COMPARISON OF PENTASTARCH VERSUS TETRASTARCH IN THE INITIAL MANAGEMENT OF HYPOVOLEMIC PATIENTS

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ABSTRACT: Hypovolemia is a state of decreased blood volume. Both crystalloids and colloids can be used but may influence coagulation beyond hemodilution. Hydroxy ethyl starch (HES) is colloids that are routinely used as intravascular volume substitutes. This prospective Randomized double blinded study was conducted in 60 patients to demonstrate the equivalence of two different molecular weight of HES in the initial management of Hypovolemia. Tetra starch (Voluven) HES130/0.4 produced excellent effect and makes it an advantage especially in hypovolemic patients because of Adequate Volume Effect Reduced tissue elimination, improved safety profile, Increased Renal elimination.

KEYWORDS: Pentastarch, Tetra starch, management of Hypovolemia.

INTRODUCTION: Hypovolemia is a state of decreased blood volume; more specifically; Decrease in volume of blood plasma. It is the intravascular component of volume contraction (or) loss of blood due to hemorrhage (or) dehydration maintaining adequate tissue perfusion and adequate circulating blood volume is important during major surgery. Both crystalloids and colloids can be used but may influence coagulation beyond haemodilution.^{1,2}

Although use of crystalloids (or) colloids for plasma volume is controversy; colloids are usually given to prevent and treat Hypovolemia. Among colloids, Hydroxy ethyl starch (HES) products have potential effects in humoral coagulation factors³, platelet function,^{4,5} clot formation,⁶ and clot polymerization.⁷ Hydroxy ethyl starch (HES) are colloids that are routinely used as intravascular volume substitutes, e.g., in case of bleeding, during acute normovolemic hemodilution (ANH) to reduce blood transfusion,⁸ and to improve rheology by decreasing the blood viscosity (Vis) and vascular tone.^{9,10} This is followed by increased tissue oxygen tension (tpo2).^{11,12} The different HES solutions are characterized by their mean molecular weight (MW), Concentration and their degree of substitution. The Hydroxy ethyl residues, especially when bound at the C2 carbon position of glucose, hinder the plasma alpha-amylase, which degrade the glucose polymers, hence increasing the intra vascular half-life of HES solution.¹³

Hydroxy ethyl starch is a large, branched, complex carbohydrate derived by adding hydroxy ethyl groups to amylopectin. The hydroxyl groups can be introduced at C2, C3, and /or C6 position of glucose. HES are comprised of molecules derived from cornstarch with a distribution of molecular weights. Depending upon molecular weight HES solution is classified as high, medium or low molecular weight preparation.¹⁴

Tetra starch is a novel HES with molecular weight of 130000 Dalton, a molar substitution of 0.4 (130/0.4) and a c2/c6 ratio greater among the HES group tetra starch has narrowest molecular weight resulting in sustained volume effect despite higher elimination.¹⁵ Renal excretion of HES130/0.4 is faster than that for pentastarch (HES 200/0.5) or hetastarch (450/0.7)^{16,17}

ORIGINAL ARTICLE

PARAMETERS	TETRA-STARCH [VOLUVEN]	PENTA-STARCH [HAES-STERIL 6%]
Volume Effect	100% for 4-6 hours	72%for 2-3 hours
Molecular Weight	130000 Daltons	200000 Daltons
Molar substitution	0.4	0.5
Substitution Pattern	C2:C6 ratio is 9:1	C2:C6 ratio is5: 1
Dosage	50ml/kg. wt./day	33ml/kg. wt./day
Usage In Renal failure	Advocated	Contraindicated
Interference with coagulation	Nil	Rarely observed
COMPARISON OF TETRASTARCH VS PENTASTARCH		

MATERIALS AND METHODS: 30 patients of either gender were taken for this study. These patients were divided into two groups

GROUP A: Pentastarch (Haes- steril 6%)

GROUP B: Tetra starch (voluven)

INCLUSION CRITERIA:

1. American Society of Anesthesiologists (ASA) I - IV
2. Scheduled for Elective or Emergency procedure

EXCLUSION CRITERIA:

1. Known hypersensitive reactions to starch solutions
2. Patient with blood dyscrasias

60 Adult patients of either sex undergoing elective or emergency procedures were divided into two groups depending on the type of colloid used for management of Hypovolemia

PREMEDICATION	PENTASTARCH	TETRASTARCH
ELECTIVE CASES	Tab.Diazepam 5 mg i.m. night before surgery	Tab.Diazepam 5 mg i.m. night before surgery
	Inj. glycopyrrolate .2mg i.m. Inj.Diazepam 5 mg i.m. 45 min before induction	Inj. glycopyrrolate 0.2mg i.m. Inj.Diazepam 5 mg i.m. 45 min before induction
EMERGENCY CASES	Inj. glycopyrrolate 0.2mg i.m.	Inj. glycopyrrolate 0.2mg i.m.
TABLE 1: PREMEDICATION USED IN TWO GROUPS		

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AGE (YEARS)	PENTA STARCH		TETRA STARCH	
	No. of patients	%	No. of Patients	%
21-40	8	26.66%	12	40.00%
41-60	12	40.00%	8	26.66%
61-80	10	33.33%	10	33.33%
TOTAL	30	100%	30	100%

TABLE 2: DISTRIBUTION OF PATIENTS ACCORDING TO AGE (YEARS)

In both groups, 33.33% belong to 61-80 years. 40% of patients belong to 41-60 years in pentastarch group compared to 26.66% in tetra starch group. 26.66% belong to 21-40 years in pentastarch group compared to 40% in tetra starch group

SEX	PENTASTARCH		TETRASTARCH	
	No. of Patients	%	No. of patients	%
MALE	12	40%	18	60%
FEMALE	18	60%	12	40%
TOTAL	30	100%	30	100%

TABLE 3: DISTRIBUTION OF PATIENTS ACCORDING TO SEX

In pentastarch group 40% were male patient and 60% were female patient when compared to 60% were male and 40% were female in tetra starch group.

WEIGHT	PENTASTARCH		TETRASTARCH	
	No. of patients	%	No. of patients	%
31-60	11	36.66%	12	40%
61-90	19	63.33%	18	60%
TOTAL	30	100	30	100

TABLE 4: DISTRIBUTION OF PATIENTS ACCORDING TO WEIGHT (KG)

In pentastarch group, 36.66 %of patients were between 31-60 kg and 63.33%of patients were 61-90 kg compared to 40%of patients belongs to 31-60 kg and 60% belong to 61-90 kg in the tetrastarch group.

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NO.OF UNITS USED	PENTASTARCH		TETRASTARCH	
	No. of patients	%	No. of patients	%
1	17	56.66%	16	53.33%
2	13	43.33%	14	46.66%
TOTAL	30	100	30	100

TABLE 5: NO. OF UNITS OF COLLOIDS USED

In pentastarch group 56.66% required 1 unit of transfusion compared to 53.33% in tetra starch group. And only 43.33% of patients required 2 units of transfusion in pentastarch group in comparison with 46.66% in tetra starch group. According to Fischer's test $P = 0.02234$, which means, it is not significant as no. of units required for transfusion in both the groups is equal.

No. of units used	PENTASTARCH		TETRASTARCH		
	NO.OF PATIENTS	%	NO.OF PATIENTS	%	
NIL	8	26.66%	30	100	$P < 0.002$
MORE THAN 1 UNIT	22	73.33%	0	0	
TOTAL	30	100	30	100	

TABLE 6: NO.OF UNITS OF BLOOD USED

According to the table none of the patients in tetra starch group required blood transfusion: but 73.33% required more than 1 unit of blood transfusion in pentastarch group. According to Fishers exact test $P < 0.0002$: this is significant. It indicates there was no requirement of blood transfusion in tetra starch group.

SYSTOLIC B.P INCREASE	PENTASTARCH	TETRASTARCH	T VALUE	P VALUE
MEAN	5.28	20.00	3.98	< 0.001
SD	11.33	8.45		

TABLE 7: MEAN CHANGE IN SYSTOLIC BLOOD PRESSURE

According to table, $P < 0.0001$ is significant which indicates that mean changes in blood pressure in tetra starch group was good in comparison to pentastarch group after infusion.

DIASTOLIC B.P INCREASE	PENTASTARCH	TETRASTARCH	T VALUE	P VALUE
MEAN	4.14	11.33	2.412	< 0.005
SD	7.66	8.33		

TABLE 8: MEAN CHANGE IN DIASTOLIC BLOOD PRESSURE

ORIGINAL ARTICLE

According to table, $P < 0.005$ is significant. It indicates that mean change in diastolic blood pressure in tetra starch group was good in comparison to pentastarch after infusion.

PULSE RATE DECREASE	PENTASTARCH	TETRASTARCH	T VALUE	P VALUE
MEAN	1.28	1.87	0.16	$P > 0.05$
S.D	4.83	12.98		

TABLE 9: MEAN CHANGE IN PULSE RATE

According to Fischer's exact test $P > 0.05$ is not significant which indicates that mean change in pulse rate after infusion of colloid is not satisfactory.

SPO2	PENTASTARCH	TETRASTARCH	T Value	P value
MEAN	0.27	0.8	0.67	> 0.005
SD	2.63	1.37		

TABLE 10: MEAN CHANGE IN SATURATION

According to Fischer's test $P > 0.05$ is not significant this indicates that mean change in saturation after infusion of colloid was not satisfactory.

OBSERVATION:

	OUR STUDY	Thomas. A. Neff	F. Bepperling
Total No. of patients	60	31	40
Male: Female	10:20	27:4	39:1

TABLE 1: NO OF PATIENTS

In our study the total number of patients included was 60 which was consistent with the study done by Thomas. A. Neff, when compared with E. Bepperling it was 40. In our study it was female predominance when compared to other study, which was male predominance.

	OUR STUDY	Oliver Langeron	Thomas A. Neff
AGE	21-80 Years	18-83 Years	27-51 Years

TABLE 2: AGE/ YEARS

The patients included in the study were between 21-80 years, which was comparable with study done by Oliver Langeron and Thomas. A. Neff

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	OUR STUDY	Oliver Langeron	Stephen. Mario Kasper
TYPE OF SURGERY	Orthopedics, gynecological, General surgical procedures	Orthopedics procedures	Coronary artery by-pass graft (CABG)

TABLE 3: TYPE OF SURGERY

When compared to study done by Oliver Langeron and Stephen Mario Kasper the surgeries were mainly pertained to orthopedic and CABG, our study was confined to gynecological, orthopedic, and general surgical procedures

Maximum Volume of Colloid	PENTASTARCH	TETRASTARCH
OUR STUDY	20 ml/kg	35ml/kg
Stephen. Mario. Kasper	33 ml/kg	50ml/kg

TABLE 4. MAXIMUM VOLUMES INFUSED

Our study is consistent with study done by Stephen Mario Kasper with regard to maximum volume of colloid used for transfusion in management of Hypovolemia.

	PRE INFUSION		POST INFUSION	
	PENTASTARCH	TETRASTARCH	PENTASTARCH	TETRASTARCH
OUR STUDY	83.20 ±23.41	88 ± 4.14	97.87± 10.13	114.67± 7.43
Oliver Langeron	107± 21	108± 16	99± 17	105± 15

TABLE 5: CHANGES IN SYSTOLIC BLOOD PRESSURE

Among the changes in systolic blood pressure before & after infusion, our study was comparable with the study done by Langeron with respect to tetra starch in the post transfusion group. Base line values of systolic blood pressure in both the groups were different.

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	PRE INFUSION		POST INFUSION	
	PENTASTARCH	TETRASTARCH	PENTASTARCH	TETRASTARCH
OUR STUDY	57.67±16.76	61.33±3.52	68±9.41	76±7.37
Oliver Langeron	61±14	62±12	58±11	66±11

TABLE 6: CHANGES IN DIASTOLIC BLOOD PRESSURE

Our present study was consistent with the study done by Oliver Langeron in the pretransfusion group with respect to tetra starch. After infusion of tetra starch present study had better results compared to study done by Langeron.

	PRE INFUSION		POST INFUSION	
	PENTASTARCH	TETRASTARCH	PENTASTARCH	TETRASTARCH
OUR STUDY	92.67	92.33	103.6	99
Bepperling	72	74	65	67

TABLE 7: PULSE RATE

Our study with respect to changes in pulse rate in both groups had better results when compared to study done by Bepperling before and after infusion.

	PRE INFUSION		POST INFUSION	
	PENTASTARCH	TETRASTARCH	PENTASTARCH	TETRASTARCH
OUR STUDY	95.87	97.63	98.67	98.67
Bepperling	98.3	96.64	97	96.9

TABLE 8: OXYGEN SATURATION

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With respect to changes in oxygen saturation, our study was comparable with the study done by Bepperling with respect to tetra starch before and after transfusion.

RESULT: In this study with comparison of pentastarch versus tetra starch in management of hypovolemic patients it was found that Hypovolemia was well treated with tetra starch (voluven) The incidence of adverse effect was nil and requirement of blood transfusion was minimal.

Thus Tetra starch produced excellent effect and makes it an advantage especially in hypovolemic patients because of Adequate Volume Effect, Reduced tissue elimination, Improved safety profile and Increased Renal elimination.

REFERENCES:

1. Boldt J, Haisch G, Suttner S, Kumle B, Schellhass A. Effects of a new modified, balanced hydroxyethylstarch preparation (Hextend) on measures of coagulation. *Br J Anaesth* 2002; 89; 722-8.
2. Ruttman T G, James M F, Aronson I. In vivo investigation into the effects of hemodilution with hydroxyethyl starch (HES 200/0.5) and normal saline on coagulation. *Br J Anaesth* 1998; 80:612-6.
3. Stump D C, Strauss R G, Henriksen R A, Petersen RE, Saunders. Effects of Hydroxy ethyl starch on blood coagulation, Particularly Factor v111. *Transfusion* 1985; 25:349-54.
4. Stogermuller B, stark. J, Willschke. H, Felfering M, Horauf K, Kozek-Langenecker S. The effects of hydroxyethylstarch 200kD on platelet function. *Anaesth Analg* 2000, 91:823-7.
5. Deusch E, Gamsjager T, Kress H, kozek- Langenecker S. Binding of Hydroxy ethylstarch molecules on platelet surface. *Anaesth Analg* 2003;92:1402-7.
6. Innerhofer P, Fries D, Markreiter J, Klinger A, Kuhlbacher G, Wachter B, Oswald E, Salner E, Frischhut B, Schobersberger W. The effects of perioperative administered colloids and crystalloids on primary platelet – mediated hemostasis and clot formation. *Anaesth Analg* 2002; 95:858-65.
7. Fries D, Innerhofer P, Reif C, Streif W, Klinger A, Schobersberger W, Velik- Salchner C, Friesenecker B. The effect of fibrinogen substitution on reversal of dilutional coagulopathy: an in vitro model. *Anesth Analg* 2006; 102:347-51.
8. Freyburger G, Dubreil M, Boisseau M R, Boisseau M R, Janvier G. Rheological properties of commonly used plasma substitutes during preoperative normovolemic acute hemodilution. *Br J Anaesth* 1996; 76:519-25.
9. Doss DN, Estafanous F G, Ferrario C M, et al. Mechanism of systemic vasodilation during normovolemic hemodilution. *Anesth Analg*; 1995;81:30-4.

ORIGINAL ARTICLE

10. Holbeck S, Grande P O. Effects on capillary fluid permeability and fluid exchange of albumin, dextran, gelatin and hydroxyethyl starch in cat skeletal muscle. Crit Care Med 2000; 28:1089-95.
11. Boekstegres P, Weidenhofer S, Kapsner T, Werdan K. Skeletal muscle partial pressure of oxygen in patient with sepsis. Crit Care Med 1994; 22:640-650.
12. Standl TG, Reeker W, Redmann G, et al. Hemodynamic changes and skeletal muscle oxygen tension during complete blood exchange with ultra-purified polymerized bovine hemoglobin. Intensive Care Med 1997; 23:865-72.
13. Vogt NH, Bothner U, Lerch G, et al. Large Dose administration of hydroxy ethyl starch 200/0.5 total hip arthroplasty: plasma homeostasis, hemostasis, and renal function compared to use of 5% human albumin. Anesth Analg 1996; 83:262-8.
14. Treib J, Baron J F, Grauer M T, Strauss RG. An international view of hydroxyethyl starches. Intensive Care Med 1999; 25:258-68.
15. Waitzinger J, Bepperling F, Pabsct G, Opitz J, Fackelmayer A, Boldt J. Effect of new hydroxy ethyl starch (HES) Specification. [6% HES (130/0.4)] on blood and plasma volumes after bleeding in 12 healthy volunteers. Clin Drug Invest 1999; 17:119-25.
16. Waitzinger J, Bepperling F, Pabsct G, Opitz J, Muller M, Baron J F. Pharmacokinetics and tolerability of a new Hydroxy ethyl starch (HES) specification [HES (130/0.4)] after a single dose infusion of 6% or 10 % solutions in healthy volunteers. Clin Drug Invest 1998; 16:151-60.
17. Waitzinger J, Bepperling F, Pabsct G, Opitz J. Hydroxy ethyl starch (HES) [HES (130/0.4)] a new specification: Pharmacokinetics and safety profile after multiple infusions of 10% solutions in healthy volunteers. Drugs R D 2003; 4:149-57.

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