

Femoral Head Core Decompression and Bone Marrow Concentrate Injection in Pediatric Sickle Cell-Related Avascular Necrosis

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INTRODUCTION:

Femoral head avascular necrosis (AVN) affects 10-40% of patients with sickle cell disease (SCD), resulting in early degeneration and decreased quality of life. The purpose of this study was to evaluate the results of femoral head core decompression and bone marrow aspirate concentrate (CD-BMAC) injection in the treatment of AVN in pediatric patients with sickle cell disease.

METHODS:

This study was a retrospective review of a prospective cohort at a tertiary referral center, pediatric patients who underwent femoral head CD-BMAC from 2010 to 2020 were identified. Patients with SCD who had longer than 1 year of follow up were selected. Hip were staged based on the Ficat system preoperatively and at final follow up by two raters. Visual analog score for pain (VAS), hip outcome score (HOS), modified Harris hip score (mHHS), and the UCLA activity score were used as patient-reported outcome measures (PROM) preoperatively, at 5-9 months postoperatively, and final follow up. Treatment failure was defined as total hip arthroplasty (THA) or VAS score >3 at final follow up. Univariate and multivariate statistical analysis was performed to determine the risk factors for treatment failure. The study was approved by the institutional review board and written informed consent was obtained from parents and children before enrolment in this study.

RESULTS:

The final sample included 23 hips in 17 patients (13 male, 4 female), with a median age at the time of surgery of 15.8 (IQR 13.1 – 17.8). Patients were followed for 4.25 ± 1.73 years. Radiographically, 10 hips showed a 1-stage increase in the Ficat stage at the final follow up, while 11 retained the same stage, and one patient had a 1-stage regression. Preoperatively, thirteen hips were classified as pre-collapse, which decreased to 11 at the final follow up. All PROMs showed significant improvement from the preoperative visit to short-term follow up, but the preop to final follow-up improvement was not significant (Table 1).

Overall, 6 treatment failures were recorded, including 3 THAs and 3 painful hips at the final follow up. In a logistic regression model including age, gender, preoperative collapse status, skeletal maturity at the time of surgery, and treatment with Hydroxyurea at the time of surgery, only skeletal maturity (OR=16.2, 95%CI: 1.44 – 183.0, P=0.024) and femoral head collapse at the time of surgery (OR=12.0, 95%CI: 1.1 – 130.5, P=0.041) were significant predictors of treatment failure (Figure 1-3).

DISCUSSION AND CONCLUSION:

Our findings suggest that CD-BMAC injection in the treatment of femoral head AVN in patients with SCD offers significant improvement in pain and functional outcomes in the short-term, although the improvements tend to diminish over the long-term. We also found that preoperative skeletal maturity and femoral head collapse (Ficat >2) were significant predictors of treatment failure. While further research is needed to determine whether CD-BMAC alters the natural history of femoral head AVN, this study suggests that CD-BMAC injection has a role in the treatment of SCD-related AVN, and younger patients with earlier stages of hip disease will benefit the most from this treatment.



Figure 1. 11-year-old patient with right hip pain, evidence of multifocal AVN and subchondral collapse on x-rays and MRI (A-E). Intra-operative dye injection following core decompression shows the extent of the pathology (D). Patient is asymptomatic 2 years postoperatively, and x-rays show a relatively maintained femoral head sphericity (E).

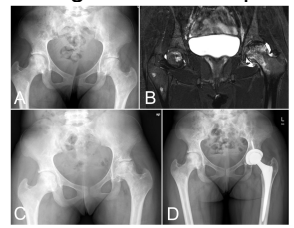


Figure 3. 10-year-old female with bilateral hip pain, and evidence of femoral head avascular necrosis (AVN) and collapse on x-ray and MRI (A-B). One year after a CD-BMAC procedure, patient was asymptomatic (C), and underwent total hip arthroplasty which provided pain relief (D).

PROM	Pre-operative (I)	Short-term post-op (II)	Final post-op (III)	P value I vs II	P value I vs III
HOS-ADL	64.0 ± 19.2	88.2 ± 12.6	70.6 ± 21.6	<0.001	0.32
HOS-Sports	46.8 ± 14.0	85.1 ± 22.9	61.1 ± 25.5	<0.001	0.06
mHHS	61.1 ± 22.0	87.9 ± 20.3	72.5 ± 17.4	<0.001	0.10
UCLA activity	5.5 (IQR 3 – 5.5)	7.5 (IQR 3.75 – 7.5)	8 (IQR 2.75 – 7)	0.000 (p=0.4)	0.82 (p=0.22)
VAS pain	4 (IQR 2.75 – 5.0)	0.5 (IQR 0 – 0.5)	3 (IQR 1.5 – 3)	0.000 (p=0.4)	0.78 (p=0.54)

Table 1. Changes in patient-reported outcome measures (PROMs) from the pre-operative visit (I) to the short-term post-operative (II, 5-9 months post-operative) and the final follow-up (III). Data are presented as mean (SD) or median (IQR). Paired sample t-tests were used for continuous variables (HOS, mHHS), and Wilcoxon signed-rank test for UCLA and VAS. Significant comparisons are indicated in bold. HOS-ADL: Hip outcome score-activities of daily living, mHHS: modified Harris hip score, UCLA activity: University of California Los Angeles activity score, VAS: visual analog scale.

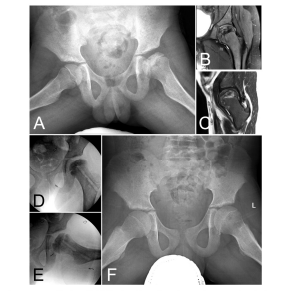


Figure 2. 5-year-old patient with left hip pain, evidence of avascular necrosis on x-ray and MRI (A-C). Intra-operative core decompression and dye injection reveals the extent of AVN (D). Patient is asymptomatic and x-rays show remodeling of the collapse 3 years after surgery (E).