Can Succinylcholine be Used Safely in Severely Burn Patients?

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Summary:

The use of succinylcholine(SC) in burn patients are relatively contraindicated for certain period after lesion aged 4 days – 10 weeks due to chance of hyperkalemia although there are no systemic data to define what period and what level of K^+ is safe. This prospective study was carried out in 60 acute burn patients who were admitted in DMCH Burn Unit and undergone surgery within 3 months of lesion. Most common type of burn was flame burn (33%).Mean age of the patient was 22.60 ± 9.61, TBSA (Total burn surface area) was 22.17 ± 9.57 and duration of burn was 23.36 ± 19.61. Every patient received standard dose of SC (1.5mg/kg) for intubation. The peripheral venous blood samples for serum K^+, Na^+, Cl^- & HCO_3^- were drawn before induction and 3 minutes after injection of SC. On analysis there were no significant change of serum K^+ and HCO_3^- ($p > .05$), on the other hand serum $Na^+$and Cl^- levels were significantly changed ($p<0.05$) due to correction of dehydration. In case of electric burn serum K+ level was raised in every cases but didn't cross the normal high level of serum K+ (5.5mEq/l). Haemodynamic parameters like pulse, NIBP, SPO2 and ECG were analyzed intra operatively and there were no significant change in NIBP and ECG, rather there were significant improvement in pulse and SPO2 ($p< 0.05$). Survival of anaesthetic was 100% and no dysrhythmias or major morbidity were found intra operatively. Therefore, these data taken in the context of a compelling case for rapid intubating condition suggest safety in succinylcholine use in the patients with acute burn.

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Introduction:

Since the 1950s, cardiac arrest has been observed in burn patients receiving succinylcholine. A decade later, hyperkalemia was determined to be the cause of cardiac arrest in these patients. Since then, other conditions have been identified that may result in succinylcholine induced hyperkalemia including cerebral vascular accident (CVA), spinal cord injury, Gullain-Barre syndrome and prolonged stays in an intensive care unit (ICU).[1] Further exploration of this phenomenon has been identified upregulation of nicotinic acetylcholine receptors (AchRs) in skeletal muscle as the cause of hyperkalemia.[2] In healthy persons, postsynaptic acetylcholine receptors are restricted to N-M junction. Acetylecholine receptors on postsynaptic membrane are organized in discrete clusters on the shoulders of junctional folds. Each cluster contains a few hundred receptors. Each receptor consists of few subunits, two of which, the alpha (á), are identical. Other three are beta (b), delta (d) and epsilon (e). Receptors are arranged as a cylinder, with a central, normally closed channel-the inophore. Each acetylcholine molecule is involved in opening one ion channel. Acetylcholine receptors are also present on presynaptic area of nerve terminal.[3] but in severe burn, where N-M junctions are affected acetylcholine receptors develop on the adjacent muscle surface. These extrajunctional receptors cause excessive release of k^+ ions from severe burn tissues.[3] Hyper metabolism is also seen with a burn injury of greater than 20% total body surface area. These causes double the cardiac output and metabolic rate over the next 24 to 48 hours. Tissue destruction especially from electrical burn causes hyperkalaemia.[4] Serum potassium may increase 0.3-0.5 mEq/l following administration of paralyzing dose of succinylcholine (SC) in normal patients and last for 3-5 minutes. But in burn patients, massive hyperkalaemia may occur after administration of succinylcholine(SC) for certain period after lesion eg. 4days- 10weeks.[5, 6] in our country, there is no such study, especially on burn patient. We therefore decided to perform such type of study to assess the safety of acute burn patients. This study was carried out to observe morbidity of severe burn patient during anaesthesia

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using succinylcholine and to observe the level of K^+ after using succinylcholine crossing critical level.

Materials and methods:

This prospective clinical study was conducted after obtaining approval from the institutional ethical committee and was carried out in the 50 bedded burn unit, the only dedicated burn facility in Bangladesh with a mean annual admission of 869 patients, under the guidance of professor and head, department. of Anesthesia and ICU of Dhaka Medical College Hospital. Patients were recruited randomly. Purpose of the study was clearly explained to each of the subjects and was recruited only after taking informed written consent. Patient with deep burn >5%- 60% and aged >1 year were included and patients with impaired renal function , failed intubations and the patients were not interested to be included in the study were excluded. All patients were given ideal general anesthesia with same I/V fluid and anesthetic agents eg. Hartman's solution, Inj. Pethidine (1 mg/kg), Inj. thiopental Na (5mg/kg), Inj. Suxamethonium (1.5 mg/kg). 1st blood sample was taken before induction and 2nd blood sample was taken 3 minutes after giving injection succinylcholine. Pulse, noninvasive blood pressure, and electrocardiography (to see any dysrhythmias) were observed in all patients. Readings were recorded according to data collecting sheet, before induction and after giving suxamethonium at 5 min, 10 min, 30 min and 1 hour after suxamethonium injection. Biochemical parameters such as serum potassium level, serum sodium level, serum chloride level, serum bicarbonate level and clinical parameters such as pulse, blood pressure, electrocardiography and SPO2 were analyzed. Data were collected in a specially designed Data collecting sheet. It was analyzed for statistical significance by t-test and ANOVA as appropriate and descriptive statistics were used for demographic profiles. Values was regarded as significant if $p<0.05$.

Results:

A total 60 people were included in this study. Their characteristics including gender, distribution of age, cause of burn, and TBSA burnt and duration of burn are presented in Table - 1. The most common type of burn was flame burn (45%), mean age was (22.6 ± 9.61) and mean duration of burn was (22.36 ± 19.61) days.

The haemodynamic parameters before induction and 5 min, 10 min, 30 min and 60 mins after injection of succinylcholine (SC) were described in Table-II.

Results shows significant improvement of pulse and SPO2 after induction expressed in Table-III.

All patients received a standard dose of succinylcholine (1.5mg/kg.) so called defasciculating doses of nondepolarizing muscle relaxants were not administered before SC. The laboratory parameters were described in Table-IV. The mean baseline value of serum potassium (K+) 4.37 ± .34 and it was not significantly changed 3 minutes after injection of succinylcholine (SC). Serum potassium level increased in all cases of electric burn but didn't cross the normal limit of serum level of potassium (5.5 mEq/l). But serum Sodium (Na+) and Chloride (Cl -) level decreased significantly.

There were no significant changes in laboratory parameters between groups and within groups (ANOVA) shown in Table-V.

Table-I

Characteristics of Patients (n-60)

Age of the Patients			Gender of the patients				Causes of Burn			TBSA % of burn		
Age in yrs	No	%	Male		Female		Type	Number	%	% of burn	No	%
0-10	6	10	No.	%	No.	%	Scald	6	10	<10	6	10
11-20	24	40	33	55	27	45	Flame	27	45	11-20	15	25
21-30	24	40					Electric	21	35	21-30	24	40
31-40	3	5					Gas Explosion	0	0	31-40	9	15
>40	3	5					Chemical	6	10	41-50	1	5
										>50	1	5
Duration of burn			minimum – 4 days				maximum – 78 days			mean – 22.36 ± 19.61		

TBSA = Total Burn Surface Area

Table-II

Haemodynamic changes before and after induction with succinylcholine (SC) (n = 60)

Parameter	Before induction	5 min after induction	10 min after induction	30 min afte r induction	60 min after induction
Pulse	109.0 ± 19.24	108.3 ± 18.30	98.1 ± 23.4	99.5 ± 22.2	95.7 ± 20.2
NIBP systolic	112.7 ± 15.20	109.2 ± 15.00	106.2 ± 12.7	114.2 ± 17.4	111.5 ± 13.1
NIBP diastolic	68.7 ± 16.20	67.2 ± 10.90	67.0 ± 14.0	78.0 ± 12.5	72.7 ± 11.4
SPO2	98.0 ± .88	98.6 ± .58	98.4 ± .82	98.6 ± .67	98.6 ± .48
ECG	1.0 ± .00	1.0 ± .00	1.0 ± .00	1.0 ± .00	1.0 ± .00

Results were expressed as mean ± SD.

Table-III

Haemodynamic changes before and after induction with succinylcholine (SC) (n = 60)

	Parameters	Mean	N	Std. Deviation	Std. Error Mean	TValue	PValue
Pair 1	Pulse before	109.0000	60	19.24633	4.30361	.225	.825
	Pulse_after_5_min	108.3500	60	18.37697	4.10922		
Pair 2	Pulse before	109.0000	60	19.24633	4.30361	2.789	.012*
	Pulse_after_10_min	98.1000	60	23.42266	5.23747		
Pair 3	Pulse before	109.0000	60	19.24633	4.30361	3.316	.004*
	Pulse_after_30_min	99.5000	60	22.22966	4.97070		
Pair 4	Pulse before	109.0000	60	19.24633	4.30361	4.532	.000*
	Pulse_after_60_min	95.7500	60	20.29487	4.53807		
Pair 5	NIBP before	112.7500	60	15.25873	3.41196	1.113	.279
	NIBP_after_5_min	109.2500	60	15.06783	3.36927		
Pair 6	NIBP before	112.7500	60	15.25873	3.41196	2.054	.054
	NIBP_after_10_min	106.2500	60	12.76044	2.85332		
Pair 7	NIBP before	112.7500	60	15.25873	3.41196	-.356	.726
	NIBP_after_30_min	114.2500	60	17.49248	3.91144		
Pair 8	NIBP before	112.7500	60	15.25873	3.41196	.398	.695
	NIBP_after_60_min	111.5000	60	13.18891	2.94913		
Pair 9	NIBP before Dias	103.7500	60	164.21163	36.71884	.992	.334
	NIBP_after_5_min_Dis	67.2500	60	10.93943	2.44613		
Pair 10	NIBP before Dias	103.7500	60	164.21163	36.71884	.956	.351
	NIBP_after_10_min_Dis	67.0000	60	14.08620	3.14977		
Pair 11	NIBP before Dias	103.7500	60	164.21163	36.71884	.822	.421
	NIBP_after_30_min_Dis	73.0000	60	12.50263	2.79567		
Pair 12	NIBP before Dias	103.7500	60	164.21163	36.71884	.829	.417
	NIBP_after_60_min_Dis	72.7500	60	11.41041	2.55144		
Pair 13	SPO2_before	98.0500	60	.88704	.19835	-2.854	.010*
	SPO2_after_5_min	98.6500	60	.58714	.13129		
Pair 14	SPO2_before	98.0500	60	.88704	.19835	-1.506	.148
	SPO2_after_10_min	98.4500	60	.82558	.18460		
Pair 15	SPO2_before	98.0500	60	.88704	.19835	-2.259	.036
	SPO2_after_30_min	98.6500	60	.67082	.15000		
Pair 16	SPO2_before	98.0500	60	.88704	.19835	-2.449	.024
	SPO2_after_60_min	98.6500	60	.48936	.10942		

P < .05 = Significant; * = Significant.

Table-IV

Laboratory parameter changes before induction and 3 minutes after induction with succinylcholine. n = 60

Parameter	Serum level before induction	Serum level 3 minutes after induction	T value	p value
Serum potassium (k+)	4.37 ± .34	4.50 ± .50	- 1.301	.209
Serum Sodium (Na+)	143.54 ± 3.33	142.10 ± 3.33	3.131	.006*
Serum Chloride(Cl -)	104.12 ± 3.67	103.37 ± 3.68	2.76	.012*
Serum bicarbonate(HCO3-)	24.50 ± 3.25	24.37 ± 2.89	.709	.487

Results were expressed as mean ± SD. p < .05 = Significant; * = Significant.

Table-V

Changes in laboratory parameters between groups and within groups (ANOVA); n = 60.

Parameter	Sum of squares between groups df -2	Sum of squares within groups df -58	Sum of squares total df -60	Mean square between groups & within groups	F value	sig
Serum potassium (k+) difference	.467	2.850	3.316	.233.168	1.392	.276
Serum Sodium (Na+) difference	23.589	56.799	80.388	-11.7953.341	3.530	.052
Serum Chloride(Cl -) difference	1.111	26.839	27.950	.5551.579	.352	.708
Serum bicarbonate(HCO3-) difference	2.268	10.514	12.782	1.134.618	1.834	.190

p < .05 = Significant; * = Significant.

Discussion:

It is well known that it is inadvisable to administer succinylcholine to burn patient. there are reports of cardiac arrest during intubation of such patient in the 1960s. These occurred between the 20th and 50th days post injury. [7] The cause was found to be a high plasma potassium level immediately following the administration of the muscle relaxants. [8, 9] There are some case reports and letters have been published reporting hyperkalemia after administration of succinylcholine to patients with burn. In our study we also found mild increase in serum potassium (k^+) level after administration of succinylcholine but we couldn't call it hyperkaleamia (serum potassium (k^+) > 5.5 mEq/l). The level of serum potassium (k^+) in our study was 4.50 ± .50 mEq/l. Dr.Charles D.Deakin reported that succinylcholine contraindicated in burns because of the risk of hyperkalemia. Probably due to entire myocyte cell membrane acting as a receptor. [10] In our study we attempted to evaluate whether any significant morbidity or mortality ensued from the administration of an induction dose of succinylcholine with moderate to severe burned patients within 3 months of injury of different type of burn like flame burn, scald, electric burn, chemical burn etc. And experiences were uneventful although there was transient increase in serum potassium (k+) level. Our findings matched with the study of Adam J. Schow MD et al.[6] who reviewed more than 40,000 general anesthetics administered over 70 months in which succinylcholine was given at the induction. This search yielded 38 patients with a preoperative potassium of 5.6 mEq/l or greater. Survival of the anesthetic was 100% and no dysrhythmias or other major morbidity were documented upon manual review of the intraoperative automated record keeper charts or the patient medical records. Rebecca M. Huggins et al.[2] found administration of succinylcholine to patients without neuromuscular disease results in a small transient increase in a serum potassium (k+) concentration of about .55 mEq/l and serum potassium (k+) increase greater than 5 mEq/l are extremely rare. Maclennan et al.[11] suggest that succinylcholine should not be used beyond 24 hours after a burn injury. However there are no reports in the literature of succinylcholine induced hyperkalemia in human occurring within 1 week after burn injury. Some other investigators found succinylcholine is safe up to 1 week after burn injury, were performed 30 years ago. [9, 12, 13] In these reports

number of patient studied within 1 week after burn injury totaled only three in the three publications, may be the treatment modality at this time was that most burn patients, especially those with big burns did not undergo excision and grafting until the burn escher had separated from the wound, which takes at least 2 weeks for spontaneous separation. Current practice advocates early excision and grafting of wound especially with major burn. [11] Martyn J.A. Jeevendra[14] states that the upregulation of acetylcholine receptors (AChRs) after burns occurs at sites immediately beneath and distant from the burn, a positive correlation between AChR number and the intensity of hyperkalemia after succinylcholine. The upregulation of acetylcholine receptors (AChRs) occurs in muscles beneath the area of burn is as profound as denervation and occur as early as 72 have after burn. Evidence for upregulation of the immature isoform has also been provided by assessment of messenger RNAs for the ã subunit. When depolarized, the immature isoform has a prolonged open channel time, which may aggravate the K^+ efflux that occur with depolarization. Yanez P. et al.[15] reconfirmed that AChRs upregulation with expression of the ã subunit as early as 3 days after a 5% burn over tibialis anterior muscle in rat. In view of Martyn J.A. Jeevendra[14] succinylcholine is probably safe up to 48 hours after burn injury, but it may be wise to avoid it beyond that periods. Geraid A. Gronert, M.D. [16] worked long time since 1959 to 2009 on this topic in different burn unit with the doses of succinylcholine of 0.4, 0.7, and 1.4 mg/kg unlike our result he found succinylcholine was unequivocally contraindicated in the patients with burns. J.A. Jeevendra Martyn [17] also found hyperkalemia with succinylcholine. E. J. Halok et al. [18] found safe (as indicated by an absence of arrhythmias and other morbidity) in patients with preoperative serum concentrations of 5.6 mEq/l or greater. In our study we studied 60 patients with 6 – 50% of mixed to deep burnt patients within 4 – 78 days of injury with succinylcholine without any adverse effect except mild transient increase in serum potassium (K+). We also found that the increase in serum potassium (K+) level was more in case of electric burn relative to other modalities of burn patients like flame burn, scald or chemical burn.

Conclusion:

Succinylcholine can be used safely for major burn patients for early excision and grafting as well as correction of deformity within 3 months of injury. However further study needed to support this inference as there is other work in this field in our country.

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