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Outcomes of Meningomyelocele Repair with or without Platelet Rich Plasma Application

Mahwish Noor ul Haq[1], Fatima Naumeri[2], Asad Munir[1], Hafiza Mariam Rafiq[1], Nadir Aman[1], Zuha Zafar[1]

[1]Department of Paediatric Surgery, Mayo Hospital, Lahore, Punjab, Pakistan.
[2]Department of Paediatric Surgery, Services Institute of Medical Sciences (SIMS), Lahore, Punjab, Pakistan.

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Corresponding Author: Mahwish Noor ul Haq,
Department of Paediatric Surgery, Mayo Hospital, Lahore, Punjab, Pakistan.
Email: mahwishnoor80@gmail.com

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ABSTRACT

Objective: Meningomyelocele (MMC) is a common congenital neural tube defect requiring early surgery and a multidisciplinary approach. This study aimed to minimize cerebrospinal (CSF) leakage and accelerate healing in infants undergoing corrective surgery. **Methodology:** The study consisted of 70 infants with meningomyelocele divided into two groups. The PRP group received platelet rich plasma during surgery, while the control group did not. Within the PRP group, 35 infants underwent primary defect repair. In the control group, 32 had primary repair and 3 had flap closure. **Results:** The results demonstrated significant benefits of PRP treatment. In the PRP group, 5.7 %(2 infants) experienced CSF leakage and 8.6% (3 infants) developed meningitis. Additionally, 17.1%(6 infants) had local skin infections and none had wound dehiscence. In contrast, the control group had substantially higher complications rates: 17.1%(6 infants) CSF leakage, 22.9%(8 infants) meningitis, 45.7%(16) local skin infection and 12.9%(9 infants) wound dehiscence. **Conclusion:** This study concludes that PRP treatment significantly reduces CSF leakage, skin necrosis, meningitis and wound dehiscence in postoperative meningomyelocele infants. PRP enhances wound healing and minimizes complications, potentially reducing morbidity and mortality. These findings suggest PRP therapy as a valuable adjunct to meningomyelocele surgery.

INTODUCTION

Meningomyelocele, a type of spina bifida is the most common congenital defect of central nervous system, occuring when the neural tube fails to close during the first four weeks of pregnancy. This can lead to serious complication like hydrocephalus, hindbrain herniation and toxin exposure, resulting in significant morbidity and mortality[1]. Both genetic and environmental factors contribute to MMC, with increased risk associated with maternal exposure to certain medication(valporate, carbamazepine),alcohol, high fever, malnutrition (especially folate or B12 deficiency), diabetes and obesity during pregnancy[2]. These are more common among families of lower socioeconomic status and older mothers and increasing the recurrence risk in future pregnancies. The recurrence rate in subsequent pregnancies is about 2-3%[3]. In Pakistan, studies estimate a range of 38.6 to 124.1 cases per 10,000 births[7,15].

Most babies with MMC over 80 % require surgical intervention(ventriculoperitoneal shunt) to manage hydrocephalus[4] . Additionally, nearly 39% of patients with MMC experience functional motor deficits at or above the level of spinal defect with more than half of these individuals experiencing deficits that extend two or more levels above the affected area[5]. Early closure of MMC defects is crucial to preserve neural tissue function and prevent life threatening infections like sepsis[6].

Platelet rich plasma is a concentrated blood product that contains a rich source of platelets and other blood products. Similar to platelets, PRP release a potent mix of bioactive molecules including growth factors, chemokines and cytokines[8] which stimulate angiogenesis, modulate extracellular matrix and accelerate cellular recruitment, proliferation and differentiation.[9-12]

The benefits of using PRP are twofold. Firstly, it can be easily prepared from a simple blood draw, a relatively painless procedure. Secondly, as an autologous biologic product, PRP eliminates the risk of immune reactions and pathogen transmission associated with non autologous materials, making it a safer and more appealing option.[13]

While PRP has been used in animal studies[14], it's use in paediatric patients during MMC pouch repair is a novel idea. We hypothesize that by applying PRP during MMC pouch repair will reduce complications like CSF leakage, meningitis, local infection, skin necrosis, wound dehiscence , hydrocephalus as well as accelerating healing of underdeveloped pouch tissue.

MATERIAL AND METHODS

Between June 2024 and November 2024 our paediatric surgery department in Mayo hospital Lahore conducted the study involving 70 infants diagnosed with meningomyelocele. These infants were divided into two groups: 35 infants received platelet rich plasma therapy, while 35 infants did not. All infants were born at term, breastfed and monitored in the neonatal intensive care unit. The mean birth weight was 2,841grams. Surgical procedures for both groups were performed under general anesthesia. In the PRP group, 35 infants underwent primary defect repair. In contrast the non PRP group consisted of 32 primary closures and 3 flap closures. Platelet rich plasma will be prepared by using 2 steps methods. About 9.5 ml of blood will be taken through venipuncture after taking aseptic measures, and will be transferred into prp tubes containing 0.5ml buffered sodium citrate. PRP will be obtained by centrifugation at 200 g at 22◦c for 10 minutes. Then uppermost layer will again be transferred into another centrifugation tube by using sterile pipette and this will again centrifugate at 400g at 22◦c . Around 1ml of PRP will be obtained by this two step method. All this will be done pre operatively to save time. During MMC repair, a neural plate was formed and watertight dural closure is done. After achieving hemostasis, PRP was applied over dural repair and wound edges. This study aimed to investigate the effectiveness of PRP therapy in reducing complications and enhancing healing in MMC infants.

Statistical Analysis

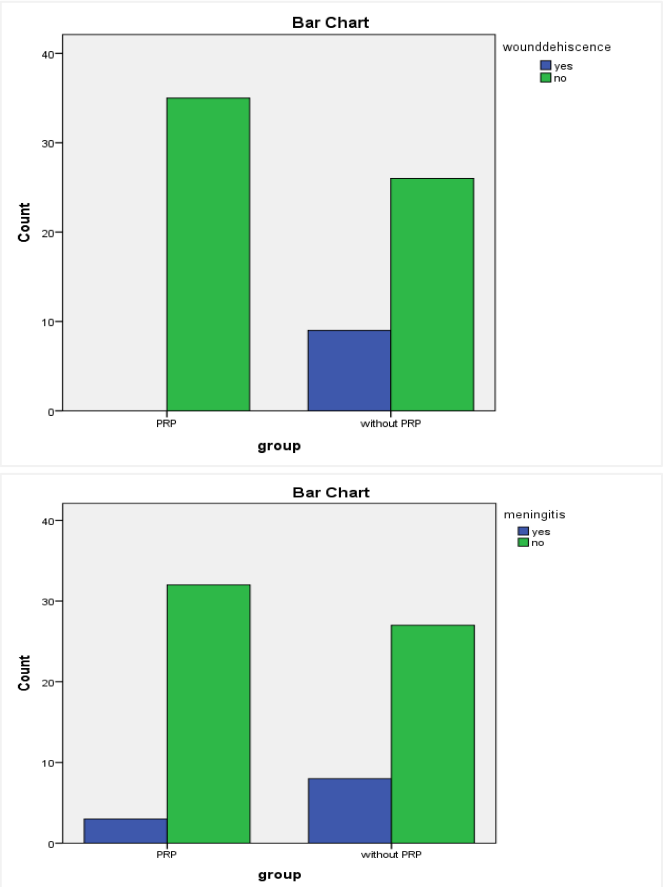
Descriptive statistics were used to summarize the data, presenting means, standard deviations, medians, ranges, frequencies, and ratios. Chi-square tests analyzed qualitative independent data, while Fisher's exact test was used when Chi-square test cnditions were not met. A p-value less than 0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics 20 software.

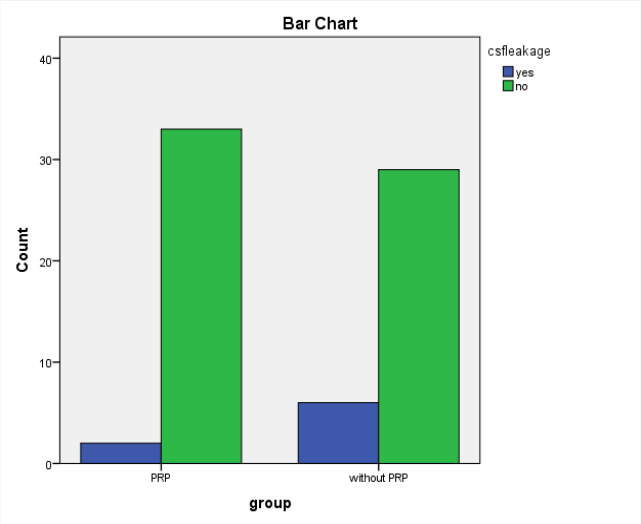
RESULTS

Our study included 70 patients born with MMC, out of these 33(47.1%) were male and 37(52.9%) were female. Birth weights ranged from 2000 to 4000 grams. MMC were divided into broad and narrow based defects, out of 70 patients, 61(87.1%) were broad based defects and 9(12.9%) were narrow based defects. Surgical procedures lasted between 45 to 120 minutes,with total blood loss ranging from 10 to 50ml. The MMC defect levels were primarily located in the cervical region 1.4% (1 patient), thoracolumbar 32.9% (23 patients), and lumbosacral regions 65.7 %(46 patients). All patients were delivered at term. Postoperative complications were significantly lower in the PRP group. CSF leakage occurred in patients, with 17.1% (6 patients) from the non-PRP group and 5.7%(2 patients) from the PRP group. Local skin infection affected patients, with 16 (45.7%) from the non-PRP group and 6 (16.1%) from the PRP group. Wound dehiscence occured in patients, with 9 (25.7%) from the non-PRP group. Hydrocephalus was present in patients, 27(77.1%) of the non-PRP group and 27(77.1%) of PRP group. The non-PRP group had primary closure in 91.4% (32 patients) and flap repair in 8.6% (3 patients) , while all 35 patients from PRP group underwent primary repair.

Figure 1

Rates of postsurgical outcomes like wound dehiscience, meningitis, CSF leakage, and local infection in meningomyelocele repair with and without platelet-rich plasma (PRP) application.





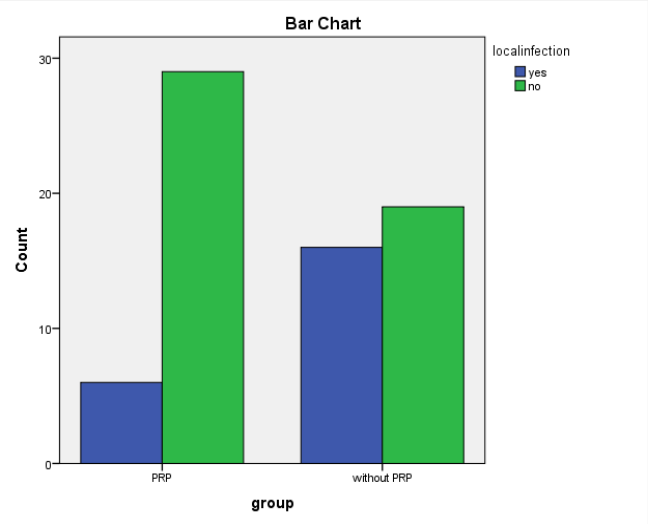


Table 1

Characteristics of postsurgical meningomyelocele repair with and without platelet-rich plasma (PRP).

		PRP (–)			PRP (+)			*p*
		Average ± ss/n-%		Median	Average ± ss/n-%		Median	
Gender	Male	13	62.9%		20	57.1%		0.094χ^2
	Female	22	37.1%		15	42.9%		
Birth weight		2.9314±0.503		3	2.7154 ± 0.422		3	
Gestational week	Term	35	100.0%		35	100.0%		1.000χ^2
Defect diameter	Broad based	32	91.4%		29	82.9%		0.284χ^2
	Narrow based	3	8.6%		6	17.1%		
Operation time (min)	<60 minutes	a. 15	a. 42.9%		a. 15	a. 57.1%		0.232χ^2
	60 to 120 minutes	b. 20	b. 57.1%		b. 20	b. 42.9%		
Blood loss (ml)	10ml	a. 7	a. 20%		a. 11	a. 31.4%		0.227χ^2
	20ml	b. 26	b. 74.3%		b. 24	b. 68.6%		
	30ml	c. 2	c. 5.7%		c. 0	c. 0%		
MMC level	Cervical	a. 0	a. 0		a. 1	a. 2.9%		0.009χ^2
	Thoracolumbar	b. 6	b. 17.1%		b. 17	b. 48.6%		
	Lumbosacral	c. 29	c. 82.9%		c. 17	c. 48.6%		
Meningitis	(+)	a. 8	a. 22.9%		a. 3	a. 8.6%		0.101χ^2
	(-)	b. 27	b. 77.1%		b. 32	b. 91.4%		
CSF leakage	(+)	a. 6	a. 17.1%		a. 2	a. 5.7%		0.133χ^2
	(-)	b. 29	b. 82.9%		b. 33	b. 94.3%		
Local wound infection	(+)	a. 16	a. 45.7%		a. 6	a. 17.1%		0.010χ^2
	(-)	b. 19	b. 54.3%		b. 29	b. 82.9%		
Wound dehiscence	(+)	a. 9	a. 25.7%		a. 0	a. 0%		0.001χ^2
	(-)	b. 26	b. 74.3%		b. 35	b. 100%		
Primary closure	(+)	a. 32	a. 91.4%		a. 35	a. 100%		0.077χ^2
	(-)	a. 3	a. 8.6%		a. 0	a. 0%		

Statistical significance (p-values) determined by χ^2 (Chi-square test). MMC: meningomyelocele; PRP (+): patients receiving PRP; PRP (−): patients not receiving PRP; CSF: cerebrospinal fluid leakage.

DISCUSSION

Meningomyelocele accounts for the majority of neural tube defects,which rank as the second most common congenital anomly, surpassed only by cardiac malformations.[6,16] It causes lifelong complications significantly impacting quality of life.[17] Clinical manifestation include paralysis, hypoesthesia, paraplagia, anesthesia, bowel/bladder dysfunction, spinal ,lower extremity deformities and hydrocephalus. This condition carries a notable mortality rate of approximately 1% annually between ages 5 and 30.[6]

Folic acid deficiency is a major risk factor for neural tube defects. Daily preconceptional folic acid

supplementation of 0.4mg reduces NTD rates by 60-70%.[16] After the baby is born, the lesion should be thoroughly examined while the infant is face down or on its side. You should apply a wet dressing over it. Use plastic wrap to keep heat from escaping. To lower risk of infection and persistent cerebrospinal fluid leakage, MMC should be closed during postnatal surgery as soon as possible, preferrably during first 48 hours following delivery.[18,20]

Complications associated with MMC can be categorized into surgical and non surgical types. Surgical complications include infection at lesion site, bleeding, cerebrospinal fluid leakage and re-tethering of the spinal cord.[6] Non surgical complications are diverse include neurological (hydromyelia, Arnold-Chiari malformation, hydrocephalus, seizures,motor and sensory impairment), musculoskeletal (scoliosis, muscle weakness), psychological and cognitive, sexual (erectile dysfunction, impotence,fertility problems) and social complications(educational problems, dependence, unemployment).[20]

Platelet rich plasma therapy has become increasingly popular across various medical fields due to its potential to enhance tissue repair. This concentrate contains high levels of bioactive molecules including growth factors,cytokines, lysosomes and adhesion proteins that start the haemostatic cascade and neovascularization.[21] Advances in technology have expanded PRP's applications to sports injuries and diverse fields including maxillofacial, gynaecology, urology, plastic surgery, dermatology, ophthalomology and spine surgery.[22] Marx et al[23] investigated the impact of PRP on bone maturation and density in mandibular reconstruction surgeries. Their study revealed that incorporating PRP into bone grafts significantly enhanced bone growth and formation.[23] PRP therapy has revolutionized sports medicine due to its remarkable effects on tissue regeneration and repair.By harnessing the body's natural healing potential, PRP accelerates recovery time, enabling injured athletes to return to their sport faster. This innovative treatment has proven beneficial for healing tendons, ligaments, muscles and cartilages having poor blood circulation and slow cell turnover.[24] The wound healing process consists of three phases; inflammatory phase, proliferation and remodeling phase. Inflammatory phase is initiated by hemostasis, where platelets form clots and release growth factors, attracting inflammatory cells to clean the wound. Proliferation phase is characterized by granulation, contraction, and epithelialization, resulting in the formation of new tissue. Remodeling phase focuses on strengthening the wound through collagen production and scar tissue formation. These phases are regulated by growth factor and cytokines found in blood components particularly abundant in platelet rich plasma.[25]

This comparative study between PRP and non-PRP groups revealed no significant differences($p>0.05$) in gender distribution, average duration of operations, amount of bleeding or primary closure rates. However there was a significant difference($p<0.05$) in MMC region distribution between groups.

Meningitis was the most frequent complication, occuring in (16)11% of cases, as reported by Rehman et al.[7] A separate trial also found meningitis in (7) 5% of cases. Additionally infection rates ranged from 11% to 13.5% according to Demir et al.[26] and other research.[7] CSF leaks were also a significant concern, affecting 23.7% of patients, with many requiring CSF diversion. Prior to surgery, neurological deficits were observed in 87 patients(58%). Postoperative complications included deterioration in 8 patients(5.4%) with initially normal strength, paraplegia in 5 patients(3.3%) and paraparesis in 3 patients(2%).[7] Lien et al. reported varying complication rates for MMC defect repair. These included 20% skin flap dehiscence rate, 4% skin flap dehiscence rate, 2% skin flap necrosis rate and 7% skin and subcutaneous tissue infection rate. Notably, Lien et al. study recorded zero cases of CSF leakage and meningitis.[27] Demir et al. examined the outcomes of MMC defect repair in 91 newborns. The results showed that 16.4% of the patients developed meningitis or shunt infection, while 11% developed surgical wound infections. The research identified several risk factors for meningitis, including open neural placodes(myeloschisis), external ventricular drainage and flap transposition. Interestingly, the study found no correlation between deep surgical wound infection and operation time or wound surface area.[26] Our study revealed significant differences in complication rates between the PRP and non-PRP groups. Notably, the PRP group had a signficant lower rate of local wound infection($p<0.05$) compared to non-PRP group. Additionally, wound dehiscence rates was significantly lower in the PRP group($p<0.05$). Although in non-PRP group wound dehiscence rate exceeded that in similar studies. No significant difference($p>0.05$) was found in meningitis rate and CSF leakage between both groups. While the non-PRP group's meningitis rate exceeded literature values, the PRP group's rate was lower.[25]

Khan et al. conducted a study on PRP treatment for MMC defects in 206 patients. The patients were grouped by defect size: 79 had defects less than 5cm^2, 68 had defects between 5-10 cm^2 and 9 had defects larger than 10cm^2. The study found that 13.5%(21) of patients developed surgical wound infections, while 86.5%(135) experienced successful wound healing. Additionally, 23.7%(23) of patients experienced CSF leakage, but 76.3%(119) fully recovered. Postoperative fever occurred in 90.4%(141) of patients and 22.4%(35) developed hydrocephalus. In comparison our study found no significant difference ($p>0.05$) in defect

diamete between PRP and non-PRP groups. Notably, our PRP group had a significantly lower rate($p<0.05$) of local infection and wound dehiscence compared to non-PRP group.[19,27,28,29]

CONCLUSION

Meningomyelocele significantly impacts individuals health and quality of life across their lifespan, posing challenges for families and society. Early surgical intervention and multidisciplinary care offer the best outcomes and survival rates. Platelet rich plasma has shown promise in various medical applications. Our study demonstrates PRP's efficacy in reducing CSF leakage, meningitis , local wound infection and wound dehiscence in MMC infants, where prompt repair and healing are crucial. We believe this research contributes valuable insights to the literature and clincal practice, enhancing care for this patient group.

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