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ORIGINAL STUDY

Comparative analysis of different total hip replacement implants used in a single health region of the United Kingdom - minimum 15 years follow-up

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We describe the functional and radiological results at minimum 15 years follow up of four groups of total hip replacement(THR) implants used in our health region.

876 THRs in 837 patients who were included in the study that used prospectively collected data in the Tayside Arthroplasty Audit Group(TAAG) database. There were 387 Charnley/Ogee cemented THRs, 188 hips in the cemented CPT/ZCA group, 106 hips in the uncemented Bicontact/Plasmacup group and 195 hips in the hybrid Exeter/Trident group.

The most common complications were dislocation (3.88%) and superficial infection (3.76%). With revision surgery for any reason as the end point, the survivorship of at 15 years in our series was 98.45% in the cemented Charnley/Ogee THR group, 96.8% in the cemented CPT/ZCA group, 96.22% in the uncemented Bicontact/Plasmacup group and 97.94% in the Exeter/Trident hybrid THR group. There was no statistically significant difference in the number of hips at risk of revision, Harris Hip Scores and complication rates at 15 years.

We feel that the choice of implant is best based on individual templating and training of the surgeon. Prospective randomised controlled trials and joint registry data may make implant selection easier in the future.

Key words : Total hip replacement ; results.

INTRODUCTION

Selection of total hip replacement (THR) implants has been a subject of constant debate with different groups of surgeons being strong advocates of different designs philosophies, bearing surfaces and implantation methods. The decision to select an implant may be based on registry data,availability, the surgeon's training and experience, industry drive, individual patient factors and cost factors especially in publically funded healthcare systems *(11,16)*. The Tayside Arthroplasty Audit Group (TAAG) maintains prospective functional and radiological data on patients who undergo THR in three National Health Service (NHS) hospitals in our health region. In our database, the most commonly used implant was the cemented Charnley/Ogee hip prosthesis(DePuy,UK). We also used cemented CPT/ZCA (Zimmer,UK), Bicontact/ Plasmacup uncemented prosthesis (Aesculap, Tuttlingen, Germany) and Exeter/Trident hybrid implants(Stryker,UK). Charnley THR has excellent long-term survivorship *(4,10,18)*. Although about

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10,000 CPT/ZCA THRs have been implanted in the United Kingdom, recent reports have raised concerns regarding increased rates of periprosthetic fracture with the CPT stem *(2,15)*. The Exeter /Trident hybrid system has been successfully implanted in about 45,000 patients with a low revision rate at 10 years *(11)*. The Bicontact/Plasmacup uncemented prosthesis has a survivorship of 93% at 12 years *(17)*. Joint registry data regarding the performance of various implants also help in decision making *(10,11,12,13,14)*. The primary aim of our study was to compare the results of the four THR designs used in our health region at 15 years follow-up.

MATERIALS AND METHOD

All patients undergoing primary THR between January 1995 and December 1999 had been registered with our TAAG database. They had been prospectively assessed by independent audit specialist practitioners pre-operatively and at 1, 5 and 10 years post-operatively and thereafter every three to five years for functional and radiological outcome. 952 hips were identified from the database of which 917 THRs had been performed for osteoarthritis or rheumatoid arthritis and 35 THRs for other indications like developmental dysplasia of the hip, avascular necrosis, ankylosing spondylitis and fracture neck of femur. Considering the small numbers in each of these groups using each type of implant, only cases in which the indication had been osteoarthritis or rheumatoid arthritis were reviewed. 41 hips had been lost to follow-up or died due to non-orthopaedic causes. Complete 15 years functional and radiological follow- up data was available for 876 THRs in 837 patients,who were included in the study. 39 patients had bilateral THR. There were 387 cemented Charnley/Ogee THRs, 188 cemented CPT/ZCA THRs , 106 Bicontact/ Plasmacup uncemented THRs and 195 Exeter V40/Trident hybrid THRs. All the patients had cobalt/chrome head-on-polyethylene articulations.

352 (90.95%) of Charnley THRs had been performed by two Consultant surgeons and 35 (9.05%) by senior registrars under direct supervision. Similarly more than 90% of procedures in the other groups had been performed by four other Consultant Orthopaedic surgeons. The choice of implant was based on the availability of the implant and surgeon preference in the three hospitals in our health region.

Operative procedure

The anaesthesia used was combined sedation and epidural block in most cases. All Charnley THRs had been performed in a supine position with a wedge under the operating hip, and through the antero-lateral approach. A pelvic alignment gig had also been used to aid in the correct placement of the acetabular component. All the other implants had been performed using the posterior approach. Palacos® bone cement with gentamycin had been used using similar mixing and retrograde cementation techniques.

Data collected

Demographic, clinical and radiological follow up data were reviewed after Caldicott Guardian ethical approval. Harris hip score (HHS) had been used to measure the functional outcome. Follow-up radiographs were reviewed by an independent senior fellow with a specialist interest in arthroplasty for wear using the method of Griffith et al., aseptic loosening, lysis, radioluscent lines, stem subsidence and other complications *(6)*. We compared the Harris hip scores, radiological results and complication rates among the 4 groups.

Statistical analysis

Power analysis was performed based on an initial pilot study and the minimum number in each group required for statistical significance was 102. The effect size used for significance was 8 point change in the HHS. $p < 0.05$ was considered significant with a power of 80%, α error probability of 0.05 and a β error probability of 0.2. Significant differences in functional outcome were assessed by using the ANOVA test. Paired t-test was used to analyse improvement post- surgery. Chi squared test with Yates correction was used to analyse complication rates and revision. Kaplan Meier survivorship analysis was performed for each of the four groups.

RESULTS

The demographic details and pre-operative diagnosis of the 4 groups are shown in Table I. The pre-operative diagnosis was osteoarthritis (OA) in 738 hips (84.24%) patients. The mean period of follow up was 18.21 ± 2.11years in the Charnley/Ogee group, 18.42 ±2.14 years in the CPT/ZCA group, 17.04 ± 1.82 years in the Bicontact/Plasmacup group and 17.45 ± 0.96 years in the Exeter/Trident hybrid group.

The mean pre-operative and follow-up HHS in each group along with statistical significance is shown in Table II. There was a significant improvement in HHS post-operatively in all groups ($p < 0.001$) which was maintained until 15 years. Analysis of the HHS at each time period of follow-up did not show any significant statistical difference among the groups. On the basis of the HHS, the functional outcome was good to excellent at 15 years in 90.43% of Charnley/Ogee hips, 89.36% of CPT/ZCA hips, 88.67% of Bicontact/Plasmacup hips and 88.20% of Exeter/Trident hips.

The most common complication was dislocation, occurring in 35 hips (3.99%) followed by superficial infection in 33 hips (3.76%) hips. All the superficial infections settled down with antibiotics. The complications in each group and their statistical significance are enumerated in Table III and IV.

Table I – Demographic data and diagnosis

Parameter	Charnley	CPT/ZCA	Bicontact/Plasmacup	Exeter/Trident
Mean age	68.27±8.34	65.82±7.25	59.43±3.27	63.22±4.32
Gender	375	178	95	189
Male	228	115	54	121
Female	147	63	41	68
Age				
<60 years	127	49	65	62
>60 years	248	129	30	127
BMI				
<25	106	46	28	61
25-29.9	159	65	41	82
30-34.9	99	53	19	37
>35	11	14	7	9
Bilateral	12	10	11	6
Diagnosis				
Osteoarthritis	318(82.17%)	154(81.9%)	92(86.79%)	174(89.23%)
Rheumatoid	69(17.82%)	34(18.08%)	14(13.2%)	21(10.76%)
arthritis				

Table II. — Harris hip score (ANOVA)

Hip class	Pre-op Mean HHS	p-value	Year 1 Mean HHS	p-value	Year 5 Mean HHS	p- value	Year 10 Mean HHS	p-value	Year 15 Mean HHS	p-value
Charnley	48.35	0.514	92.95	0.384	91.97	0.474	89.75	0.327	88.95	0.285
CPT/ZCA	43.33		86.19		85.81		81.10		80.32	
Bicontact/Plasmacup	42.42		83.37		83.75		80.75		80.19	
Exeter/Trident	46.85		90.09		89.87		86.53		85.74	

Table III. — Complications

Complication	Charnley	CPT/ZCA	Bicontact/Plasmacup	Exeter/Trident
Dislocation	12 (3.10%)	12 (6.38%)	2 (1.89%)	8 (4.10%)
Superficial infection	12 (3.10%)	7 (3.72%)	2 (1.89%)	12 (1.15%)
Deep vein thrombosis	11 (2.84%)	7(3.72%)	3(2.83%)	7(3.58%)
Aseptic loosening	5 (1.29%)	4(2.12%)	2(1.89%)	2(1.02%)
Deep infection	1(0.25%)	1(0.53%)	2(1.89%)	1(0.51%)
Periprosthetic femoral fracture	2 (0.52%)	0(0%)	2(1.89%)	1(0.51%)

Table IV. — Statistical analysis of complications(Chi squared test -p value)

Hip class	Dislocation	Superficial infection	Deep vein thrombosis	Aseptic loosening	Deep infection	Femur Fracture
Charnley						
CPT/ZCA	0.076	0.695	0.569	0.448	0.601	0.323
Bicontact/Plasmacup	0.504	0.504	0.994	0.646	0.061	0.163
Exeter/Trident	0.531	0.080	0.623	0.780	0.620	0.994
CPT/ZCA						
Charnley	0.076	0.695	0.569	0.448	0.601	0.323
Bicontact/Plasmacup	0.082	0.380	0.684	0.888	0.267	0.058
Exeter/Trident	0.315	0.273	0.944	0.385	0.979	0.325
Bicontact/Plasmacup						
Charnley	0.744	0.504	0.994	0.646	0.061	0.163
CPT/ZCA	0.082	0.380	0.684	0.888	0.267	0.058
Exeter/Trident	0.305	0.093	0.725	0.533	0.251	0.251
Exeter/Trident						
Charnley	0.531	0.080	0.623	0.780	0.620	0.994
CPT/ZCA	0.315	0.273	0.944	0.385	0.979	0.325
Bicontact/ Plasmacup	0.305	0.093	0.725	0.533	0.251	0.251

The difference in complication rates between the different THR groups was not statistically significant.

Revision surgery was performed in 20 hips (2.28%). The number of revisions and components 'at risk' in each group is shown in Table V. With revision surgery for any reason as the end point, the survivorship of at 15 years in our series was 98.5% in the Charnley/Ogee group, 96.8% in the CPT/ZCA group, 96.6% in the Bicontact/Plasmacup group and 97.8% in the Exeter/Trident hybrid THR group. There was no statistically significant difference in survivorship between the different groups with revision for any reason as the end point. Based on the analysis of radiographs for signs of implant at risk, there was no statistically significant difference in the number of hips at risk of revision at 15 years. The Kaplan Meier survivorship curve is shown in Figure 1.

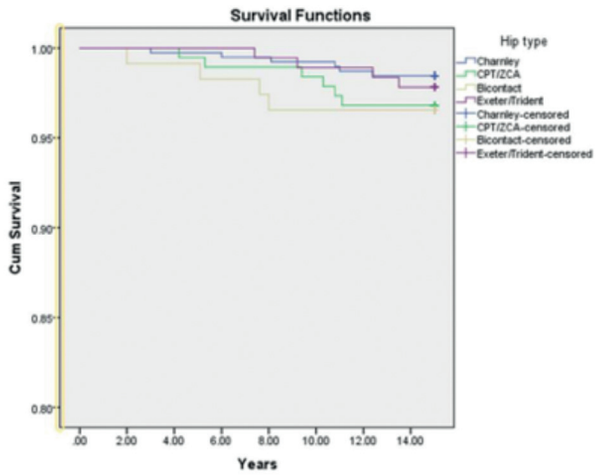

Fig. 1. — Kaplan-Meier Survivorship analysis at 15 years

DISCUSSION

The best design for a total hip replacement has been a topic of constant debate. The choice of THR implant can be influenced by patient, surgeon, industry and hospital related factors *(16)*. Although metaanalyses comparing cemented and uncemented implants have not shown any significant difference in functional outcome between the two methods of fixation *(1,7,8)*, most joint registries have a shown an increasing trend towards using uncemented implants *(10,11,12,13,14)*. The Swedish Joint Registry has shown that there was no significant difference in revision rates between hybrid and cemented implants. Cemented THRs have the longest period of follow-up with good results *(10,18)*. Uncemented implants were developed to avoid the osteolysis observed in cemented hip replacements. Constant improvements in design and cementing techniques have resulted in better long term results. However, there have been very few studies in literature comparing the long term results of different designs and implantation techniques *(5,8)*.

Survivorship data of implants from joint registries can help in decision making. Additionally, these registries show the volume of each type of implant used in a country and flag up early failures. The cumulative probability of revision at ten years in the National Joint Registry of England and Wales for Charnley/Ogee THR, CPT/ZCA and Exeter/Trident hybrids are 2.99,3.60 and 2.30 respectively. Orthopaedic data evaluation panel (ODEP) ratings provide data regarding the survivorship and quality of implants. All the implants used in our study were 10A rated, which is a survivorship of atleast 90% at 10 years. Similarly, published case series' can help in decision making. Wroblewski et al. noted 73% survivorship of Charnley low friction THR at 30 to 40 years. Ateschrang et al. had a survivorship of 95% at 22 years with the Bicontact/Plasmacup hip system. Swamy et al. had a 93.5% survivorship with the Bicontact/Plasmacup hip system at 12 years. Yates had a 95.9% survivorship of the CPT stem at 10 years but this reduced to 80.7% at 16 years. Additionally, these series' may show complications associated with the implants. There have been reports of increased risk of periprosthetic femoral fractures with the CPT stem *(2,15)*. In contrast, in our cohort we did not have any fractures with this implant. Although there were a number of peroperative femoral fractures with the uncemented stems, as seen in most series comparing cemented and uncemented implants, this did not show statistical significance in our study *(5,9)*.

The strength of our study is the prospective collection of data in the TAAG database. Additionally, we compared four different groups

of implants that are currently in clinical use with 15 years follow-up. Although the weakness of our study was that the patients were not prospectively randomised, every patient had an equal chance of attending one of the hospitals in our region and being operated by a team of surgeons that believed in different philosophies when deciding the implant. It could have potentially distributed all the confounding factors equally among the three hospitals.

To our knowledge there have been no prospective, pragmatic randomized control trial published in literature that has definitively established the best THR implant. At 15 years, we did not find any difference in functional and radiological outcome between proven cemented, uncemented and hybrid implants. Longer follow-up may, however, bring forth any differences among the groups. Based on our study, we feel that good long term functional outcomes may be achieved using any design philosophy with a good track record and ODEP rating as evidenced by National Joint Registry data. We also believe that similar outcomes were achieved by all the groups because each surgeon was trained well to use a particular implant, resulting in continuity, control of variation in operative technique and improvement with experience. Joint registries in different countries are collecting prospective data which in the future may shed further light and enable an evidence based choice of implant *(9,11,12,13)*.

CONCLUSION

In conclusion, good to excellent long term functional results can be achieved using any implant with a proven track record. Therefore, until we can conclusively prove the results of a design to be superior to others based on prospective pragmatic randomised controlled trials or worldwide joint registry data, the choice of implant would be based on individual patient templating, surgeon experience and review of trends in the registries.

REFERENCES

1. **Abdulkarim A, Ellanti P, Motterlini N, Fahey T, O'Byrne JM.** Cemented versus uncemented fixation in total hip replacement: a systematic review and meta-analysis of randomized controlled trials. *Orthop Rev* 2013 ; 5 : e8.
2. **Brodén C, Mukka S, Muren O** *et al.* High risk of early periprosthetic fractures after primary hip arthroplasty in elderly patients using a cemented, tapered, polished stem. *Acta Orthop.* 2015 ; 86 : 169-174.
3. **Burston BJ1, Barnett AJ, Amirfeyz R, Yates PJ, Bannister GC.** Clinical and radiological results of the collarless polished tapered stem at 15 years follow-up. *J Bone Joint Surg* (Br) 2012 ; 94 : 889-94.
4. **Callaghan JJ, Albright JC, Goetz DD, Oleiniczak JP, Johnston RC.** Charnley Total Hip Arthroplasty with Cement. *J Bone Joint Surg* (Am) 2000 ; 82 487-497.
5. **Chandran P, Azzabi M, Miles J, Andrews M, Bradley J.** Furlong Hydroxyapatite Coated Hip Prosthesis vs the Charnley Cemented Hip Prosthesis. **J Arthroplasty** 2010 ; 25 : 52-57.
6. **Griffith MJ, Seidenstein MK, Williams D, Charnley J.** Socket wear in Charnley low friction arthroplasty of the hip. *Clin Orthop* 1978 ; 137 : 37-47.
7. **Mäkelä KT, Eskelinen A, Pulkkinen P, Paavolainen P, Remes V.** Results of 3,668 primary total hip replacements for primary osteoarthritis in patients under the age of 55 years. *Acta Orthop* 2011 ; 82 : 521-529.
8. **Marston RA, Cobb A, Bentley G.** Stanmore compared with Charnley Total Hip Replacement. A prospective study of 413 arthroplasties. *J Bone Joint Surg* (Br) 1995 ; 78B : 178-184.
9. **Morshed S, Bozic KJ, Ries MD, Malchau H, Colford JM Jr.** Comparison of cemented and uncemented fixation in total hip replacement: a meta-analysis. *Acta Orthop* 2007 ; 78 : 315-326.
10. **Neumann L, Freund K, Sorenson KH.** Long-term results of Charnley Total Hip Replacement.Review of 92 patients at 15 to 20 years. *J Bone Joint Surg* (Br) 1994 ; 76B : 245- 251.
11. **No authors listed.NJR 12th Annual report.** http://www.njrcentre.org.uk. Accessed 9 January 2017.
12. **No authors listed.Swedish Hip Arthroplasty Register report** 2014. http://www.shpr.se. Accessed 9 January 2017.
13. **No authors listed.The New Zealand Joint Registry report** 2015. http://www.nzoa.org.nz/nz-joint- registry. Accessed 9 January 2017.
14. **No authors listed.The Norwegian Arthroplasty Register report** 2015. http://nrlweb.ihelse.net. Accessed 9 January 2017.
15. **Palan J, Smith MC, Gregg P** *et al.* The influence of cemented femoral stem choice on the incidence of revision for periprosthetic fractureafter primary total hip arthroplasty: an analysis of national joint registry data. *Bone Joint J* 2016 ; 98 : 1347-1354.

16. **Sharkey PF, Sethuraman V, Hozack WJ, Rothman RH, Stiehl JB.** Factors influencing choice of implants in total hip arthroplasty and total knee arthroplasty: perspectives of surgeons and patients. *J Arthroplasty* 1999 ; 14 : 281-7.
17. **Swamy G, Pace A, Quah C, Howard P.** The Bicontact/ Plasmacup cementless primary total hip arthroplasty: long-term results. *Int Orthop* 2012 ; 36 : 915-920.
18. **Wroblewski BM, Siney PD, Fleming PA.** Charnley low-frictional torque Arthroplasty. Follow-up for 30 to 40 years. *J Bone Joint Surg* (Br) 2009 ; 91B : 447-450.
19. **Yates PJ, Burston BJ, Whitley E, Bannister GC.** Collarless polished tapered stem: clinical and radiological results at a minimum of ten years' follow-up. *J Bone Joint Surg* (Br)2008 ; 90 : 16-22.