were carefully assessed in the form of detailed history and clinical examination, radiological and laboratory investigations were done and interpreted along with the history and clinical findings. It was critical to identify any remote source of pain which might mimic hip pain and give a false indication for surgery, like spine pathology. Detailed history about the previous mobility status was obtained. Harris Hip Score ([Harris, 1969](#)) was used to assess all included patients postoperatively at 3 months, 6 months and 1 year which evaluate level of pain, function, absence of deformity and range of motion. Its rating 100 points: from 90 to 100 is considered excellent 80 to 89 is considered good 70 to 79 is considered fair and below 70 is considered poor. The 20 patients in our study were rated between 30 to 80 years. All included patients are subjected to the following:

Detailed history taking and analysis which included Personal history Name, Age, Special habits, Sex, Occupation, Address and Contact number. Complaint: History of patients' complaints was fully analyzed: Onset, Course, Duration, What increases and what relive the symptoms, Associated symptoms and, Symptoms at other joints

### *Mobility Status:*

Mobility status was a subject of concern in history taking. All 20 patients were clearly asked and examined for their mobility status, which is always vital in decision making and follow up. 8 patients were bed ridden 7 due to fracture and failed osteosynthesis, 1 due to dislocated hemiarthroplasty, and the rest of the patients were mobilized with variable grades of walking aids and support.

### *Past medical history:*

Assessment of other medical comorbidities was done with assistance of spechialist for better control: diabetes mellitus and hypertension (1 patient) and hypertension (2 patients).

### *Symptoms of other systems:*

Any history suggestive of urinary tract, dental, ENT, chest or any remote infection, warrant referral to corresponding specialty doctor for eradication this septic focus.

### *Examination:*

*General orthopedic examination;*

Was done to all included patients, in the form of spinal examination with special concern related to the neurological status. Contralateral hip is well assessed as a reference for the diseased limb.

*Local Examination:*

*Inspection:*

It starts with observing the gait of the mobilized patients, and walking aids. Out of the 20 patients 8 patients were bed ridden and the remaining 12 were mobilized with support and/or limp. Limb deformity was obvious in 4 patients due to fracture neck of femur (external rotation of the whole limb) and 1 patient with flexion and marked external rotation with mild flexion and abduction due to posterior dislocation of Thompson hemi-arthroplasty. The other 15 patients with no obvious limb deformity.

Muscle wasting was well assessed for possible neurological insult of spinal origin or strokes. No patients with a past history of neurological insult or strokes in this study. Local soft tissue condition was assessed for previous scars, bed sores, or any possible local source of infection. All patients were free from local source of infection.

*Palpation:*

- Tenderness; tenderness was mostly anterior deep and lateral tenderness.
- Muscles power; assessment of hip was not possible in some patients (4 patients), however assessment of ankle and knee muscles was used to exclude any neurological deficits (20 patients).
- Sensations: were assessed as part of spinal examination for correlation with any suspected spinal pathology.
- Vascular examination; none of the included patients had any vascular compromise.

Out of these 20 patients, six patients were diagnosed as advanced OA, with pain interfering with their daily activities, four patients with recent neck femur fracture, three patients with failed osteosynthesis, five patients who underwent hemiarthroplasty for neck femur fracture (one Thompson and four bi polar prosthesis) and two patient with previous primary THR (Table 1) .

Table (1)  
Indications for THR in the studied groups.

Primary pathology	NO.of cases	Percentage
Advanced osteoarthritis	6	30%
Previous hemi-arthroplasty	5	25%
Fracture	4	20%
Failed osteosynthesis	3	15%
rTHR	2	10%

*Patient inclusion criteria:*

These 20 patients indicated for dual mobility total hip arthroplasty with mean age ranged between 30 years to 80 years with different activities, as they were identified to have one or more risk factors (age,sex,ASA score  $\geq 3$ ) for dislocation after THR surgery. These risk factors were clearly discussed earlier in literature

review. Some of the selected patients had more than one risk factor for dislocation.

*Exclusion criteria:*

Similar to contraindications for other hip arthroplasty like:

- 1- Active local or systemic infection.
- 2- Neuropathic joint arthropathy.
- 3- Severe systemic illness.

*ROM:*

It was not possible to assess ROM in 8 patients; 4 due to acute neck of femur fracture, 1 due to dislocated hemiarthroplasty, and 3 due to failed DHS,DCS fixation. Other patients were carefully assessed for ROM and included in their Harris hip score for follow up (Table 2-6).

*Pre-Operative ROM:*

Table (2)  
Preoperative hip joint flexion

Range of hip flexion	No. of patients	Percentage
0	8	40%
40-60	6	30%
61- 80	5	25%
81-90	1	5%

Table (3)  
Range of Preoperative hip joint external rotation

Range of hip external rotation	No. of patients	Percentage
0	8	40%
1-10	5	25%
11-20	7	35%
21-30	0	0%

Table (4)  
Range of Preoperative hip joint internal rotation

Range of hip internal rotation	No. of patients	Percentage
0	8	40%
1-10	5	25%
11-20	7	35%

Table (5)  
Preoperative hip joint abduction

Range of abduction	No. of patients	Percentage
0	8	40%
1-10	5	25%
11-20	7	35%
21-30	0	0%

Table (6)  
Range of Preoperative hip joint adduction

Range of adduction	No. of patients	Percentage
0	8	40%
1-10	6	30%
11-20	6	30%
21-30	0	0%

*Limb length discrepancy:*

Out of the included patients one was identified to have shortening of the affected limb by 2 cm, and this was considered in pre-operative planning.

*Radiography:*

*Plain radiograph*

Obtaining appropriate radiographs was mandatory for all cases for proper pre-operative planning. A minimum of two views required, one in the antero-posterior (AP) projection for the pelvis and one lateral view for the affected hip.

*CT scan;*

CT scan was done for one patient with suspected acetabular bone defect (Fig.1).



Fig. (1): CT scan was done for suspected acetabular bone defect

*Laboratory tests:*

Basic blood investigations were done to all cases, it included; CBC, Renal and liver functions tests, Coagulation profile, hepatitis markers, and random blood sugar for all included cases. For one diabetic patient fasting blood sugar was done and glycated Hb (HbA1c) was done to get the real diabetic control over the last 3 months and the laboratory tests for the remaining cases (19 patients) were accepted.

*Surgical technique;*

All patients were advised to have a bath at the night of surgery,

*Anesthesia;*

Out of the 20 patients, 12 underwent spinal anesthesia and 8 patients with epidural anesthesia. All cases underwent catheterization for urine output monitoring.

*Positioning;*

All patients underwent surgery in the well-controlled true lateral position, with proper padding of all pressure areas, and well-fixed supports which are always critical to keep the patient in a true lateral position for implant orientation

*Approach used;*

Direct Lateral approach (Modified Harding) was used in 19 cases and posterior approach was used in one case.

*Type of implant used:*

A mix between cemented and cementless components as patient need and surgeon's decision.

*Post-Operative care;*

All patients were shifted after surgery to the recovery area where they were monitored for vital signs and neurovascular status then shifted to the ward after adequate recovery. First dressing was usually done in the third post-operative day deep venous thrombosis prophylaxis was started post operatively in the same day of surgery in the form of subcutaneous. Injection till discharge then oral anticoagulants for 5 weeks.

*Protocol of weight bearing;*

15 patients started immediate partial weight bearing with frame post-operatively the other five patients underwent bed rest for 4 weeks then start to walk with a frame.

X ray; was done post operatively in 2 views anteroposterior and lateral Patient has been discharged to home after ensuring proper wound care and education for rehabilitation for 6 to 8 weeks.

*Follow up plan*

Patients were given appointment to our outpatient clinics on 2 weeks for wound assessment and sutures removal 6 week 3 month 6 month and one year then yearly after that. All patients were given detailed explanation for post hip arthroplasty precautions; like elevated toilet seats, chair praying, and avoiding ground sitting and squatting.

**Results***Post-operative assessment:*

All the 20 patients were carefully assessed in the form of detailed history and clinical examination for any recent complaints. Radiological examination was

done in the form of AP pelvis and lateral hip views. ROM was carefully assessed post operatively and was included in Harris Hip Score in all included patients, at 3 months, six months and at one year (Table.7-11, Figs. 2-5).

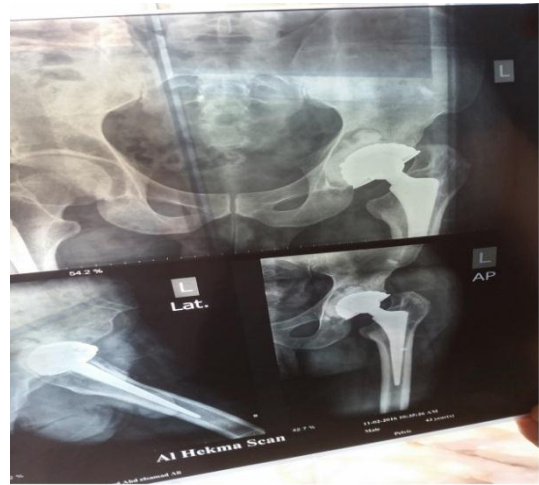


Fig. (2): preoperative Ap x rays left hip Fig. (3): Immediate postoperative X ray AP



Fig.(4):Preoperative X ray AP Pelvis



Fig.(5): postoperative X ray AP pelvis

*Postoperative ROM: At 1 year*

Table (7)  
Postoperative hip joint flexion

Range of hip flexion	NO. of the patient	Percentage.
75-90	4	20%
91-100	8	40%
101-110	4	20%
111-120	4	20%
Total	20	100%

Table (8)  
Postoperative hip external rotation

Range of hip external rotation	NO. of patients	Percentage
20-30	18	90%
31-40	2	10%
Total	20	100%

Table (9)  
Postoperative hip internal rotation

Range of hip internal rotation	NO. of patients	Percentage
15-25	16	80%
26-35	4	20%
Total	20	100%

Table (10)  
Postoperative hip abduction

Range of abduction	NO. of patients	Percentage
20-30	19	95%
31-40	1	5%
Total	20	100%

Table (11)  
Postoperative hip adduction

Range of adduction	NO. of patients	Percentage
20-30	18	90%
31-40	2	10%
Total	20	100%

*Complications:*

There was no dislocation, deep infection, or any neurovascular compromise. One patient developed wound dehiscence and surgical site infection at 6 weeks post operatively. Culture and sensitivity results showed Staph.aureus which was sensitive to Leavofloxacin. Patient was taken to operation Theater and there was superficial infection not reaching deep tissues layers, which was thoroughly debrided and kept in hospital for intravenous antibiotics for 2 weeks. Patient was

then discharged home on oral antibiotics. At regular follow up, wound was completely healed with no recurrence of infection and progressed well after that. Another patient developed limb length discrepancy by 2cm, on operated side was longer by 2cm. Patient was walking with mild limp, he was advised orthotic shoe-raise to the contralateral side, but he did not like it and was walking independently with a mild limp at the last follow up (Table 12-15).

Table (12)  
Post-operative data and complications

post- operative data	No.	%
Full weight bearing After 8 weeks with aids	20	100.0%
Complication		
• No	18	90.0%
• Limb Length Discrepancy (2cm)	1	5.0%
• super-facial infection	1	5.0%

Table (13)  
P-value in comparison comparing pre and post OP.  
Harris hip score ranges

	HHS (mean $\pm$ SD)	Friedman test	P value
Pre-operative	43.7 $\pm$ 23.1	40.0	<0.001*
3 months	75.7 $\pm$ 5.9		
1 year	86.0 $\pm$ 4.7		

Table (14)  
Final result of Harris hip score at 1 year post OP.

Harris hip score	No. of patients	percentage
Fair(70-79)	0	0
Good(80-89)	13	65%
Excellent(90-100)	7	35%

*Pre and post -operative ROM:*

Table (15)  
Range of motion

Range of motion	Pre	Post	Wilcoxon test	P value
	Mean $\pm$ SD			
Flexion	37.0 $\pm$ 32.5	99.0 $\pm$ 10.4	3.2	<0.001*
Abduction	8.0 $\pm$ 7.1	24.7 $\pm$ 4.4	3.3	<0.001*
Adduction	8.2 $\pm$ 8.1	24.2 $\pm$ 4.6	3.4	<0.001*
Internal rotation	8.0 $\pm$ 7.5	23.7 $\pm$ 4.5	3.9	<0.001*
External rotation	8.5 $\pm$ 8.1	25.7 $\pm$ 5.9		<0.001*

\*(Significant)

## Discussion

This work highlighted prosthetic hip instability as an ongoing issue in primary and revision hip arthroplasty. Hip arthroplasty play a major role not only for patient and surgeon satisfaction but also has significant impact on readmission rates and financial burden to the health care system. [De Martino et al. \(2014\)](#) reported that approximately one third of readmissions following revision total hip arthroplasty are instability related. Given the increased life expectancy, aging population and increasingly active patients the cost burden will also continue to rise highlighting the need for improvements in techniques and technologies ([Kurtz et al., 2007](#)).

A 2 to 5% rate of postoperative dislocation following primary total hip arthroplasty has been reported in large series ([Berry et al., 2004](#)). In revision total hip arthroplasty factors such as muscular insufficiency, enlarged synovectomy, implant positioning problems or the need for bone reconstruction have been implicated in postoperative instability. Depending on the reasons for revision mean dislocation rates in the literature range from 5 to 30% ([Alberston et al., 2002](#)). Constrained or tripolar cup designs have reduced postoperative dislocation rates but only to a limited extent and to the detriment of long-term acetabular fixation ([Williams et al., 2007](#)).

Dual mobility was introduced at the end of 1970s to minimize the risk of dislocation after primary total hip arthroplasty and used as another option to fixed bearing system in both primary and revision total hip arthroplasty in high risk patient to improve the outcome and. longevity ([Jama, 1995](#)).

This study also highlighted the effect of surgical approach on dislocation rate as a subject of debate in orthopedic literatures. Out of the 20 cases of total hip arthroplasty 1 was performed through posterior approach with capsular repair and 19 through lateral approach. There was no dislocation at the last follow up 4 years. Our result was matching the result which was published by [Kwon et al. \(2006\)](#) who found similar dislocation rates associated with direct lateral and posterior approach was concluded that surgeon's preference and training have detrimental role on approach selection.

In our study we used dual mobility implant for ten cases with primary hip pathology 0wh0o did not have any previous hip surgeries three cases with failed hip osteosynthesis and five cases of previous hemiarthroplasty surgery two cases with failed total hip arthroplasty 0and dislocation rate was 0 % at the last follow up 4 years. Considering our result along with data of previously mentioned studies obviously this concept is very promising in hip arthroplasty but some concerns remain.

Dual mobility articulations have shown promising results. Dual mobility cups have been shown to decrease the rate of dislocation in primary total hip arthroplasty and have been used to treat and prevent instability in revision total hip arthroplasty. Greater range of motion and greater head to neck ratio and greater jump distance are achieved resulting in a lower risk of instability. Concerns with dual mobility cups include wear and intraprosthetic dislocation.

Specific design modifications have aimed to improve cup fixation and decrease polyethylene wear and the risks of intraprosthetic dislocation.

In a study done in Egypt alexandria University [Rashed et al. \(2018\)](#) concluded that dual mobility cup total hip replacement is an acceptable method for treatment of displaced femoral neck fracture in active middle aged patients in Egypt as it provides pain relief and good function without compromising the stability.

A unique complication of dual mobility liners is intra prosthetic dislocation. This occurs when the inner head disengages from the polyliner to which it is constrained. In the study by [Boyer et al. \(2012\)](#) these intra prosthetic dislocation's were found to be occurring late average of 9 years. This complication was theorized to be coming from wear at the retentive rim of the polyethylene building up slowly over time, as at extremes of range of motion the neck engages the rim causing wear eventually enough for the inner constraint to fail. Reductions in intra prosthetic dislocations have been seen with improvement in poly wear characteristics ([Vielpeau et al., 2011](#)). In our study there was no single case of intra prosthetic dislocation at the last follow up. However there was one case of radiological aseptic loosening at the acetabular side which was attributed to an inadequate cementing technique. And this patient is symptoms free at the last follow up and is under close observation.

Dual mobility cup giving an excellent result as compared with standard bearing implants in both primary and revision total hip arthroplasty. In a study done by [EpINETTE \(2015\)](#) reported that significant difference in dislocation rate between dual mobility and fixed system favouring dual mobility.

[Caton et al. \(2014\)](#) reported a significant difference in dislocation rate between dual mobility and fixed bearing in both primary and revision total hip arthroplasty 0.9% versus 12.9% respectively and revision rate 2.1% versus 12.9% respectively at 10 years follow up.

Dual mobility is commonly used in France so many registry data about dual mobility is available otherwise in America using dual mobility cup is 9.7% of all primary hip arthroplasties ([AJRR., 2019](#)).

The excellent results of dual mobility cup encourage its use in Europ ([Tarasevicius et al., 2017](#)). In jermany study comparing revision rate for dislocation between dual mobility cup and standered bearing system the result was 0.2% for the first and 0.5% for the later ([Bloemheuvél et al., 2019](#)).

[Haughom et al \(216\)](#) reported significant reduction in dislocation rates by using larger femoral head size versus anatomic head size 0.5% for the first versus 4.5% for the later. Using dual mobility cup with large femoral head is an implant of choice for both primary and revision total hip arthroplasty with the lowest rate of revision and dislocation rate compared with the fixed bearing system ([Pituckanotai et al., \(2018\)](#)).

[Hernigou et al. \(2016\)](#) compared the dislocation rate between dual mobility cup and fixed cup in obese patient's excellent reduction in dislocation rate observed in

these patients who used dual mobility 2% as compared with fixed cup 9%. In cerebral palsy patients or other neurologic diseases who are high risk patient of instability following total hip arthroplasty. Due to increased neck shaft angle increased femoral anteversion and imbalanced between adductor, internal rotator and hip flexor muscles.

Raphael et al (2010) reported an excellent result in these high risk patients by using dual mobility cup as compared with the using of fixed bearing system which report 14% dislocation rate. Sanders et al.(2013) report an excellent result in these high risk patient with no dislocation rat in 11 dual mobility total hip arthroplasty. Morin et al. (2016) reported no aseptic loosening or dislocations in 40 dual mobility total hip arthroplasty performed for patients with neurological diseases.

### Conclusions

Total hip arthroplasty is considered one of the successful operations providing pain relievers and enhance the patient quality of life. However postoperative instability remains a major problem on which patient readmission has been done. With regarding the first generation dual mobility cup which has amajor problem such as intra prothetic dislocation. So implant modifications including the use of highly cross linked poly ethylene with Osmooth cylindrical femoral necthe intra prothetic dislocation.

With comparison between dual mobility total hip arthroplasty and the fixed bearing system there are significant reduction in dislocation in the first giving promising result in high risk patient e.g female and femoral neck fracture. From an economic view dual mobility is considered a lower cost in comparison with standared bearing total hip arthroplasty. In the future dual mobility is consider one of the gold standered for total hip arthroplasty especially in high risk patient but along term study is needed before recommendations and widespread use.

### References

1. Austin, M.S., Higuera, C.A., & Rothman, R.H. (2012). Total hip arthroplasty at the rothman institute. *HSS J*; 8:146–150.
2. Guyen, O., Pibarot, V., Vaz. G., Chevillotte, C., & Béjui-Hugues. J. (2009). Use of a dual mobility socket to manage total hip arthroplasty instability. *Clinical Orthopaedics and Related Research*, 467:465–472
3. Patel, PD, Potts, A., & Froimson MI. (2007). The dislocating hip arthroplasty: prevention and treatment. *Arthroplasty*, 22:86–90.
4. Prudhon, J.L., Ferreira, A., & Verdier, R. (2013). Dual mobility cup: dislocation rate and survivorship at ten years of follow-up. *International Orthopaedics*, 37:2345–2350.
5. Schairer, W.W., Sing, D.C., Vail, T.P., & Bozic, KJ. (2014). Causes and frequency of unplanned hospital readmission after total hip arthroplasty. *Clinical Orthopaedics and Related Research*, 472:464–470.
6. Philippot, R., Camilleri, J.P., Boyer, B., Adam, P., & Farizon F. (2009). The use of a dual-articulation acetabular cup system to prevent dislocation after

- primary total hip arthroplasty: analysis of 384 cases at a mean follow-up of 15 years. *International Orthopaedics*, 33:927-932.
7. Harris, W.H. (1969). Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *The Journal of Bone & Joint Surgery American Volume*, 51(4):737-55.
  8. De Martino, I., Triantafyllopoulos, G.K., Sculco, P.K., et al. (2014). Dual mobility cups in total hip arthroplasty. *World Journal of Orthopaedics*, 5:180.
  9. Kurtz, S., Ong, K., Lau, E., Mowat, F., & Halpern, M. (2007): Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *The Journal of Bone and Joint Surgery. American Volume*, 89:780-5.
  10. Berry, D.J., VonKnoch, V., Schleck, C.D., Harmsen, W.S. (2004). The cumulative long-term risk of dislocation after primary Charnley total hip arthroplasty. *The Journal of Bone and Joint Surgery. American Volume*; 86, pp. 9-14
  11. Alberton, G.M., High, W.A., Morrey B.F. (2002). Dislocation after revision total hip arthroplasty: an analysis of risk factors and treatment options *The Journal of Bone and Joint Surgery. American Volume*; 84; 1788-1792
  12. Williams, J.T., Ragland, P.S., & Clarke, S. (2007). Constrained components for the unstable hip following total hip arthroplasty: a literature review *International Orthopaedics*, 31: 273-277
  13. Jama, NIH. (1995): Total hip replacement. NIH Consensus Development Panel on Total Hip Replacement. *Jama Consensus Conference*; 273: 1950-1956.
  14. Kwon, M.S., Kuskowski, M., Mulhall K.J., Macaulay, W., Brown, T.E., & Saleh, K.J. (2006). Does surgical approach affect total hip arthroplasty dislocation rates? *Clinical Orthopaedics and Related Research*, 447:34-8.
  15. Rashed, R.A., Sevenoaksc, H., Shabaana, A.M., Choudryb, Q.A., Hammada, A.S., Kasema, M. S., El Khadrawea, T.A., & El Dakhakhnya M.M. (2018). Functional outcome and health related quality of life after dual mobility cup total hip replacement for displaced femoral neck fractures in middle aged Egyptian patients. / *Injury*, 49: 667-672.
  16. Boyer, B., Philippot, R., Geringer, J., et al. (2012). Primary total hip arthroplasty with dual mobility socket to prevent dislocation: a 22-year follow-up of 240 hips *International Orthopaedics*, 36(3):51 8.
  17. Vielpeau, C., Lebel, B., Ardouin, L., Burdin, G., Lautridou, C. (2011). The dual mobility socket concept: experience with 668 cases. *International Orthopaedics*, 35:225-230.
  18. Epinette, J.A. (2015). Clinical outcomes, survivorship and adverse events with mobile-bearings versus fixed-bearings in hip arthroplasty: a prospective comparative cohort study of 143 ADM versus 130 trident cups at 2 to 6-year follow-up. *Journal Arthroplasty*, 30:241-248.
  19. Caton, J.H., Prudhon, J.L., Ferreira, A., Aslanian, T., & Verdier, R. (2014). A comparative and retrospective study of three hundred and twenty primary Charnley type hip replacements with a minimum follow up of ten years to assess whether a dual mobility cup has a decreased dislocation risk. *International Orthopaedics*, 38:1125-1129.
  20. AJRR (American Joint Replacement Registry). Annual Report. (2019). <http://www.ajrr.net/publications-data/annual-reports> (date last accessed 20 February 2019).

21. Tarasevicius, S., Smailys, A., Grigaitis, K., Robertsson, O., & Stucinskas, J. (2017). Short-term outcome after total hip arthroplasty using dual-mobility cup: report from Lithuanian Arthroplasty Register. *International Orthopaedics*, 41:595–598.
22. Bloemheuvel, E.M., van Steenberghe, L.N., Swierstra, B.A. (2019). Dual mobility cups in primary total hip arthroplasties: trend over time in use, patient characteristics, and mid-term revision in 3,038 cases in the Dutch Arthroplasty Register (2007–2016). *Acta Orthopaedics*, 90:11–14.
23. Haughom, B.D., Plummer, D.R., Moric, M., DellaValle, C.J. (2016): Is there a benefit to head size greater than 36 mm in total hip arthroplasty? *Journal of Arthroplasty*, 31:152–155.
24. Pituckanotai, K., Arirachakaran, A., Tuchinda, H., et al. (2018). Risk of revision and dislocation in single, dual mobility and large femoral head total hip arthroplasty: systematic review and network meta-analysis. *European Journal of Orthopaedic Surgery and Traumatology*, 8; 28:445–455.
25. Hernigou, P., Trousselier, M., Roubineau, F., Bouthors, C., & Lachaniette. C.H. (2016): Dual-mobility or constrained liners are more effective than preoperative bariatric surgery in prevention of THA dislocation. *Clinical Orthopaedics and Related Research*, 474:2202–2210.
26. Raphael, B.S., Dines, J.S., Akerman, M., & Root, L. (2010). Long-term follow up of total hip arthroplasty in patients with cerebral palsy. *Clinical Orthopaedics and Related Research*, 468:1845–1854.
27. Sanders, R.J., Swierstra, B.A., & Goosen, J.H. (2013). The use of a dual-mobility concept in total hip arthroplasty patients with spastic disorders: no dislocations in a series of ten cases at midterm follow-up. *Archives of Orthopaedic and Trauma Surgery*, 133:1011–1016.
28. Morin, C., Ursu, C., & Delecourt, C. (2016). Total hip replacement in young non-ambulatory cerebral palsy patients. *Orthopaedics & Traumatology: Surgery & Research*, 102:845–849.