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Research Article

Outcomes after Dynamic Hip Screw or 3 Cannulated Hip Screws for the Fixation of Displaced and Undisplaced Intracapsular Neck of Femur Fractures. A Comparative Study with mean 18 month follow-up

Aun H Mirza[1*], Amr Eldessouky[2], Ahmed MFA Srour[3], Joanna Richards[4], Akshay Mehra[5].

1. Department of Trauma & Orthopaedic Surgery
Worcestershire Acute Hospitals NHS Trust, Charles Hastings Way, Worcester WR5 1DD.

***Correspondence to:** Aun H Mirza, Department of Trauma & Orthopaedic Surgery
Worcestershire Acute Hospitals NHS Trust, Charles Hastings Way, Worcester WR5 1DD.

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Abstract:

Background: *Intracapsular hip fractures may be managed by fixation or arthroplasty depending on patient age and fracture configuration. The implant of choice for fixation remains controversial and can depend on surgeon preference and experience. The aim of this study is to compare outcomes of two fixation methods - the Dynamic hip screw (DHS) and 3 parallel cannulated hip screws (CHS)- in treating intracapsular hip fractures.*

Methods: *We performed a retrospective analysis on intracapsular hip fractures treated surgically with either three cannulated hip screws (CHS) or 2-hole dynamic hip screw (DHS) between January 2013 and June 2019. A total of 230 patients were included. The mean follow up was 18 months. We compared these groups with respect to fracture displacement, radiological signs of union, AVN, metalwork failure, re- operation and infection rates.*

Results: *The study demonstrated no statistically significant difference in age, gender distribution, ASA score or fracture patterns between the groups. The rate of AVN in the CHS group was higher (13.5% vs 9.5% p= 0.39), while metal irritation was significantly higher in the CHS group (14.7% vs 2.7%, p= 0.006). We found higher reoperation rates in the group undergoing CHS (22.4% vs 18.9%, p= 0.49). Fracture configuration appears to demonstrate a much more significant effect on outcome, with a significantly higher incidence of reoperation (p<0001), AVN (p=0.009), non-union (p<0.0001) and metal cut-out (p=0.0012) in patients with displaced fractures irrespective of the implant used.*

Conclusions: *In the surgical management of intracapsular hip fractures, the use of CHS over DHS or vice versa can simply be a case of surgeon preference. Our study seems to imply a statistically insignificant difference, with the CHS group demonstrating a higher overall risk of requiring revision surgery. Fracture configuration appears to play a larger role than implant choice in the outcome of these patients.*

Keywords: *Hip Fracture Intracapsular Fixation Femur.*

Introduction

Treatment strategies for intracapsular femoral neck fractures can present the surgeon with management dilemmas.

The patient group sustaining these fractures increasingly commonly are the osteoporotic elderly after low energy injury, however there is also a small incidence of this injury in younger patients after high energy injuries.

Displaced fractures in the majority of elderly patients are best served by some form of arthroplasty, discussion of which is beyond the scope of this paper.

Undisplaced or valgus impacted pattern fractures (Garden type 1 or 2) are amenable to fixation, as are some displaced fractures in younger patients. Displaced fractures require reduction by open or closed techniques.

In specific patients or fracture configurations which may be amenable to fixation, both the dynamic hip screw (DHS), usually in 2-hole configuration in our institution, and multiple cannulated hip screws (CHS) offer viable options.

Whilst CHS are less invasive, and have been shown to demonstrate lower requirement for blood transfusion, the DHS requires a more invasive approach but may achieve a more stable construct allowing limited weight bearing.

Whilst there are numerous studies comparing these two fixation methods, none has conclusively demonstrated superiority of one technique over the other.

We postulated that the mode of failure for DHS was less predictable and more destructive to native bone than CHS.

Patients & Methods

Our institution employs contemporaneous data and radiographic collection of all surgical procedures undertaken, for the medical record. By examining these records we undertook a retrospective single centre non-randomised study, collecting data from January 2013 until June 2019 for all patients undergoing cannulated screw fixation using three screws or 2 hole DHS.

Exclusion criteria were as follows:

1. Non-intracapsular fractures.

2. Previous surgery or fracture to the affected hip.
3. Follow-up less than 6 months.
4. Non-adult patient.
5. Usage of any other implant with the DHS eg an additional screw.
6. More than or less than 3 cannulated screws.
7. Absent image intensifier films.
8. Incomplete records

All surgeries were performed on a fracture table, under image intensifier. Demographic data, surgical duration, and grade of primary surgeon were collected. As a measure of medical comorbidity, the American Society of Anaesthesiologist Score (ASA) as stated by the anaesthetist was recorded. Because patients attended for follow-up visits, we were also able to record any complication or revision surgery undertaken.

Imaging for each patient was reviewed to include the pre-operative injury films, the intra- operative screening images and the post-operative plain X-Rays at follow-up. Union was defined as obliteration of the fracture line seen on both AP and lateral views.

AVN was determined on the basis of clinical and radiographic data including MRI. Risk factors for AVN such as alcohol intake and smoking habit were recorded where available. The primary outcomes were recorded to include death, metalwork failure, cut-out, irritation, superficial or deep infection, non-union, or revision surgery.

Statistical analysis was performed using Analyse-it for Microsoft Excel (version 2.26 Analyse- it Software, Ltd. Leeds http://analyse-it.com/) and p-values of less than 0.05 were taken as significant. Kaplan-Meier Survival analysis was performed using GraphPad Prism version 5.01 for Windows, GraphPad Software, San Diego, California USA.

The surgical implants used were the Depuy Synthes 2-hole DHS and the Synthes Cannulated 6.5mm partially threaded cancellous screw system.

All patients underwent a standardised rehabilitation, under the supervision of physiotherapists, which entailed early mobilisation and weight-bearing as tolerated unless specifically stipulated in the surgical note.

Results

A total of 493 patient records were reviewed. After applying our exclusion criteria, there were a total of 230 patients remaining which were suitable to be included in the study.

There were 164 females (mean age 72 years) and 66 males (mean age 64.8 years).

The overall mean age was 69.9 years. The majority of patients suffered an undisplaced fracture equivalent to Garden Type 1 or 2 (61.7% n=141), with displaced fractures accounting for 38.3% (n=88). All patients underwent surgery within 48 hours of injury. 156 patients (67.8%) underwent cannulated screw fixation, and 74 patients underwent 2-hole DHS (32.2%). The two populations in this study were comparable and demonstrated no statistically significant difference in their age, gender distribution, or medical condition as assessed by ASA score. These measures indicate a good match between the cohorts.

Demographic data is shown in table 1 below.

Most of the procedures were undertaken by non-Consultant grade surgeons (n=166). There was a difference in mean duration of surgery between Consultant-undertaken-procedures and non-Consultant-undertaken procedures (mean 39.9 minutes vs 48.3 minutes). There did not appear to be any difference in reoperation rate between the two grades of surgeon (p=0.67).

	DHS n=74	**CHS n=156**
Mean Age (years)	71.4	69.2
Gender		
Male	21 **(28.4%)**	45 **(28.8%)**
Female	53 **(71.6%)**	111 **(71.2%)**
ASA score		
1	9 (12.2%)	26 (16.7%)
2	33 (44.6%)	78 (50.0%)
3	23 (31.1%)	46 (29.5%)
4	8 (10.8%)	5 (3.2%)
5	0	1
Fracture Displacement		
Undisplaced	47 (63.5%)	95 (60.9%)
Displaced	27 (36.5%)	61 (39.1%)
Duration of Surgery (mins)	48.4 (19 – 120)	44.8 (10 – 105)
Mean Duration of F/u (months)	18.7	20.5

Table 1 demographic data of the two groups

There were 52 deaths, and the overall mean age at death was 84 years (range 55 – 104). The DHS group demonstrated a higher mean age at death, however they also displayed a higher age at initial surgery. Whilst the CHS group demonstrated a mean age at surgery of 69.2 years and a mean age at death of 82.8 years, the DHS group had a mean age at surgery of 71.4 and a mean age at death of 87.3 years.

Kaplan-Meier survival analysis was performed using the end points of death and revision for all cause and are shown in figures 4 and 5. There was no significant difference found in the curves for either case.

Complications			
	DHS (n=74)	**CHS (n=156)**	***p* value**
AVN	7 **(9.5%)**	21 **(13.5%)**	*0.39*
Metal Cutout	11**(14.9%)**	20 **(12.8%)**	*0.67*
Metal Irritation	2 **(2.7%)**	23 **(14.7%)**	*0.006*
Non-union	6 **(8.1%)**	14 **(9%)**	*0.81*
Infection Superficial	1 **(1.4%)**	3 **(1.9%)**	
Infection Deep	1 **(1.4%)**	0	
Re-operation	14 **(18.9%)**	35 **(22.4%)**	*0.49*
Death	14 **(18.9%)**	38 **(24.4%)**	
Time from index to revision (months)	16.4	19.2	*0.58*
Type of Reoperation			
Arthroplasty	12 **(16.2%)**	22 **(14.1%)**	
Removal of metal	1 **(1.4%)**	13 **(8.3%)**	
Debridement	0	1	

Table 2 Complications within the groups.

As can be seen from table 2 above, implant choice did not appear to result in a significant difference in outcomes, however as would be expected, when we examine the effect of fracture configuration on outcome, this is clearly more influential. As seen in table 3, fracture displacement had a clear link with duration of surgery, risk of reoperation, and rates of AVN, non-union.

	Undisplaced (n=142)	Displaced (n=88)	
Duration (mins)	44.0	49.1	*p*=0.028
Re-operation	17 (11.9%)	32 (36%)	*p*<0.0001
AVN	11 (7.5%)	17 (19.3%)	*p*=0.0091
Non-union	3 (0.02%)	17 (19.3%)	*p*<0.0001
Metal Cut-out	11 (7.7%)	20 (22.7%)	*p*=0.0012

Table 3 Comparison of outcomes for fracture displacement

The overall mean time from surgical fixation to death for all patients was 40.25 months, however although there was a difference between the two groups, we did not find that this was statistically significant (DHS 34.8 months vs CHS 42.2 months, p=0.32).

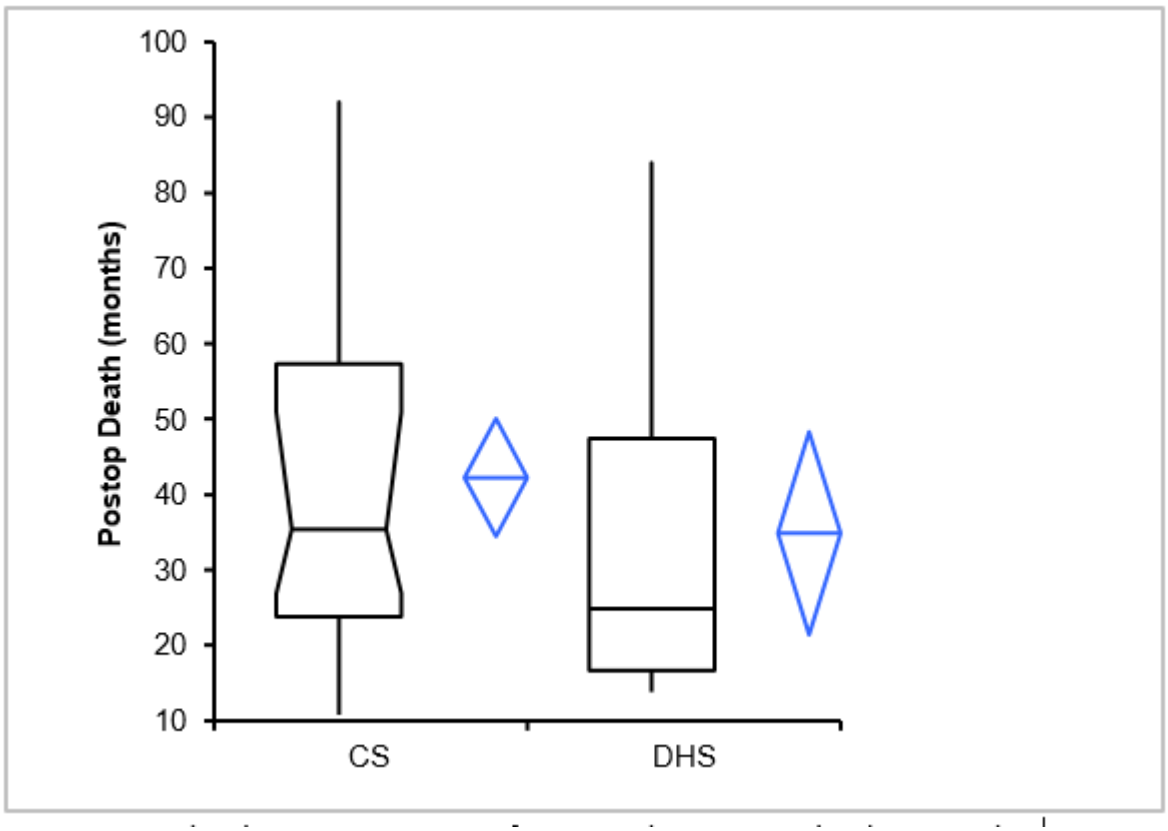


Figure 1 Boxplot demonstrating time from initial surgery to death in months

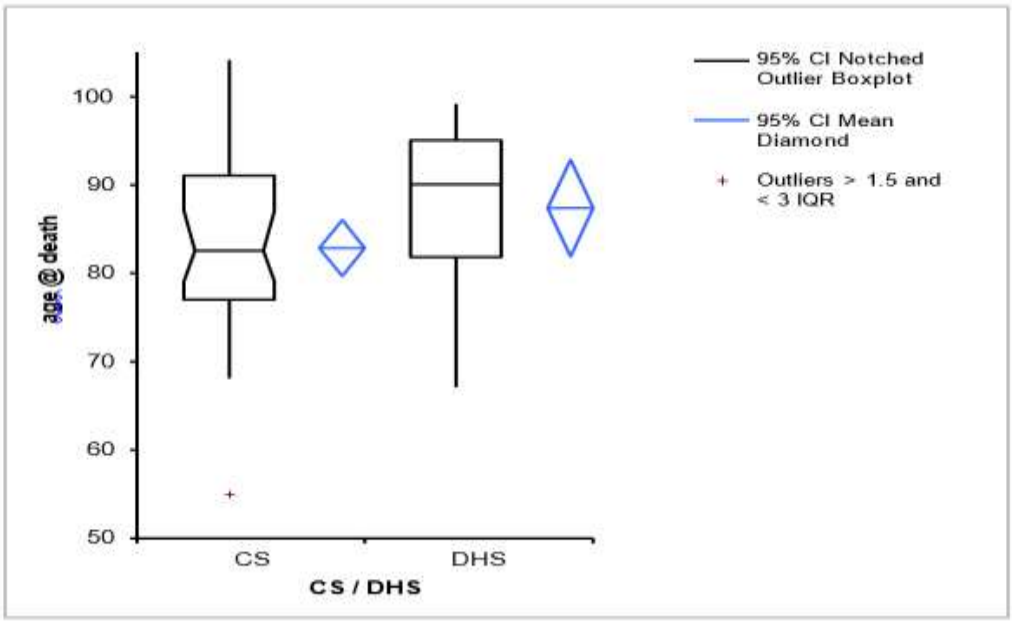


Figure 2 Boxplot demonstrating mean age at death

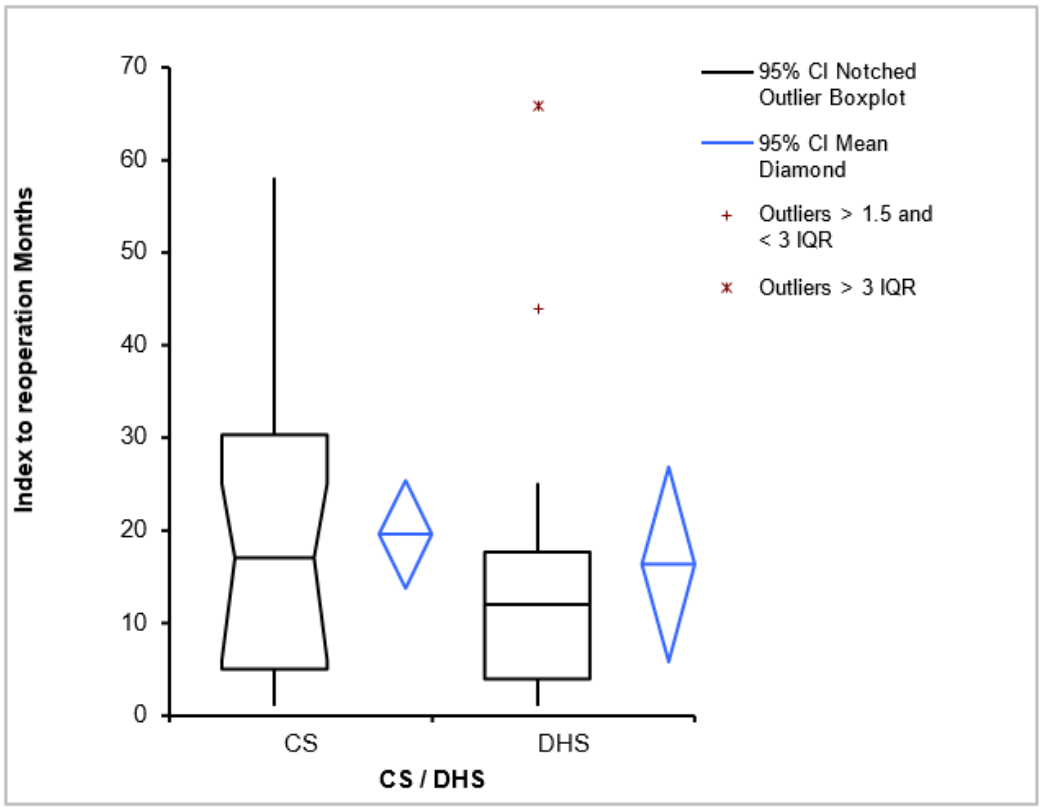


Figure 3 Boxplot demonstrating time from initial fixation to (any) revision surgery

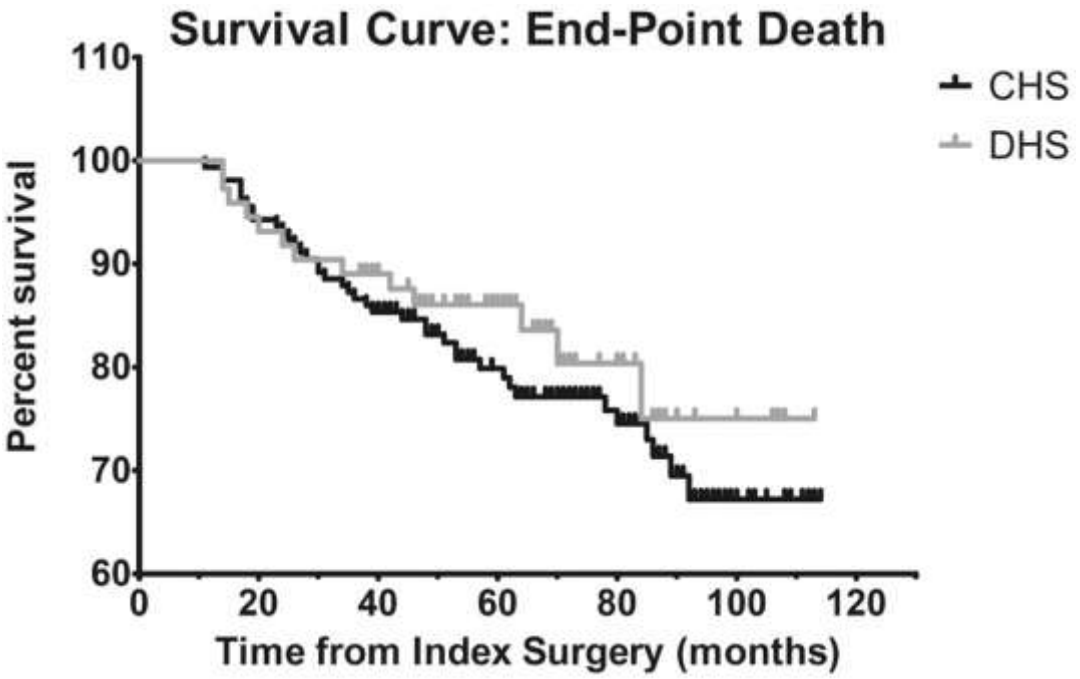


Figure 4: Kaplan-Meier Survival curve with death as end-point.

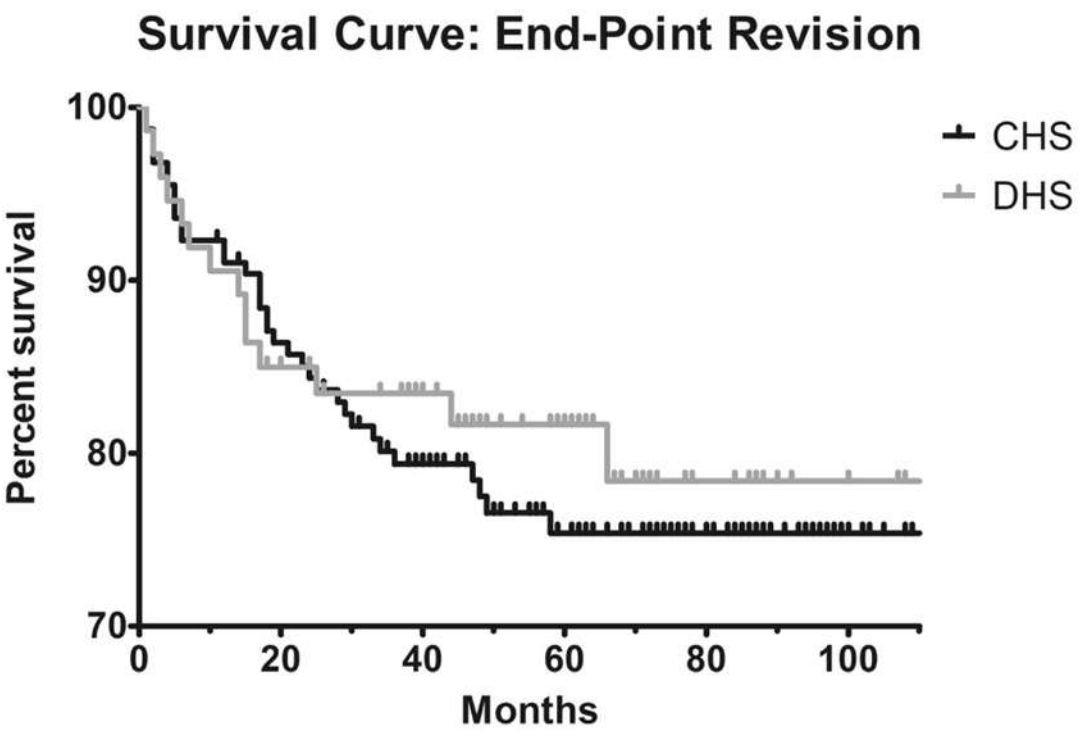


Figure 5: Kaplan-Meier Survival Curve with any revision as end-point.

We found 21 patients in whom a smoking history was positive at the time of surgery. Chi- squared analysis

found no statistically significant association between smoking and AVN or non-union (p values 0.14 and 0.07 respectively)

50 patients admitted to an alcohol intake of some quantity and there was a statistically significant association between alcohol intake and AVN incidence (p=0.02). There was no association found with infection for either smoking or alcohol.

Discussion

This study finds a higher overall reoperation rate in the group undergoing CHS than in the DHS group. Our study also demonstrates a higher incidence of AVN in the group undergoing CHS. Metal irritation, as defined by symptomatic and radiological evidence of joint penetration by metalwork, was also significantly higher in the CHS group. The rates of non- union and infection appear to be comparable for the two groups.

The duration of surgery for the DHS group was longer by a mean of 3.6 minutes.

The data clearly demonstrates that irrespective of implant choice, a poorer outcome is more likely in the fixation of displaced fractures with respect to reoperation, AVN and non-union rates. A re-operation rate of 36% was noted for those patients with a displaced fracture that underwent fixation.

Whilst Kaplan-Meier survival analysis did not demonstrate a statistically significant difference when comparing death or revision as end-points, there did appear to be a superior outcome in the DHS group at 36 months onwards.

From figures 4 and 5 it may be inferred that patients surviving over 24 months following fixation may be more likely to undergo revision surgery. These cases should not be classed as failures, rather as the culmination of treatment following the initial injury. We recognise that in some patients the initial trauma of sustaining a fracture requires minimisation of the “second hit” from surgery. In these patients, once they have returned to baseline function some years after fracture and fixation, performing elective arthroplasty surgery appears to be the best way to ameliorate their quality of life.

Our study is broadly consistent with the only published randomised controlled trial performed by Bhandari et al, published in 2017. Our findings of higher rates of AVN in the CHS group is in contrast to theirs however. Bhandari et al suggest that in patient groups such as smokers or those with displaced fractures, the DHS may be preferable.

In 2016 Jettoo et al retrospectively examined a database of 52,884 patients undergoing either DHS or multiple

cannulated screws for intracapsular neck of femur fractures. The patients were extracted from an NHS database for the whole of England. Notwithstanding the uncertainties associated with such a database, they found that the CHS patients had a shorter stay in hospital, lower rates of 30-day MI, lower 90-day mortality, and lower AVN rates. Findings of a higher revision rate for CHS as seen in other studies are also noted. The strength of this study was the size of the patient pool and numbers included, to answer a very focussed specific question.

Gurusamy et al performed a retrospective study of 395 patients in 2004 examining the effect of cannulated screw positioning and angulation on healing of displaced intracapsular fractures, finding that the most important factor for union being an adequate spread of screws in the lateral view. Whilst this was not a specific measurement recorded in our data, surgeons in our unit are encouraged to place three screws in an inverted 'T', parallel fashion, ending 5 to 10mm from the joint surface.

Bigoni et al published a retrospective study in 2019 examining the mortality and complication rates for intracapsular fractures fixed with CHS in 246 hips. They found a 4.5% revision rate to hemiarthroplasty and an overall complication rate of 8.9%. Unlike our study, they limited their patients to those with Garden I or II fractures, and some patients required CT for the diagnosis. They found an overall mortality rate of 50%, however it is noted that the ASA distribution in their study demonstrates a higher preponderance of ASA III and ASA IV patients than our study.

Widhalm et al published their retrospective series of 453 patients in 2019, comparing DHS and two CHS for undisplaced intracapsular femur fractures. They found the DHS to be associated with a 13 minute longer surgery and found a complication rate of 20.5% for DHS vs 13.1% for CHS. AVN rates of 9.4% in DHS patients and 5.0% in the CHS group was seen. Despite this they state in their conclusions that CHS was a more favourable fixation technique in socioeconomic terms, and that there was no significant difference in revision rate

Our study finds very similar AVN rates for DHS patients, however a much higher incidence of 13.5% is seen in our cohort of CHS, likely due to the fact that our patients included displaced fractures.

The difference between using 2 or 3 cannulated screws has not clearly been defined in the available literature, although a study performed by Xu et al in 2022 compared three versus four cannulated screws concluding no difference for undisplaced fractures but for displaced fractures four cannulated screws resulted in less neck shortening. They found no difference in AVN rates for either implant configuration.

A Cadaveric study performed by Maurer et al in 2004 examined the effect of loading 2 versus 3 cannulated

cancellous screws in artificially created fractures of the femur and found the three-screw construct to be more resistant to loading and gapping at the fracture site.

Studies such as those performed by Londhe et al in 2018 comparing a “three CHS construct” to “DHS plus an additional derotation screw” may find benefits of such “DHS plus” constructs. Although this method defeats the principle of sliding fixation upon which the DHS is based it may reduce the occurrence of neck shortening seen post-operatively. This is an area for further study.

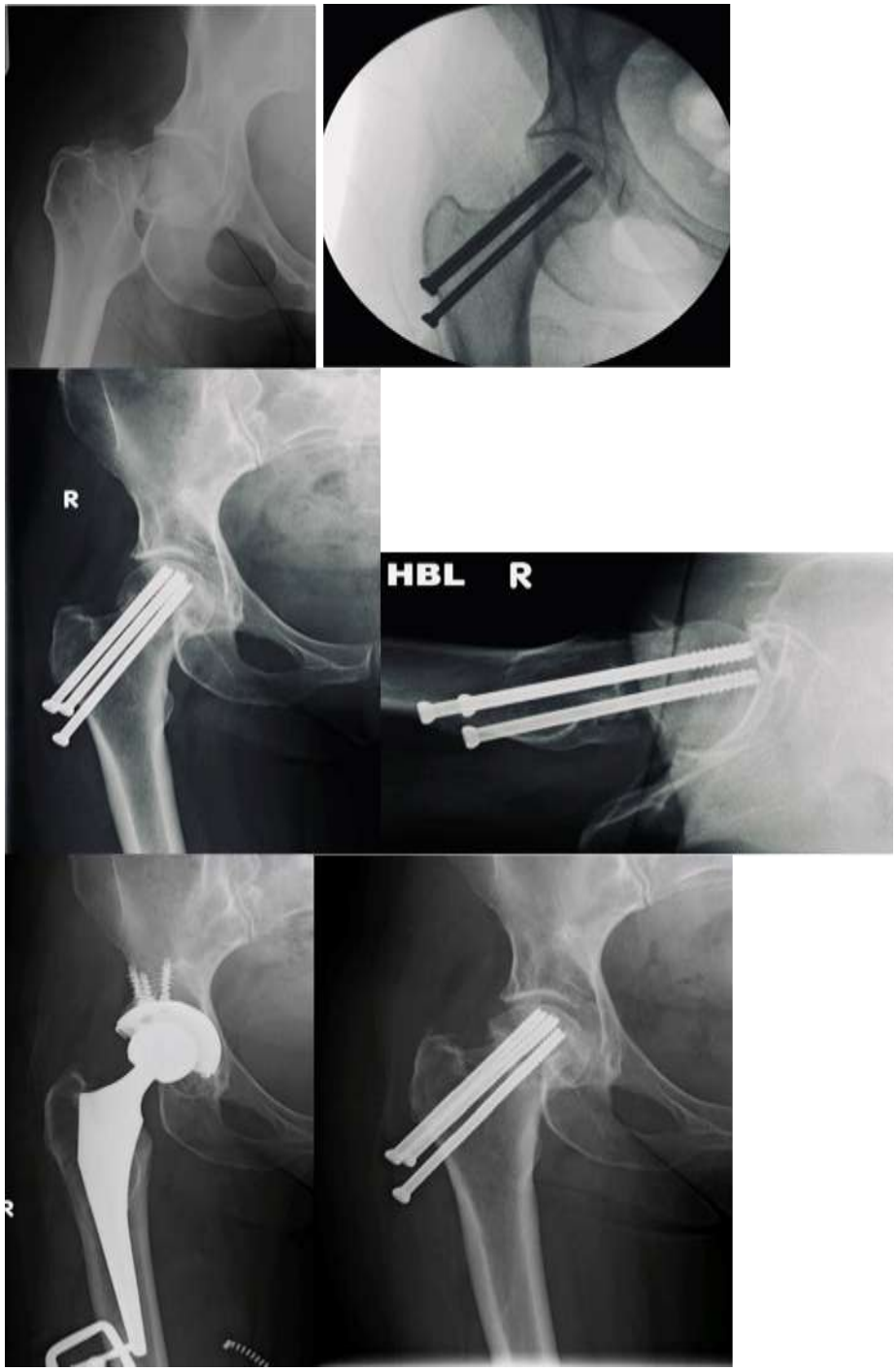
Conclusions

In the surgical management of intracapsular neck of femur fractures, the use of CHS over DHS or vice versa can simply be a case of surgeon preference. Our study seems to imply a statistically insignificant difference, with the CHS group demonstrating a higher overall risk of requiring revision surgery.

Fracture configuration has a significant effect on re-operation, AVN rates, metal cut-out and non-union rather than implant choice. Surgeons considering fixation of displaced fractures must consider management options carefully on a case-by-case basis, and employ all means to maximise chances for a successful outcome in this challenging group.

These findings are consistent with other published series.

Figures 6 a,b,c,d (clockwise from top left). This 79 year-old female patient presented with an impacted fracture of the left neck of femur. She suffered from polio in the left leg previously and had undergone a cemented THR on the right side approximately 35 years earlier. Figure 6a demonstrates initial post-surgery film. Figure 6b clearly demonstrates an area of AVN developing in the femoral head at review 25 months postop. Figure 6c at 53 months post-surgery demonstrates collapse and destruction of the femoral head. THR performed 66 months post injury. Figure 6d post dual-mobility THR radiograph.



Figures 7 a,b,c,d,e,f (clockwise from top left). This 55 year-old female patient sustained a displaced fracture of her right neck of femur for which she underwent satisfactory closed reduction and CHS (figures 7a, 7b).

Although the fracture united (figures 7c, 7d), she was left with significant symptoms from neck shortening and prominent metalwork (figure 7e, 12 months post-surgery). She underwent uncemented THR 18 months post injury (figure 7f).

Figure 8 a,b,c,d,e,f (clockwise from top left). This 67 year-old female patient underwent DHS for a displaced intracapsular fracture (figures 7a, 7b). Despite a valgus reduction and slight persistent displacement, the fracture went to union however as seen in radiographs in figures 7c (12 months post) and 7d (18 months) this was at the expense of significant neck shortening. She underwent cemented THR at 49 months post fracture.

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