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Local anesthetic systemic toxicity: Evaluation of awareness and knowledge levels of anesthesia technicians

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Abstract

Aim: The aim of our study is to measure the levels of knowledge about the systemic toxicity of local anesthetics among anesthesia technicians, who will be the first to recognize local anesthetic systemic toxicity in the absence of an anesthesiologist or related physician.

Materials and Methods: A total of 196 anesthesia technicians working at different hospitals were included in the study. A questionnaire was used as a data collection tool. The data obtained were evaluated statistically using IBM SSPS Statistics 25.0 for Windows.

Results: When the distribution of the participants according to knowledge of systemic toxicity was examined, it was seen that 56.1% of the participants answered "yes" to having such knowledge, 24% of the participants said "no," and 19.9% of the participants did not remember. Regarding what must be done urgently in the event of local anesthetic systemic toxicity development, 74% of the participants said that the administration of local anesthetic should be stopped, 84.2% said that airway safety should be ensured, 100% said that oxygen should be administered, 65.3% said that a call for help should be made, 65.8% said that preparations for tracheal intubation should be started, 66.3% said that a safe venous line should be opened, 30.1% said that convulsions should be treated, and 51% said that a 20% lipid solution should be administered.

Conclusion: Based on our findings, we conclude that anesthesia technicians need training to increase their awareness of and knowledge about the symptomatology, prevention, and treatment of local anesthetic systemic toxicity.

Introduction

Local anesthetic drugs are used widely in the perioperative setting by anesthesiologists and other surgical specialists to facilitate surgical procedures for patients or to provide postoperative pain management. The widespread usage of local anesthetics enables surgical processes to be performed painlessly. However, at the same time, it leads to increasing morbidity and mortality risks for surgical patients and complication risks caused by local anesthetic systemic toxicity (LAST) [1].

LAST, which generally appears with central nervous system (CNS) or cardiovascular system symptoms, is a very serious complication. Though it is rare, it can be fatal when not detected early. The injection site, injection technique, type of anesthetic drug, dose of the local anesthetic drug injected, and individual factors of the patient to whom the local anesthetic is administered all contribute to the development of toxicity [2]. The incidences of LAST reported in the literature display substantial differences and it is not possible to draw a firm conclusion about its overall incidence. The reporting deficiency created by the inability to completely diagnose all LAST cases is the main source of the differences in reported incidence rates. In a study using an American database, the incidence of LAST was calculated over the course of 15 years in different hospitals among patients who underwent peripheral nerve block for total joint arthroplasty. During the study period, for every 1000 peripheral nerve blockades, 1.04 cases of LAST were determined with a decreasing trend over time [3]. In different studies of orthopedic patients who underwent peripheral nerve block, the incidence of LAST was reported as 0.87 and 0.07 cases for every 1000 cases [4-6]. With the introduction of peripheral nerve blocks under ultrasound guidance, the incidence of LAST decreased significantly [4]. However, despite the low and apparently decreasing incidence, LAST remains a concern for clinicians. There is common agreement that optimizing LAST management is extremely important [7]. LAST manifests itself with CNS symptoms in the early pe-

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riod. Among these symptoms are numbness of the tongue, tinnitus, drowsiness, metallic taste, nystagmus, clouding of consciousness, confusion, tremors, seizures, coma, and respiratory arrest, which may occur in less than 1 minute. The severity of the CNS symptoms depends on the dose. At higher doses, the severity of the symptom increases. Symptoms of the cardiovascular system generally appear after CNS symptoms. In the early period, tachycardia, hypertension, and arrhythmia are observed. As the amount of the local anesthetic increases in the blood, bradycardia, cardiac depression, cardiovascular collapse, and asystole may be observed [8]. Early recognition and appropriate management of toxicity symptoms can prevent the development of adverse outcomes, including death [9].

Anesthesia technicians assist anesthesiology and reanimation specialists in the safe implementation, maintenance, and termination of local anesthetic procedures. In the implementation of anesthesia, they maintain the anesthesia records of the patient. They share the patient's follow-up information and data on the anesthesia procedure with anesthesiology and reanimation specialists. They help the patient to be safely taken to the recovery room following the end of anesthesia after the operation is over [10]. In the event of the absence of an anesthesia specialist, the first person to identify LAST is an anesthesia technician. Therefore, anesthesia technicians must be able to recognize the symptoms of LAST and initiate emergency response procedures when LAST develops. Literature data suggest that half of all cases of LAST develop in the absence of an anesthesiologist [11].

It is clear that the levels of knowledge and awareness among anesthesia technicians about LAST play an important role in providing safe and noncomplicated anesthesia. The recognition and appropriate management of rare but potentially fatal LAST symptoms in the early period can significantly prevent adverse outcomes. The primary aim of our study is to evaluate the level of information about the systemic toxicity of commonly used local anesthetics among anesthesia technicians, who are often the first to identify LAST. Our secondary aim is to ensure that appropriate plans are made for the necessary training in the event that a lack of knowledge exists.

Materials and Methods

This questionnaire study was carried out after obtaining the approval of the Atatürk University Faculty of Medicine Local Ethics Committee (date: 04.11.2021, decision number: B.30.2.ATA.0.01.00/). It was performed with anesthesia technicians working in a city hospital, a training and research hospital, a university hospital, a state hospital, and a private hospital. A questionnaire was used as a data collection tool. The questions were entered into the Google Forms software program, which is part of the web-based Google Docs Editors suite. These questions were prepared in line with the literature by reviewing previous studies. All participants were included in the study on a voluntary basis, and information on the study was given to all participants and their written informed consent was obtained before the questionnaire was administered. The questionnaire was prepared in a way that would be easily understood by everyone who completed it. It included 23 questions. A total of 200 people participated in the study, but 4 participants did not complete the questionnaire and their data were excluded. Thus, the completed questionnaires of 196 people were evaluated.

Statistical analysis

The data obtained in this research were analyzed using IBM SPSS Statistics 25.0 for Windows. While evaluating the data, descriptive statistical methods (number, percentage) were used. To test the relationships between categorical variables, chi-square analysis was used.

Results

The distribution of the participants who completed the questionnaire according to sociodemographic characteristics is provided in Table 1. The distributions of the participants' answers to the questions are given in Tables 2, 3, 4, and 5. The relationship between the professional experience of anesthesia technicians and knowledge of the early signs of LAST is shown in Table 6. The relationship between the professional experience of anesthesia technicians and knowledge of the immediate actions to be taken in the event of LAST is shown in Table 7.

Discussion

The findings of this study, which we obtained as a result of administering a questionnaire, reveal that the level of awareness and knowledge of LAST among anesthesia technicians is not sufficient.

LAST is a rare complication, but it may result in death [7,12]. It is possible to prevent fatal outcomes if precautions are taken in advance against the possibility of the development of LAST, and to ensure that LAST is detected at an early stage when it does occur so that the necessary interventions are performed in a timely manner [11,13]. Therefore, the LAST awareness and knowledge levels of local anesthesia practitioners are of crucial importance [14]. In local anesthetic applications in the operating room, the anesthesiologist and other surgeons work together with anesthesia technicians [15]. In the literature, a number of case reports have been published regarding situations where LAST developed in the absence of an anesthesiologist [16,17]. As a result, we believe that awareness and knowledge of LAST must also be high among anesthesia technicians. When the literature is examined, studies that aimed to measure the awareness and knowledge levels of physicians can be found [18,19]. Previous research has also measured the knowledge and awareness levels of certificated anesthesia nurses in the United States [20]. However, among the studies conducted in Turkey, there has been insufficient research on this subject for anesthesia technicians.

Anesthetic agents should be prepared in adequate doses according to the method that is used and the anatomical area to which they will be administered in order to prevent the development of LAST [21,22]. Local anesthetic drugs not prepared in adequate doses according to the route of administration and often unwittingly prepared in high doses enter the systemic circulation rapidly [23]. Perianesthesia

Table 1. Distribution of study participants according to sociodemographic data.

Variables		n	%
Gender	Male	98	50.0
	Female	98	50.0
Age	18-29	86	43.9
	30-40	66	33.6
	41-50	37	18.9
	Over 50	7	3.6
Educational Status	I am a graduate of the Technician Field. Health Vocational High School Anesthesia	27	13.8
	I am a graduate of Health Services Vocational School Anesthesia Technician	145	74.0
	Health Officer	21	10.7
	Other	3	1.5
Institution employed	City Hospital	64	32.7
	Training and Research Hospital	76	38.8
	University Hospital	32	16.3
	State Hospital	15	7.7
	Private Hospital	9	4.5
Professional experience	0-1 year	13	6.6
	1-5 year	48	24.5
	5-10 year	32	16.3
	Over 10 years	103	52.6
The educational status about local anesthetic drugs in the educational life	Yes	134	68.4
	No	38	19.4
	Not remember	24	12.2
In the institution employed, the status of receiving education on the local anesthetic drugs by the academic staff or anesthetic specialist	Yes	49	25.0
	No	122	62.2
	Not remember	25	12.8
Total		196	100.0

nurses should be aware of the maximum dose ranges of the administered anesthetic drugs in order to predict the potential development of LAST. Careful injections should be administered according to hospital protocol under the supervision of an anesthesiologist [24]. In our study, when the distribution of the participants was examined according to the people preparing local anesthetic drugs in the institutions in which the participants were employed, it was seen that 82.1% of the participants were anesthesia technicians, 6.6% of the participants were anesthesiologists, 8.7% of the participants were anesthesia assistants, and 2.6% had other job titles. Considering the distribution of the participants according to their knowledge of the maximum doses of the local anesthetic drugs used in their clinics, 48% of the participants answered "yes" to having such knowledge, 35.2% answered "no," and 16.8% stated that they did not remember. At this point, with a high rate of 82.1% of local anesthetic drugs being prepared by anesthesia technicians and less than half of the participants knowing the maximum doses of local anesthetics, it can be concluded that the knowledge levels of technicians are extremely important. Furthermore, when the distribution of participants according to their knowledge of LAST was examined, it was seen that 56.1% of the participants answered "yes" to having such knowledge, 24% of the participants answered "no," and 19.9% of the participants stated that they did not remember. In other words, 44% of local anesthetic drugs are prepared by 82.1% of the participants who do not know or do not remember the possible lethal complications of local anesthetic drugs.

Early detection of the development of LAST and the timely application of necessary interventions make it possible to prevent mortality [8]. The duration of time to the appearance of symptoms in cases of LAST varies in the clinical setting. It has been reported that LAST may appear within the first few minutes, after 30 minutes, or even 60 minutes after the administration of local anesthetic drugs. In the event of intravascular injection, symptoms may be observed in the first few minutes [25,26]. In our study, when the distribution of participants was examined according to the time of development of systemic toxicity after the administration of local anesthetic drugs, it was observed that 29.6% of the participants stated that symptoms would occur at the time of local anesthetic drug administration, 52% within the first 30 minutes, 10.2% after 60 minutes from administration, 1.6% after 120 minutes from administration, and 6.6% "other". The answer of the first 30 minutes was accepted as a reasonable answer in line with the literature. Regarding the distribution of participants according to the frequency at which a patient who

Table 2. Distribution of the answers given by the participants to the questionnaire.

Variables			n	%
The Local Anesthetic Agents Preferred in the Institution Employed	Bupivacaine	Yes	160	81.6
		No	36	18.4
	Lidocaine	Yes	169	86.2
		No	27	13.8
	Prilocaine	Yes	71	36.2
		No	125	63.8
	Levobupivacaine	Yes	2	1.0
		No	194	99.0
The Person preparing the Local Anesthetic Drugs in the institution		Anesthesia Technicians and technicians	161	82.1
		Anesthesiologists	13	6.6
		Anesthesia assistants	17	8.7
		Other	5	2.6
The Knowledge of the maximum doses of the Local Anesthetics used in the clinics		Yes	94	48.0
		No	69	35.2
		Not remember	33	16.8
The Method in use of the Local Anesthetic Drug in the institution	Subcutaneous	Yes	34	17.3
		No	162	82.7
	Intramuscular	Yes	21	10.7
		No	175	89.3
	Topical	Yes	11	5.6
		No	185	94.4
	Spinal/Epidural	Yes	176	89.8
		No	20	10.2
	Regional intravenous anesthesia (RIVA)	Yes	84	42.9
		No	112	57.1
	Intranasal	Yes	2	1.0
		No	194	99.0
	For peripheral nerve block, around the nerve	Yes	134	68.4
		No	62	31.6
	Infiltration block	Yes	41	20.9
		No	155	79.1

has received a local anesthetic application should be monitored in follow-up, 45.9% of the participants stated "every day," 20.4% stated "more than twice a week," 7.7% stated "once a week," 6.1% stated "once a month," 5.6% stated "3 or 4 times a year," and 14.3% stated "other." Thus, almost half of the participants follow patients who receive local anesthesia on a daily basis and this group is quite likely to encounter LAST at any time.

LAST manifests itself with CNS symptoms in the early period and later with cardiovascular symptoms [27]. The severity of CNS symptoms is dose-dependent. As the dose increases, the severity of the symptoms also increases. Tongue numbness, tinnitus, drowsiness, metallic taste, nystagmus, confusion, convulsions, coma, and respiratory arrest may occur, often in less than 1 minute [13]. Cardiovascular system symptoms generally appear after CNS symptoms. Tachycardia, hypertension, and arrhythmias are observed in the early period. As the amount of the local anesthetic drug increases in the blood, bradycardia, cardiac depression, cardiovascular collapse, and asystole may occur [28]. In our study, when the distribution of participants according to their knowledge of the early symptoms of LAST was examined, it was seen that 52% of the participants named respiratory depression as a symptom, 40.8% loss of consciousness, 29.1% cardiac arrest, 28.1% convulsions, 63.8% bradycardia, and 63.8% hypertension. These results show that the knowledge of anesthesia technicians regarding LAST symptoms is not sufficient. Considering the relationship between the knowledge of early symptoms of LAST and the occupational experience of these anesthesia technicians, it is seen that 69.1% of the participants with more than 10 years of experience an-

Table 3. Distribution of the answers given by the participants to the questionnaire.

Variables			n	%
The Most Commonly Used Three Peripherals Nerve Block in the Institution	Axillary block	Yes	124	63.3
		No	72	36.7
	Interscalene block	Yes	96	49.0
		No	100	51.0
	Supraclavicular block	Yes	80	40.8
		No	116	59.2
	Infraclavicular block	Yes	59	30.1
		No	137	69.9
	Femoral block	Yes	49	25.0
		No	147	75.0
	Sciatic block	Yes	43	21.9
		No	153	78.1
	Femoral block + Sciatic block	Yes	65	33.2
		No	131	66.8
	PSOAS compartment block	Yes	2	1.0
		No	194	99.0
	Lateral femoral cutaneous nerve block	Yes	10	5.1
		No	186	94.9
	Popliteal block	Yes	10	5.1
		No	186	94.9
	Digital blocks	Yes	9	4.6
		No	187	95.4
	Transversus abdominis plane (TAP) block	Yes	30	15.3
		No	166	84.7
	Ankle block	Yes	11	5.6
		No	185	94.4
	Penile block	Yes	11	5.6
		No	185	94.4

swered "yes" to convulsions being an early symptom of LAST and this answer was statistically significant. Convulsions are an early symptom. As the amount of professional experience increases, we think that clinical experience will lead to better recognition of the early symptoms of LAST. Furthermore, we are of the opinion that the insufficient knowledge obtained in the educational setting may be offset by professional in-service training sessions over the years.

The American Association of Regional Anesthesia and Pain Medicine created a checklist for LAST management. When LAST develops, the following steps must be done: stopping the local anesthetic administration, ensuring airway safety and administering 100% oxygen, calling for help, preparing for tracheal intubation, opening a safe venous line, treating the convulsions, and administering a 20% lipid solution [29]. In our study, 74% of the participants recognized stopping the local anesthetic administration as a step to be done, 84.2% ensuring airway safety and administering 100% oxygen, 65.3% calling for help, 65.8% preparing for tracheal intubation, 66.3% opening a safe venous line, 30.1% treating the convulsions, and 51% administering a 20% lipid solution. These values show that the participants do have knowledge about the treatment of LAST, but not to a sufficient level. Many case reports have shown that the use of a 20% lipid infusion is beneficial in reversing the effects of LAST [30,31]. Likewise, in animal studies, the efficacy of lipid emulation infusion was reported with the significant improvement of cardiac symptoms [32,33]. Lipid emulsion therapy is explicitly supported in the LAST treatment guidelines of the Association of Anesthetists of Great Britain and Ireland (AAGBI), the American Association of Regional Anesthesiologists (ASRA), and the American Heart Association (AHA) [7,34]. In our study, as the occupational experience of the participants increased, the probability of them knowing about the use of a 20% lipid solution increased. In general, the use of lipid emulsion for LAST therapy has increased over the last 10 years based on clinical and experimental studies, and as individuals gain more years of professional experience, they will also see more toxicity cases. With in-service training sessions, knowledge about the use of 20% lipid emulsion can be increased.

It is recommended that written protocols or algorithms and even LAST treatment kits be prepared in clinics for

Table 4. Distribution of the answers given by the participants to the questionnaire.

Variables			n	%
Local Anesthesia Administration (By Anesthesiologist or Any Surgical Branch) Follow-up Frequency of the Patient		Every day	90	45.9
		2 per week	40	20.4
		1 per week	15	7.7
		1 per month	12	6.1
		3-4 per year	11	5.6
		Other	28	14.3
Local Anesthetic Systemic Toxicity (LAST) Awareness		Yes	110	56.1
		No	47	24.0
		Not remember	39	19.9
After Local Anesthetic Drug is Administered, the period in which Systemic Toxicity Develops		At the moment when the Local Anesthetic Drug is administrated	58	29.6
		In the first 30 minutes	102	52.0
		After 60 minutes following the administration	20	10.2
		After 120 minutes following the administration	3	1.6
		Other	13	6.6
In any patient for whom Local anesthetic Application is administrated, Occuring of the Systematic Toxicity of Local Anesthetic (LAST)		Yes	51	26.0
		No	104	53.1
		Not remember	41	20.9
Type of application that developed LAST after local anesthetic drug administration	Subcutaneous	Yes	2	3.9
		No	49	96.1
	Intramuscular	Yes	1	2.0
		No	50	98.0
	Topical	Yes	1	2.0
		No	50	98.0
	Spinal/Epidural	Yes	15	29.4
		No	36	70.6
	Intranasal	Yes	1	2.0
		No	50	98.0
	For peripheral nerve block, around the nerve	Yes	26	51.0
		No	25	49.0
	Infiltration block	Yes	2	3.9
		No	49	96.1

the diagnosis and treatment of LAST [35]. In our study, when we asked participants about the presence of such an algorithm in their places of employment, 14.3% stated that an algorithm exists, 41.3% answered "no," and 44.4% did not know. Thus, we think it is likely that the physicians in these clinics do not educate or sufficiently inform the technicians in this regard.

Conclusion

It is our responsibility as anesthesiologists to ensure patient safety in medical practice. Therefore, we must take serious steps to educate our colleagues about LAST and its management.

In the field of health, we must not forget that the education quality of healthcare personnel is a key determinant of the quality of health services. Based on our findings, we think that anesthesia technicians require training to increase their awareness and knowledge of the symptomatology, prevention, and treatment of LAST. We believe that the education process of anesthesia technicians should be reviewed and that the management and education departments of hospitals should be more concerned about the educational needs of anesthesia technicians.

Limitations

The primary limitation of this study was the failure to achieve our goal of including more participants. Since it was a web-based survey study, it was designed as a multicenter study involving technicians working in different hospitals in different cities.

However, out of the large number of participants we

Table 5. Distribution of the answers given by the participants to the questionnaire.

Variables			n	%
Type of block that develops LAST after peripheral nerve blockade	Supraclavicular block	Yes	11	42.3
		No	15	57.7
	Infraclavicular block	Yes	16	61.5
		No	10	38.5
	Sciatic block	Yes	1	3.8
		No	25	96.2
	Digital blocks	Yes	1	3.8
		No	25	96.2
	Ankle block	Yes	1	3.8
		No	25	96.2
Early Stage Symptoms of LAST	Respiratory depression	Yes	102	52.0
		No	94	48.0
	Loss of consciousness	Yes	80	40.8
		No	116	59.2
	Cardiac arrest	Yes	57	29.1
		No	139	70.9
	Convulsion	Yes	55	28.1
		No	141	71.9
	Bradycardia	Yes	125	63.8
		No	71	36.2
	Hypertension	Yes	125	63.8
		No	71	36.2
In case of LAST development, The Things to be done urgently	Stopping local anesthetic administration	Yes	145	74.0
		No	51	26.0
	Ensuring airway safety and administering 100% oxygen	Yes	165	84.2
		No	31	15.8
	Calling for help	Yes	128	65.3
		No	68	34.7
	Preparation for tracheal intubation	Yes	129	65.8
		No	67	34.2
	Opening of safe venous line	Yes	130	66.3
		No	66	33.7
	Treatment of convulsions	Yes	59	30.1
		No	137	69.9
	Administration of 20% lipid solution	Yes	100	51.0
		No	96	49.0
20% Lipid Solution Presence in the Institution		Yes	63	32.2
		No	31	15.8
		Not knowing	102	52.0
Presence of Written Protocol/Algorithm for Diagnosis of Local Anesthetic Toxicity and Treatment		Yes	28	14.3
		No	81	41.3
		Not knowing	87	44.4

invited to complete the questionnaire, only 200 volunteered.

Ethics approval

This survey study was carried out by taking the approval of Atatürk University Faculty of Medicine local ethics committee, dated 04.11.2021 and decision numbered B.30.2.ATA.0.01.00/.

Table 6. Relationship between years of occupational experience and knowledge of early signs of LAST.

		Ocuupational Experience									
		0-1 Year		1-5 Year		5-10 Year		Over 10 Years		Test Value	p
		n	%	n	%	n	%	n	%		
Respiratory Depression	Yes	6	5.9	23	22.5	14	13.7	59	57.8	2.522**	0.471
	No	7	7.4	25	26.6	18	19.1	44	46.8		
Loss of consciousness	Yes	4	5.0	16	20.0	15	18.8	45	56.3	2.494**	0.476
	No	9	7.8	32	27.6	17	14.7	58	50.0		
Cardiac Arrest	Yes	1	1.8	12	21.1	10	17.5	34	59.6	4.115**	0.249
	No	12	8.6	36	25.9	22	15.8	69	49.6		
Convulsion	Yes	1	1.8	6	10.9	10	18.2	38	69.1	12.571**	0.006*
	No	12	8.5	42	29.8	22	15.6	65	46.1		
Bradycardia	Yes	7	5.6	28	22.4	17	13.6	73	58.4	4.988**	0.173
	No	6	8.5	20	28.2	15	21.1	30	42.3		
Hypertension	Yes	7	5.6	34	27.2	15	12.0	69	55.2	6.007**	0.111
	No	6	8.5	14	19.7	17	23.9	34	47.9	2.522**	

*p<0.05, ** Chi-square analysis.

Table 7. Relationship between years of occupational experience and knowledge of what should be done immediately in the event of the development of LAST.

		Ocuupational Experience									
		0-1 Year		1-5 Year		5-10 Year		Over 10 Years		Test Value	p
		n	%	n	%	n	%	n	%		
Stopping Local Anesthetic Adminstration	Yes	7	4.8	32	22.1	23	15.9	83	57.2	6.477**	0.091
	No	6	11.8	16	31.4	9	17.6	20	39.2		
Ensuring Airway Safety and administrating 100 % oxygen	Yes	10	6.1	37	22.4	27	16.4	91	55.2	3.676**	0.299
	No	3	9.7	11	35.5	5	16.1	12	38.7		
Call for help	Yes	7	5.5	29	22.7	22	17.2	70	54.7	1.748**	0.626
	No	6	8.8	19	27.9	10	14.7	33	48.5		
Preparation for tracheal intubation	Yes	8	6.2	27 20.9	20.9	21	16.3	73	56.6	3.230**	0.358
	No	5	7.5	21	31.3	11	16.4	50	44.8		
Opening of Safe venous line	Yes	5	3.8	28	21.5	20	16.4	77	59.2	9.380**	0.025*
	No	8	12.1	20	30.3	12	18.2	26	39.4		
Treatment of convulsions	Yes	1	1.7	5	8.5	10	16.9	43	72.9	18.602**	0.000*
	No	12	8.8	43	31.4	22	16.1	60	43.8		
Administration of 20% lipid solution	Yes	2	2.0	19	19.0	16	16.0	63	63.0	13.374**	0.004*
	No	11	11.5	29	30.2	16	16.7	40	41.7		

*p<0.05, ** Chi-square analysis.

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