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Original Research Article

The physical characteristics and anthropometric measurements among different gestational age of newborn infants

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ABSTRACT

Background: Prematurity or short gestational age is associated with increased neonatal mortality and morbidity. In low income or developing countries precise gestational age is still frequently not known and making the identification of premature newborns is not easy. The aim of this study was to investigate the physical characteristics and anthropometric measurements to estimate gestational age of newborn infants.
Methods: In a cross-sectional study, we included 90 pregnant women, 27 were preterm with gestational age 28-36 weeks, 55 were term with gestational age 37-41 weeks and remaining 8 were post term with gestational age 42-43 weeks. After normal delivery the physical characteristics and anthropometric measurements were recorded in all 90 singleton live newborns. Statistical analysis was performed using SPSS windows version 20.0 software.
Results: The physical characteristics namely sole creases, ear firmness, skin texture, skull firmness, hair texture and anterior Fontenelle were well developed in term and post term newborns as compared pre term newborns babies. All the anthropometric measurements such as length of infants, birth weight, head circumference, chest circumference and crown rump length were significantly higher in newborns of post term ($p<0.0001$) and term ($p<0.001$) groups as compared to newborns in preterm group.
Conclusions: It is concluded from this study that the physical characteristics and anthropometric measurements in generally have increased with the advancement of gestational age. Hence, physical characteristics and anthropometric measurement can be used to estimate the gestational age of newborn babies.

Keywords: Anthropometric, Gestational age, Newborns, Physical characteristics, Preterm birth, Term, Post term

INTRODUCTION

Anthropometric measurements of the newborn population are the most important precise research tool to study the factors and consequences of impaired or extreme foetal growth.[1] It is a non-invasive and inexpensive widespread technique to evaluate the body size, proportions, and individual composition. Importance of anthropometric measurement is the fundamental gold standard technique to explain growth at individual and population level.[2] Birth weight of newborn, the mainly broadly used anthropometric indicator of size at birth, does not only show the baby's growth, development, and endurance but also a precious indicator of maternal health, nutrition, genetics, socioeconomic status, environmental influences, and quality of antenatal services.[3] It is particularly strongly associated with fetal, neonatal, post-neonatal mortality, and with infant and child morbidity. Birth length and head circumference may give significant diagnostic and prognostic information further than that gave by birth weight alone.[4] Moreover, due to several technical problems in measurement of birth weight in developing countries like India, numerous literatures have shown that different anthropometric measurements can guess birth weight and used as legal indicators of low

birth weight.[5-7] It is well documented that normal neonatal anthropometric measurements vary at different gestational ages in most of countries but not well documented in the newborns populations of western region of India. Perinatal risk assessment can be done by weight percentile criteria, other anthropometric measurements such as crown heel length, head circumference, chest circumstance and ponderal index help in identifying at risk newborns.[8] There is no such measurement for universal use because it is dependent on racial, ethnic and geographic factors.[9] As valid measurement of the gestational age, size at birth, mainly birth weight and other anthropometric measurements as well as physical characteristics have not been studied during the neonatal period in the western region of India. Therefore, the present study was an effort to investigate the physical characteristics and anthropometric measurements among different gestational age of newborns population of western of India.

METHODS

The present cross-sectional study was performed in department of obstetrics and gynecology, at C.U. Shah medical college, Surendranagar, Gujarat, India for duration of two years from July 2014 to June 2016. Total 90 pregnant women were randomly selected from attending to the labour room, department of obstetrics and gynecology for the present study, out of which 27 were preterm with gestational age 28-36 weeks (group-I), 55 were term with gestational age 37-41 weeks (group-II) and remaining 8 pregnant women were post term with gestational age 42-43 weeks (group-III). All pregnant women were healthy and without signs of any kind of illness, normal duration of menstrual cycle, normal labour with no sign of fetal distress and there was no history of bleeding during 1st two months after last menstrual period, were included for present study. Women with history of malignancy, liver disease and any kind of blood disorders were excluded from study. They were also excluded if having any disorders related to cardiovascular system, central nervous system, respiratory system and endocrine system prior to the study.

A comprehensive reproductive (period of gestation, present and past illness, obstetric history) and menstrual (LMP and date of delivery) history of all the women was taken and their general, physical and systemic examination was performed to exclude any disease which was known to affect the present study. Abdominal examination was also performed in references to contour and girth of abdomen, height of fundus, size of uterus, fetal presentation and position and auscultation of fetal heart sound. Furthermore, using a structured questionnaire, interviewed the all women to obtain the information on socio-demographic characteristics, physical activity, dietary characteristics, personal and family history of diseases and hospitalization recorded in proforma. Informed consent was obtained from all the women or relative prior to start the study. The study protocol was approved by institutional ethics committee.

After normal delivery, all the 90 newborn infants were free from any disease or congenital malformations selected for present study. All anthropometric measurements were recorded after complete general, systemic, one minute APGAR score (appearance-skin color, pulse-heart rate, Grimace-reflex irritability, activity-muscle tone, and respiration) and physical or external characteristics examination in each newborn.[10] The birth weight of newborns babies was recorded in kilogram by on a standard salter no 50 balance. Length of newborn baby was measured in centimeters with using the scale, which was set into the measuring table. The baby was placed supine on the measuring table. The head was held firmly in position against a fixed upright head board. Legs were straightened, keeping feet at right angles to legs with toes upwards. A free footboard was brought with firm contact the newborn baby's heel. The length of the baby from crown to rump (ischial tuberositics) in centimeters was measured using measuring board with supports for the head and ischial tuberosities. The head circumference was measured by help of a plastic measuring tape passing over the most prominent part of the occipital and the forehead above the supra-orbital ridge. The chest circumference was measured by a plastic tape, at the level of nipples midway between inspiration and expiration.

Statistical analysis

Statistical analysis was done on IBM statistical package for social science (SPSS) version 20.0 and expressed as mean ± SD. Statistical analysis of the variance (anthropometric measurements) of newborns between different gestational age of women were compared by using unpaired independent student's t test. The p values<0.05 were considered statistically significant.

RESULTS

In the present study the external physical characteristics of the newborns were studied to ascertain the gestational age. Up to 36 weeks of gestation infant had smooth sole or few sole creases; absent or small breast nodule; fuzzy or wooly hair; pliable ear lobes due to lack of ear cartilage; underhanded or partially descended tests with empty scrotum; absent or few scrotal rigidities; in females, labia minora uncovered by labia majora; gelatinous or pink and thin skin and receding nails. After 37 weeks the sole creases well developed; breast nodules larger (4.7 mm); hair silky; earlobes stiff by folds of cartilages; testes fully descended; well-developed scrotal rugosities (male); labia minora fully covered by labia majora (female); nails normal; skin pink and thicker. In post term group (42 weeks and above); skin was pale and thick; hair course and nails projecting (Table 1 and 2).

Table 1: Physical characteristics of infants with different gestational age.

Length of gestation	Breast nodule		Male genitals-testes			Scrotal rugosities				All over	Genitals	Sole creases						
	Range	Mean in mm	Inguinal canal	Ring	Scrotal neck	Base	Absent	Few inferior surface	On lateral surface		Incompletely covered	None	None	1/4	1/2	2/3	3/4	1
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	1-3.2	2.00	1	2	-	-	-	2	-	-	6	-	3	3	3	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	0.8-5	2.1	1	2	-	-	-	3	-	-	2	-	0	3	2	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	4-8.6	3.7	-	1	-	-	-	1	-	-	2	-	-	-	-	-	2	-
33	3.1	3.1	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
34	3-5.0	3.2	-	-	2	-	-	-	2	-	1	-	-	-	1	1	-	1
35	5.0	5	-	-	1	-	-	-	1	-	-	-	-	-	-	1	-	-
36	3-3.9	6.3	-	-	1	1	-	-	1	-	1	1	-	-	1	-	3	1
37	10	10	-	-	1	-	--	1	-	--	-	-	-	-	-	-	-	-
38	5-10	8	-	-	4	2	-	-	4	2	-	6	-	-	-	6	5	1
39	8-10	9.5	-	-	-	5	-	-	-	5	-	1	-	-	-	1	-	6
40	5-10	9.39	-	-	-	11	-	-	-	11	2	18	-	-	-	-	-	30
41	8-10	9.7	-	-	-	3	-	-	-	3	-	2	-	-	-	-	-	5
42	8-10	9.75	--	-	-	3	-	-	-	3	-	4	--	--	-	-	-	7
43	10.00	10	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1

Table 2: Physical characteristics of infants with different gestational age.

Length of Gestation (weeks)	For cartilage			Skin texture			Skull firmness			Nail			Hair texture		Lanugo hair					Ant. Fontenelle	Total cases		Total
	Pinna soft flat	Begin in curv	Partial in curv	Full in curv firm erect	Thin shinv	Medium thickeners smooth	Opaque	Soft near A.F.	Springy at edges	Bone Displaces at	Non displaceable	Till tip	Beyond tip	Fine	Coarse	abscat	Face	Shoulder	Back	All over	Mean	Male	Female	
26	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
27	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
28	9	-	-	-	9	-	-	9	-	-	-	9	-	9	-	-	1	1	-	7	3.31	3	6	9
29	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	4	1	-	-	4	1	-	4	1	-	-	4	1	5	-	1	-	3	-	1	3.16	3	2	5

Continued.

Length of Gestation (weeks)	For cartilage			Skin texture				Skull firmness					Nail		Hair texture		Lanugo hair					Ant. Fontenelle	Total cases		Total
	Pinna soft flat	Begin in curv	Partial in curv	Full in curv firm erect	Thin shinv	Medium thickeners smooth	Opaque	Soft near A.F.	Springy at edges	Bone displaces	Non displaceable	Till tip	Beyond tip	Fine	Coarse	abscat	Face	Shoulder	Back	All over	Mean	Male	Female	
31	-		-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	-	3	-	-	3	-	-	3	-	-	-	-	-	3	-	-	-	-	1	2	3	1	2	3
33	-	1	-	-	1	-	-	-	1	-	-	1	-	1	-	-	-	1	-	-	2	1	0	1
34	-	1	2	-	1	2	-	1	3	-	-	2	1	1	2	-	-	1	2	-	3.7	2	1	3
35	-	-	1	-	-	1	-	-	-	-	-	1	-	-	1	-	-	1	1	-	3	1	0	1
36	-	1	2	2	-	4	1	-	4	1	-	4	1	-	5	1	1	-	3	-	3.5	1	4	5
37	-	1	-	-	-	-	1	-	1	-	-	-	1	-	1	1	-	-	-	-	4	1	0	1
38	-	-	1	11	-	6	6	-	5	7	-	6	6	-	12	7	-	4	1	-	3.85	6	6	12
39	-	-	-	6	-	-	6	-	1	5	-	2	4	-	6	7	-	-	-	-	4.04	5	1	6
40	-	-	3	28	-	1	5	-	8	20	-	5	26	-	31	25	1	3	1	-	3.79	11	20	31
41	-	-	-	5	-	-	7	-	1	2	2	2	3	-	5	8	-	-	-	-	3.8	3	2	5
42	-	-	-	7	-	-	1	-	1	3	4	1	6	-	7	6	-	1	-	-	3.93	3	4	7
43	-	-	-	1	-	-	-	-	-	-	1	-	1	-	1	-	-	-	1	-	2.5	1		1
44	-	-	-		-	-	-	-	-	-		-		-	-	-	-	-		-	-	-	-	-

Table 3: Anthropometric measurements of infants in various gestational age groups.

Anthropometric measurements	Gestational age groups	No of cases	Mean ± SD	Level of significant		
				Preterm v/s term	Preterm v/s post term	Term v/s post term
Length of infants (cm)	Preterm	N=27	43.5±3.7	t=9.67 p<0.0001	t=8.28 p<0.0001	t=14.18 p<0.0001
	Term	N=55	48.64±0.99			
	Post term	N=8	54.9±2.07			
Birth weight (kg)	Preterm	N=27	1.87±0.42	t=11.15 p<0.0001	t=8.29 p<0.0001	t=4.74 p<0.0001
	Term	N=55	2.74±0.28			
	Post term	N=8	3.28±0.43			
Head circumference (cm)	Preterm	N=27	29.79±2.46	t=8.75 p<0.0001	t=4.16 p<0.001	t=1.50 p>0.05
	Term	N=55	32.81±0.53			
	Post term	N=8	33.1±0.31			
Chest circumference (cm)	Preterm	N=27	26.74±2.61	t=10.86 p<0.0001	t=9.10 p<0.0001	t=0.51 p>0.05
	Term	N=55	30.70±0.53			
	Post term	N=8	30.85±1.75			
Crown rump length (cm)	Preterm	N=27	26.80±2.94	t=8.79 p<0.0001	t=6.56 p<0.0001	t=8.64 p<0.001
	Term	N=55	30.71±1.07			
	Post term	N=8	34.15±3.10			

The mean birth weight in the preterm group was 1.87 kg in term group 2.74 kg and in post term group 3.28 kg. The mean body length of preterm group was 43.5 cm, term group 48.64 cm and post term group were 54.9 cm. The average head circumference in preterm group was 29.79 cm in term group 32.81 cm and in post term group 33.1 cm. The mean chest circumference in preterm group was 26.74 can; term group 30.70 cm and in post term group 30.85 cm. the mean crown-rump length in preterm group was 26.80 cm in term group 30.71 cm and in post term group 34.15 cm.

The Table 3 shows the mean ± SD of the various anthropometric parameters in different gestational age groups. The length of infants was significantly higher in post term newborns ($p<0.0001$) and full-term newborns ($p<0.0001$) as compared to preterm newborns, moreover the length of infants statistically significant ($p<0.001$) lower in newborns of full-term group when compared to newborns of post term group. Similarly, birth weight of newborns infants significantly higher ($p<0.0001$) in infants of post term and term group as compared to infants of preterm. Furthermore, the head circumference of newborns infants was significantly ($p<0.0001$) more in infants of term group and post term group when compared to newborns in preterm group while there was no statistically significant ($p>0.05$) difference observed in head circumference of infants between term and post groups. The chest circumference was significantly ($p<0.0001$) higher in infants of term and post term groups as compared to infants of preterm group while there was no statistically significant ($p>0.05$) difference observed in chest circumference of infants in term group when compared to post term group. In the same way, the Crown rump length (CRL) was significantly higher in post term newborns ($p<0.0001$) and full-term newborns ($p<0.0001$) as compared to preterm newborns, moreover the Crown rump length statistically significant ($p<0.001$) lower in newborns of full-term group when compared to newborns of post term group. All the anthropometric measurements in generally have increased with the advancement of gestational age.

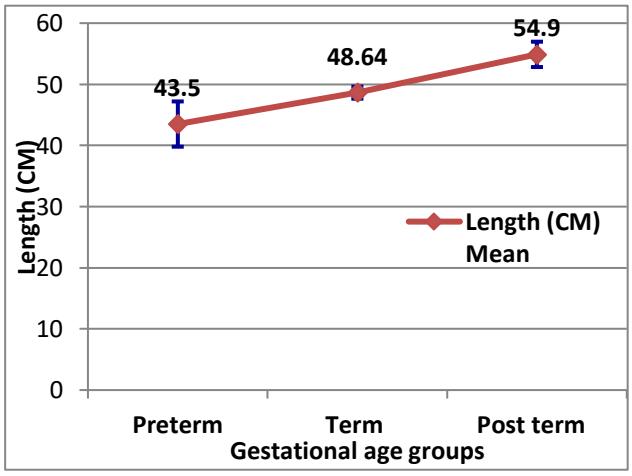

Figure 1: Length of infants in gestational age.

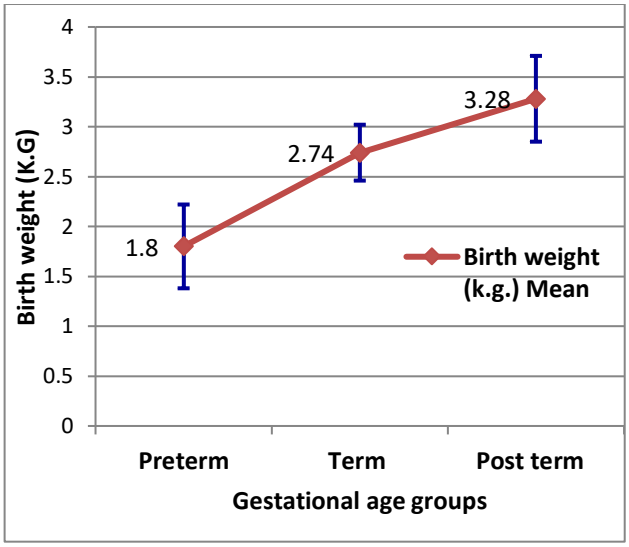

Figure 2: Birth weight of infants in gestational age.

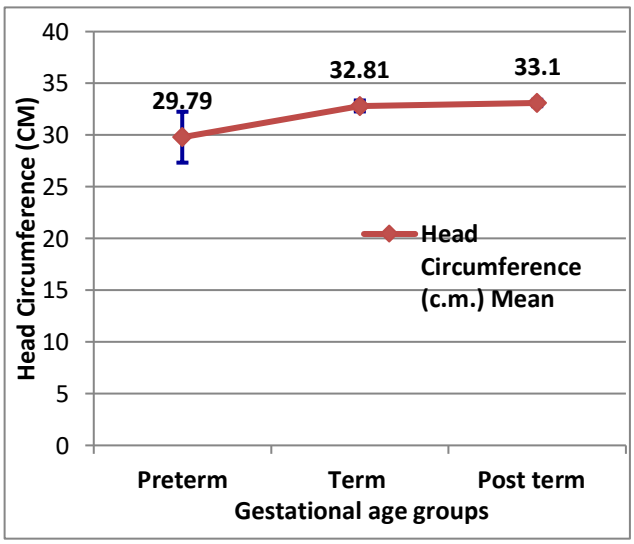

Figure 3: Head circumference of infants in gestational age.

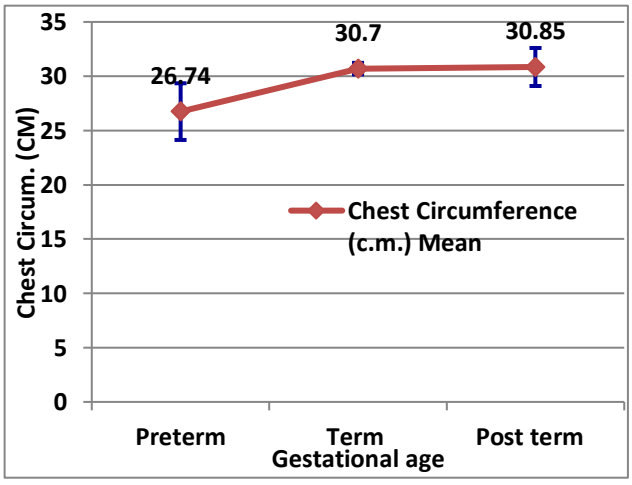

Figure 4: Chest circumference of infants in gestational age.

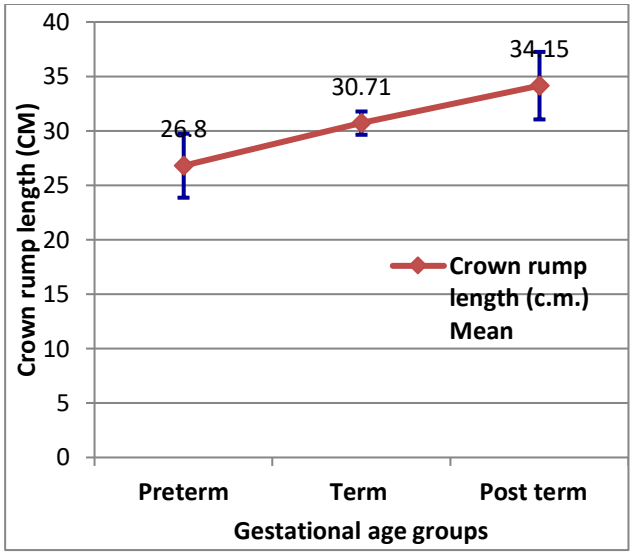

Figure 5: Crown rump length of infants in gestational age.

DISCUSSION

In the present study the anthropometric measurements and external physical characteristics of newborns at different gestational ages has been observed. In the study the external physical characteristics of the newborns were also studied to ascertain the gestational age. Up to 36 weeks of gestation the infant had smooth sole or few sole creases; absent or small breast nodule; fuzzy or wooly hair; pliable ear lobes due to lack of ear cartilage; undescended or partially descended tests with empty scrotum; absent or few scrotal rigidities; in females, labia minora uncovered by labia majora; gelatinous or pink and thin skin and receding nails. After 37 weeks the sole creases well developed; breast nodules larger (47 mm); hair silky; earlobes stiff by folds of cartilages; testes fully descended; well-developed scrotal rugosities (male); labia minora fully covered by labia majora (female); nails normal; skin pink and thicker. In the post term group (42 weeks and above); skin was pale and thick; hair course and nails projecting. The relationship between external physical characters and gestational age has been established by several previous studies, have been done by Usher, Al-Mansoob, Allan and Narayana et al.[11-14] The findings of present study are well correlated with these observers.

The average birth weight in the preterm group was 1.87 kg in term group 2.74 kg. and in post term group 3.28 kg. The average body length of preterm group was 43.5 cm, term group 48.64 cm and post term group were 54.9 cm. The average head circumference in preterm group was 29.79 cm in term group 32.81 cm and in post term group 33.1 cm. The average chest circumference in preterm group was 26.74 can; term group 30.70 cm and in post term group 30.85 cm. the average crown-rump length in preterm group was 26.80 cm in term group 30.71 cm and in post term group 34.15 cm.

The all-anthropometric measurements like length of infants, birth weight, head circumference, chest circumference and Crown rump length were significantly higher in post term newborns and full-term newborns as compared to preterm newborns. Moreover, the all these measurements statistically significant lower in newborns of full-term group when compared to newborns of post term group while there was no statistically significant difference observed in head and chest circumference of infants between term and post groups. All the anthropometric measurements in generally have increased with the advancement of gestational age. The results of the present study compare favorably with the results of various earlier studies which was done by Finnstrom, Balkrishna and Kheir et al.[15-17] According to them all anthropometric measurements in general have increased with the advancement of gestational age, the values for length and weight were higher in the studies done by Finnstrom and Kheir et al than the present study.[15,17] This may be the result of deficient nutritional state increased parity, different climatic condition and racial and geographical variation.

There are few limitations of the study, first is that, this is a cross sectional design, further a prospective cohort study studies are needed to investigate the interactions between anthropometric measurement and different gestational age and their relation with physical characteristics of the newborn. Second point of consideration is that we did not include the various factors governing the birth weight, other biochemical and radiological investigations which might be accountable for estimation of the gestational age of newborn babies.

CONCLUSION

The results of physical characteristics as well as anthropometric measurements namely length of infants, birth-weight, crown heel length, head circumference and chest circumference provide documentations for the care of newborns. Anthropometric measurements and physical characteristics can be use in epidemiological and clinical references. The assessment of charts referring to different and clearly defined population living in the same country or indifferent countries is a technique of assessing the extent of discriminations in health between populations or to supervise trends over time in response to public health development program. From a clinical view point, anthropometry is a tool to find out newborns at higher risk of neonatal and postnatal morbidity and growth improvement. The physical characteristics and anthropometric parameters should be assessed routinely after delivery and noted in each birth certificate. We concluded that enforcement on improvement of maternal and child health services with emphasis on better accessibility to antenatal care as well as physical characteristics and anthropometric measurement can be used to estimate the gestational age of newborn babies. Present study suggested that further more clinical interventions are required to reach a consensus on how to

combine neonatal and prenatal information to discriminate different neonates.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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