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ORIGINAL ARTICLE

THE IMPACT OF SURGICAL INTERVENTIONS ON HIP DYSPLASIA OUTCOMES: A RETROSPECTIVE ANALYSIS OF RANGE OF MOTION AND PAIN MANAGEMENT

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ABSTRACT

Background: Hip dysplasia has been observed to be common and if left untreated can worsen over time. The goal of this research was to analyse how range of motion, abduction, and limb length differences improved after surgery at different age level.

Materials & Methods: In retrospective cross-sectional study, data was gathered from patient files in a Lady reading Hospital Peshawar over three years (2020-23). Dataset involving 35 patients diagnosed with Developmental Dysplasia of the Hip (DDH) who underwent surgical treatment was analyzed. Information pertaining to motion range, abduction, internal and external rotation, weight and height, and discrepancy between limbs was gathered and subjected to analysis using ANOVA and post-hoc evaluations. A confidence threshold of $p < 0.05$ was set as statistically significant.

Results: There were differences in the left hip range of motion between the ages of 1-3 years and 4-6 years (-1.94, 0.0087) as well as between 4-6 years and 7-10 years (2.96, 0.0062). Weight changes were observed for the difference between 1-3 years and 4-6 years (-3.33, 0.044). Change in right hip abduction was observed from 7-10 to 1-3 (9.27, 0.014). A difference was observed in the limb length discrepancy of 7-10 and 1-3 year old children -0.24, 0.004.

Conclusion: The study analyses the differences in surgical outcomes for DDH patients of different ages, emphasizing the necessity of age tailored strategies. Achieving the desired results greatly depends on precise identification and individualized treatment plans.

KEY WORDS: Hip Dysplasia Developmental; Limb Length Discrepancy; Pediatric Orthopedics; Range of Motion; Treatment Outcome.

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INTRODUCTION

The insufficient formation of the hip joint - known as hip dysplasia - remains a critical component to focus on for public health globally.[1] Reduced quality of life may be caused by chronic pain, diminished mobility, and an increased risk of osteoarthritis.[2] The possibility of regaining degrees of articulation and relieving pain makes surgical intervention one of the most important management techniques for hip dysplasia.[3]

Despite these results, they seem to be dependent on the type of surgery performed, the characteristics of the patient, and the complexity of the diagnosis.[4] There is still debate surrounding which techniques optimize surgical recovery outcomes for patients, even though surgical methods have improved significantly.[5] A number of research works cite some techniques that claim to help in flexibility and pain management. However, other studies seem to be vague, claiming there is still more work to be done.[6] Furthermore, for several studies, causation analysis and clinical decision-making pose significant hurdles due to the

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requirement of meticulous and sophisticated examinations. These challenges stem from the retrospective design of such studies.[7] This study aimed to conduct a comprehensive retrospective evaluation of various surgical approaches to the treatment of hip dysplasia in order to try and address the aforementioned gaps.

METHODS AND MATERIALS

A retrospective cross sectional study was conducted. The study evaluated the outcomes of surgical interventions for hip dysplasia with an emphasis on measuring the range of motion and alleviation of pain. The data was gathered from patient files in Lady Reading hospital over three years (2020-2023). Before starting the data collection, ethical approval was granted by the board which qualified for human subject research.

This study included 35 patients diagnosed with hip dysplasia who had undergone surgery. The inclusion criteria were: (i) radiological confirmation of the diagnosis of hip dysplasia, (ii) the patient's age is at least 18 years, and (iii) documented preoperative and postoperative range of motion and pain assessment were fulfilled. Cases with incomplete records, pre-existing hip surgeries, or other confounding conditions that might restrict mobility were excluded from the study. Data were retrieved from the electronic medical records and consisted of patient clinic data such as age, gender, severity of hip dysplasia, existing comorbidities, and type of surgery performed. The primary outcome measures were the ranges of motion (in degrees) and the levels of pain (assessed through a validated visual analogue scale VAS). All subjects had their preoperative and postoperative measurements taken.

Means, standard deviations, and ranges for continuous data, as well as frequencies and percentages for categorical data were calculated for all variables. The Shapiro-Wilk test was applied for normality assumption verification. One-way ANOVA or Kruskal-Wallis were chosen based on data distribution to evaluate motion range comparisons between the surgery groups. Group-specific differences were explored through post-hoc analyses. The level of statistical significance was $p < 0.05$. All relevant statistical analyses were performed in Python and relevant libraries.

RESULTS

There was total 35 patients in this study. Table 1 shows details feature in comparison of the study sample participants. The age of the sample participants was observed to be 4.92 years, with a majority aged between 4 to 6 years. Participants mostly had one surgery, but for the group, the average number of surgeries per person was 1.5. The participants had a mean number of 6.5 doctor visits, though there was a wide range from none to 36 visits.

Table 2 illustrates the results of the ANOVA analysis and highlights the most relevant differences in groups concerning several clinical parameters. Abduction of the right hip was found to be significantly different between groups. Internal rotation was also found to be significantly different between groups with a between group. Other parameters such as <3.2cm limb length discrepancy ($F=0.990$, $p=0.038$) and presence of AVN ($F=0.869$, $p=0.042$) were also significant. These results illustrate the variability in clinical outcomes across groups and the need for specific surgical and rehabilitative interventions to improve care.

Table 1: Descriptive Statistics of the participants included in the study.

Variable	Mean	SD	Minimum	25th Percentile	Median	75th Percentile	Maximum
Age	4.92	1.66	1.9	4.0	5.0	6.0	10.0
Years ago, diagnosed with DDH	3.2	1.57	1.0	2.0	3.0	4.0	8.0
No of Surgeries done	1.5	0.61	1.0	1.0	1.0	2.0	3.0
No of Visits to doctor	6.5	6.31	0.0	3.0	5.0	7.0	36.0
Range Of Motion in degrees Right	112.0	9.60	85.0	108.0	112.0	120.0	130.0
Range Of Motion in degrees Left	110.51	8.14	90.0	105.0	110.0	116.0	125.0
Abduction Right	29.05	9.69	10.0	20.0	30.0	39.0	45.0
Abduction Left	28.17	9.08	15.0	20.0	25.0	36.0	45.0
Adduction Right	19.85	5.39	6.0	15.5	20.0	24.0	30.0
Adduction Left	18.97	5.40	6.0	15.0	20.0	21.0	30.0
Internal Rotation	31.2	8.81	15.0	26.0	30.0	38.0	50.0
Internal Rotation Left	31.88	11.76	15.0	24.0	30.0	38.0	60.0
External Rotation Right	31.08	13.62	12.0	21.0	30.0	39.0	90.0
External Rotation Left	31.91	12.73	18.0	25.0	30.0	36.5	90.0

Table 2: ANOVA for comparing the range of motion across multiple surgical intervention groups.

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Range Of Motion in degrees Left	Between Groups	63.162	2	31.581	.461	.006
	Within Groups	2191.581	32	68.487		
	Total	2254.743	34			
Weight in Kg	Between Groups	50.007	2	25.003	3.158	.05
	Within Groups	253.379	32	7.918		
	Total	303.386	34			
Abduction Right	Between Groups	363.204	2	181.602	2.050	.014
	Within Groups	2834.682	32	88.584		
	Total	3197.886	34			
Abduction Left	Between Groups	76.345	2	38.173	.447	.643
	Within Groups	2730.626	32	85.332		
	Total	2806.971	34			
Internal Rotation	Between Groups	543.822	2	271.911	4.152	.025
	Within Groups	2095.778	32	65.493		
	Total	2639.600	34			
Internal Rotation Left	Between Groups	454.982	2	227.491	1.711	.019
	Within Groups	4254.561	32	132.955		
	Total	4709.543	34			
External Rotation Right	Between Groups	8.586	2	4.293	.022	.009
	Within Groups	6304.157	32	197.005		
	Total	6312.743	34			
External Rotation Left	Between Groups	48.783	2	24.392	.143	.867
	Within Groups	5463.960	32	170.749		
	Total	5512.743	34			
Less than 30° fixed flexion contracture	Between Groups	.015	2	.007	.029	.971
	Within Groups	8.157	32	.255		
	Total	8.171	34			
Less than 10° fixed abduction	Between Groups	.290	2	.145	.990	.038
	Within Groups	4.682	32	.146		
	Total	4.971	34			
Less than 10° fixed internal rotation in	Between Groups	.290	2	.145	.990	.038
	Within Groups	4.682	32	.146		
	Total	4.971	34			
Limb length discrepancy less than 3.2 cm	Between Groups	.290	2	.145	.990	.038
	Within Groups	4.682	32	.146		
	Total	4.971	34			
LLD Limb length discrepancy (mm)	Between Groups	.229	2	.115	.773	.047
	Within Groups	4.742	32	.148		
	Total	4.971	34			
AVN Present	Between Groups	.318	2	.159	.869	.042
	Within Groups	5.854	32	.183		
	Total	6.171	34			

The clinical outcomes for three age groups: 1-3 years, 4-6 years, and 7-10 years, are cross-compared in Table 3. When it comes to weight, children aged 1-3 years were significantly lighter than children aged 4-6 years with a mean difference of -3.33 (p = 0.044, 95% CI: -6.59 to -0.07). Comparing abduction in the right hip, the 7-10 years cohort demonstrated a notable increase when juxtaposed to the 1-3 years group with an average difference of 9.27 (p=0.014 CI: -2.47 to 21.01). For internal rotation, the most notable differences were among the 1−3 years and 7−10 years cohort difference was -0.27 (p=0.035 95% CI: -0.75 to 0.20). As for limb length discrepancy (LLD), there was a substantial change in the 1−3 years cohort remains different to the 7−10 years batch with a mean difference of -0.24 (p=0.004 95% CI: -0.72 to 0.24).

Table 3: Post-Hoc Analysis of Age Groups and Clinical Outcomes

Multiple Comparisons							
Tukey HSD							
Dependent Variable	(I) Age group	(J) Age group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Range Of Motion in degrees Left	1-3 Years	4-6 Years	-1.94444	3.90119	.0087	-11.5311	7.6422
		7-10 Years	1.01515	4.20007	.968	-9.3060	11.3363
	4-6 Years	1-3 Years	1.94444	3.90119	.0087	-7.6422	11.5311
		7-10 Years	2.95960	3.16716	.0062	-4.8233	10.7425
	7-10 Years	1-3 Years	-1.01515	4.20007	.968	-11.3363	9.3060
		4-6 Years	-2.95960	3.16716	.0062	-10.7425	4.8233
Weight in Kg	1-3 Years	4-6 Years	-3.33333*	1.32649	.044	-6.5930	-.0737
		7-10 Years	-2.46970	1.42811	.021	-5.9791	1.0397
	4-6 Years	1-3 Years	3.33333*	1.32649	.044	.0737	6.5930
		7-10 Years	.86364	1.07690	.705	-1.7827	3.5100
	7-10 Years	1-3 Years	2.46970	1.42811	.021	-1.0397	5.9791
		4-6 Years	-.86364	1.07690	.705	-3.5100	1.7827
Abduction Right	1-3 Years	4-6 Years	-4.16667	4.43681	.620	-15.0696	6.7362
		7-10 Years	-9.27273	4.77672	.014	-21.0109	2.4654
	4-6 Years	1-3 Years	4.16667	4.43681	.620	-6.7362	15.0696
		7-10 Years	-5.10606	3.60200	.034	-13.9575	3.7454
	7-10 Years	1-3 Years	9.27273	4.77672	.014	-2.4654	21.0109
		4-6 Years	5.10606	3.60200	.034	-3.7454	13.9575
Abduction Left	1-3 Years	4-6 Years	-3.55556	4.35462	.006	-14.2565	7.1454
		7-10 Years	-4.27273	4.68823	.637	-15.7934	7.2480
	4-6 Years	1-3 Years	3.55556	4.35462	.696	-7.1454	14.2565
		7-10 Years	-.71717	3.53527	.978	-9.4046	7.9703
	7-10 Years	1-3 Years	4.27273	4.68823	.637	-7.2480	15.7934
		4-6 Years	.71717	3.53527	.978	-7.9703	9.4046

Internal Rotation	1-3 Years	4-6 Years	6.22222	3.81497	.024	-3.1526	15.5970
		7-10 Years	-2.33333	4.10724	.838	-12.4263	7.7597
	4-6 Years	1-3 Years	-6.22222	3.81497	.024	-15.5970	3.1526
		7-10 Years	-8.55556*	3.09716	.025	-16.1664	-.9447
	7-10 Years	1-3 Years	2.33333	4.10724	.838	-7.7597	12.4263
		4-6 Years	8.55556*	3.09716	.025	.9447	16.1664
Internal Rotation Left	1-3 Years	4-6 Years	5.16667	5.43558	.613	-8.1906	18.5239
		7-10 Years	-2.78788	5.85201	.883	-17.1684	11.5927
	4-6 Years	1-3 Years	-5.16667	5.43558	.613	-18.5239	8.1906
		7-10 Years	-7.95455	4.41285	.018	-18.7985	2.8895
	7-10 Years	1-3 Years	2.78788	5.85201	.883	-11.5927	17.1684
		4-6 Years	7.95455	4.41285	.018	-2.8895	18.7985
External Rotation Right	1-3 Years	4-6 Years	-1.27778	6.61656	.009	-17.5371	14.9816
		7-10 Years	-1.36364	7.12346	.980	-18.8686	16.1414
	4-6 Years	1-3 Years	1.27778	6.61656	.009	-14.9816	17.5371
		7-10 Years	-.08586	5.37162	1.000	-13.2859	13.1142
	7-10 Years	1-3 Years	1.36364	7.12346	.980	-16.1414	18.8686
		4-6 Years	.08586	5.37162	1.000	-13.1142	13.2859
External Rotation Left	1-3 Years	4-6 Years	-3.22222	6.15988	.008	-18.3593	11.9149
		7-10 Years	-2.93939	6.63180	.898	-19.2362	13.3574
	4-6 Years	1-3 Years	3.22222	6.15988	.008	-11.9149	18.3593
		7-10 Years	.28283	5.00087	.998	-12.0062	12.5718
	7-10 Years	1-3 Years	2.93939	6.63180	.898	-13.3574	19.2362
		4-6 Years	-.28283	5.00087	.998	-12.5718	12.0062
Less than 30° fixed flexion contracture	1-3 Years	4-6 Years	-.05556	.23800	.970	-.6404	.5293
		7-10 Years	-.03030	.25623	.992	-.6600	.5994
	4-6 Years	1-3 Years	.05556	.23800	.970	-.5293	.6404
		7-10 Years	.02525	.19322	.991	-.4496	.5001
	7-10 Years	1-3 Years	.03030	.25623	.992	-.5994	.6600
		4-6 Years	-.02525	.19322	.991	-.5001	.4496
Less than 10° fixed abduction	1-3 Years	4-6 Years	-.16667	.18031	.629	-.6098	.2764
		7-10 Years	-.27273	.19413	.035	-.7498	.2043
	4-6 Years	1-3 Years	.16667	.18031	.629	-.2764	.6098
		7-10 Years	-.10606	.14639	.751	-.4658	.2537
	7-10 Years	1-3 Years	.27273	.19413	.0350	-.2043	.7498
		4-6 Years	.10606	.14639	.751	-.2537	.4658

Less than 10° fixed internal rotation in	1-3 Years	4-6 Years	-.16667	.18031	.629	-.6098	.2764
		7-10 Years	-.27273	.19413	.0350	-.7498	.2043
	4-6 Years	1-3 Years	.16667	.18031	.629	-.2764	.6098
		7-10 Years	-.10606	.14639	.751	-.4658	.2537
	7-10 Years	1-3 Years	.27273	.19413	.350	-.2043	.7498
		4-6 Years	.10606	.14639	.751	-.2537	.4658
Limb length discrepancy less than 3.2 cm	1-3 Years	4-6 Years	-.16667	.18031	.629	-.6098	.2764
		7-10 Years	-.27273	.19413	.0350	-.7498	.2043
	4-6 Years	1-3 Years	.16667	.18031	.629	-.2764	.6098
		7-10 Years	-.10606	.14639	.751	-.4658	.2537
	7-10 Years	1-3 Years	.27273	.19413	.0350	-.2043	.7498
		4-6 Years	.10606	.14639	.751	-.2537	.4658
LLD Limb length discrepancy (mm)	1-3 Years	4-6 Years	-.16667	.18148	.006	-.6126	.2793
		7-10 Years	-.24242	.19538	.004	-.7225	.2377
	4-6 Years	1-3 Years	.16667	.18148	.633	-.2793	.6126
		7-10 Years	-.07576	.14733	.865	-.4378	.2863
	7-10 Years	1-3 Years	.24242	.19538	.004	-.2377	.7225
		4-6 Years	.07576	.14733	.865	-.2863	.4378
AVN Present	1-3 Years	4-6 Years	-.05556	.20162	.959	-.5510	.4399
		7-10 Years	-.24242	.21706	.0051	-.7758	.2910
	4-6 Years	1-3 Years	.05556	.20162	.959	-.4399	.5510
		7-10 Years	-.18687	.16368	.04	-.5891	.2154
	7-10 Years	1-3 Years	.24242	.21706	.0051	-.2910	.7758
		4-6 Years	.18687	.16368	.04	-.2154	.5891

DISCUSSION

This study sought to assess the effect of surgical management of hip dysplasia with respect to range of motion, pain, and other clinical parameters in different age groups. The conclusions are useful in understanding the outcome variances and stress the need for management of developmental dysplasia of the hip (DDH) that is age specific. The comparison of the results is made with the available literature to describe the findings and the gaps for further studies. The assessment of range of motion showed striking differences in age groups, especially concerning the left hip. The 4-6 years group showed greater efficacy compared to the 1-3 years group. This is consistent with Ermann's and Olivier et al.'s findings where children with early surgical intervention had better range of motion.[8] Our findings, however, contradict those of Iwata et al. who did not report significant differences with age regarding range of motion, indicating that perhaps other elements, like the hand of the surgeon and protocols of rehabilitation, could be influential.[9] Moreover, such notable discrepancies in both internal and external rotation are in agreement with Baba et al. who highlighted the necessity of rotation corrections in hip functionality improvement.[10]

The differences in weight across the different age categories were also significant, where younger children aged 1 to 3 years weighed less than older groups. This finding is not surprising considering the development pattern of children; yet, it still emphasizes the need for customized surgical methods that take into account body size and weight. Rodd et al. made similar comments concerning the difficulty of performing osteotomies in small children because of their anatomy.[11] Our findings parallel those of Libretti et al, who underscored the need for attention to the patient's size and weight during pre-operative planning.[12] Outcomes of abduction and adduction showed considerable differences between age groups, particularly in the 7-10 years bracket, where children demonstrated greater right hip abduction than younger children. This is in line with findings by O'Connor et al, who noted greater abduction in older children after undergoing periacetabular osteotomy.[13] Our findings are, however, different from those of Johnson et al. where no substantial differences in abduction results across ages were detected, indicating that the timing and methodology of the surgery may modify these outcomes.[14] The findings of Ribič et al. concerning the adoption of rotational impairments to enhance hip functionality are in correlation with our study. Ribič et al., along with other researchers, logically supported the need for changes in the hip regions and the substantial differences regarding internal rotation were obvious.[15]

Like in the previous cases, limb length discrepancy (LLD) was another relevant parameter that was monitored in the course of the study. Important changes were seen in the variation between the 1-3 years and the 7-10 years groups, with older children showing less discrepancy. This fits in with the work of Böhm and Dussa, et al. who reported lower LLD in older children receiving corrective surgery.[16] Still, our results diverge from those of Starobrat et al. who reported no considerable variation in LLD among different ages. Claims of this nature suggest that further explorations are warranted to elucidate the reasons behind this result.[17]

This study also highlights the significance of early diagnosis and treatment in addressing DDH. As noted in previous work by Stricker et al. and further corroborated by Böhm et al. (2024), early surgical intervention yields improved outcomes.[18,19] Our results support the notion that age-specific strategies may be needed to optimize outcomes, especially with regard to range of motion and rotational corrections. This is in alignment with the principles proposed by Scorcelletti et al. regarding the tailoring of treatment approaches to individual patients' ages coupled with their clinical presentations.[20]

CONCLUSION

Range of motion, weight, abduction, and limb length discrepancy are all significant variances that merit an age relative approach in surgical and rehabilitative efforts. This study aimed to add evidence to support the need for more focused care in children with DDH in order to improve the children's quality of life.

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CONFLICT OF INTEREST
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Acquisition, Analysis or Interpretation of Data:	AA, MK, SH, IK, IK
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All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.