11. A. S. Sobolev, S. D. Zhamsaronova, A. N. Orekhov, et al., Radiobiologiya, 14, No. 1, 78 (1974).
12. R. J. Boucek, in: Serotonin in Health and Disease, Vol. 4, New York (1978), pp. 1-39.
13. G. A. Buznikov, in: Neurotransmitters. Comparative Aspects, J. Salanki and T. M. Turpaev, eds., Budapest (1980), pp. 7-29.
14. W. B. Quey, Adv. Pharmacol., 6, 283 (1968).

BINUCLEAR CELLS DURING POSTEMBRYONIC DEVELOPMENT AND REGENERATION OF THE CHICKEN LIVER

UDC 612.35.014.2:612.6.03+
612.35.014.2:612.647

K. A. Dzhivanyan and K. S. Ter-Oganyan

KEY WORDS: liver; somatic polyploidization; postembryonic development; regeneration.

An important feature of postnatal growth and regeneration of the mammalian liver is that an important role in these processes is played by somatic polyploidization, which is accompanied by the appearance of a population of binuclear cells, averaging 17-20% of the total number of cells [3, 7, 11, 15]. The possible mechanism of formation of these cells is considered to be amitotic division of the polyploid nucleus [3, 7, 8]. The number of binuclear cells in the mammalian liver is subject to regular changes in postnatal development during the 24-h period with changes in the functional load on the organ [1, 8, 11]. A considerable (3-10-fold) decrease in the number of binuclear cells has been described in the rat, rabbit, mouse, and monkey liver in the early stages after partial hepatectomy [2, 10, 11]. It has been suggested that binuclear cells are the source of formation of mononuclear tetraploid [10, 15] cells, although there are data [14] to show that there are no significant changes in the number of binuclear and polyploid cells in the regenerating rat liver in different age groups and that regenerative growth of the organ is entirely on account of an increase in the number of cells.

In this investigation changes in the number of binuclear cells were studied over a period of time in the chicken liver during postembryonic development and after partial hepatectomy. This subject has not been studied previously [4, 6, 12].

EXPERIMENTAL METHOD

The intact and regenerating liver of chickens aged 40 days, 5-6 months, and one year or more was studied. Part of the right lobe, accounting for 1/5-1/4 of the weight of the liver, was removed from the experimental birds. Material for investigation was taken from the resected lobe and from the left, intact lobe. Pieces of liver were fixed in Bouin's and Carnoy's fluids and processed by the usual histological methods. All experimental and control birds were killed at the same time of day.

EXPERIMENTAL RESULTS

Binuclear cells are rarely found in the intact chicken liver at the age of 40 days and they account on average for not more than 0.3% of the total number of cells (Table 1).

The number of binuclear cells in both lobes one day after resection of the liver in chickens aged 40 days was increased more than threefold. Later their number continued to rise, to reach a maximum 15-30 days after the operation, when it was 5-6 times higher than the control. The number of binuclear cells in the liver two months after hepatectomy was

Department of Zoology, Erevan University. (Presented by Academician of the Academy of Medical Sciences of the USSR A. P. Avtsyn.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 95, No. 1, pp. 91-93, January, 1983. Original article submitted August 13, 1982.

0007-4888/83/9501- 0123$07.50

TABLE 1. Changes in Number of Binuclear Cells in Regenerating Liver of Chickens Aged 40 Days, 5-6 Months, and One Year

Age of birds	No. of birds	Time of observation, days	Zone of resection		Left intact lobe	
			No. of binuclear cells, percent	% of control	no. of binuclear cells, percent	% of control
40 days	8	Control	0,19±0,01	—	0,27±0,07	—
	5	1	0,63±0,25	331,6	0,80±0,25	293,6
	6	5	0,73±0,1	384,2	0,86±0,96	318,5
	6	15	1,14±0,22	600,0	1,11±0,26	401,1
	5	30	1,03±0,28	542,1	1,23±0,45	455,5
	6	60	0,39±0,05	139,3	0,44±0,04	141,9
	6	Final control	0,28±0,03	—	0,31±0,03	—
5—6 months	8	Control	0,36±0,05	—	0,35±0,05	—
	6	3	0,43±0,1	119,4	0,6±0,05	166,6
	6	5	0,59±0,19	163,9	0,83±0,26	230,5
	6	10	0,56±0,15	155,5	0,84±0,14	222,2
	6	20	0,63±0,06	175	0,83±0,07	230,5
	6	30	0,7±0,18	194,6	0,84±0,15	233,3
	6	60	0,57±0,16	142,2	0,55±0,09	122,2
	6	Final control	0,4±0,07	—	0,45±0,14	—
1 year	7	Control	0,51±0,04	—	0,52±0,02	—
	6	1	0,74±0,25	145,1	0,87±0,26	167,5
	6	5	0,78±0,12	152,9	1,07±0,21	205,8
	5	15	1,08±0,22	211,7	1,05±0,1	201,9
	6	30	1,2±0,52	235,3	1,09±0,25	209,6
	6	60	0,49±0,09	96,1	0,52±0,2	100
	6	Final control	0,51±0,02	—	0,52±0,02	—

considerably reduced, but it was still 40% above the control value.

The number of binuclear cells in the liver of chickens aged 5-6 months months was a little greater (Table 1). Partial hepatectomy also caused an increase in their number in this group of birds. A maximum was reached 20-30 days after the the operation. The number of binuclear cells was smaller two months after the operation, but it was still higher than the control.

The number of binuclear cells in the intact liver of chickens aged one year or more was very slightly increased. The dynamics of the change in the number of these cells after partial hepatectomy obeyed the same rules as in younger birds. In chickens of this age group the number of binuclear cells in the liver returned to the control value two months after the operation.

Postembryonic growth of the liver in chickens, just as in mammals, is thus accompanied by an increase in the number of binuclear cells. However, their maximal number, observed in chickens one year old, did not exceed 0.55% of the total number of cells.

Partial hepatectomy in chickens, unlike in mammals, caused an increase in the number of binuclear cells in the period of most rapid regenerative growth of the organ. When this phenomenon is appraised it is important to bear in mind that regenerative growth of the liver in chickens takes place mainly on account of hypertrophy of the cells [5]. A high percentage of cells with very large nuclei, probably polyploid, is formed under these circumstances [11]. So far as mitotic cell division is concerned, when regeneration of the liver was studied in chickens of different age groups, few mitotically dividing cells were observed (in the intact chicken liver mitosis is an extremely rare event). Under these circumstances the formation of new binuclear cells as "an additional means of intensifying cell metabolism" [3], is a compensatory reaction under conditions of increased functional load in the first month of regeneration of the organ. During the second month of regeneration the number of binuclear cells is reduced. On the basis of these observations and also of conclusions drawn by the workers cited above, it can be postulated that these cells become the source for formation of polyploid cells.

LITERATURE CITED

1. A. M. Astakhova and V. I. Anufriev, Tr. Mosk. Ova. Ispyt. Prir. Otdel. Biol. Nauk, 37, 64 (1971).

2. I. D. Belyaeva and T. S. Ivleva, Byull. Éksp. Biol. Med., No. 4, 347 (1979).
3. V. Ya. Brodskii, Cell Nutrition [in Russian], Moscow (1966).
4. N. I. Grigor'ev, Structure and Regeneration of the Liver after Local Injury [in Russian], Leningrad (1975).
5. K. A. Dzhivanyan and K. S. Ter-Oganyan, Biol. Zh. Arm., 28, No. 4, 45 (1975).
6. R. P. Zhenevskaya, in: Problems in Regeneration of Organs and Tissues of Vertebrates [in Russian], Moscow (1954), p. 40.
7. S. S. Laguchev, Vestn. Akad. Med. Nauk SSSR, No. 7, 62 (1963).
8. M. T. Lutsenko, in: Proceedings of a Conference to Celebrate the Centenary of the Department of Histology, S. M. Kirov Military Medical Academy [in Russian], Leningrad (1968), p. 140.
9. T. L. Marshak, Ontogenez, No. 2, 192 (1974).
10. A. M. Polischuk, E. Yu. Kalmykova, and A. V. Urzhenko, Ontogenez, No. 3, 300 (1976).
11. Z. A. Ryabinina and V. A. Benyush, Polyploidy and Hypertrophy of Cells during Growth and Regeneration [in Russian], Moscow (1973).
12. V. F. Sidorova, in: Abstracts of Proceedings of the 2nd Conference on Regeneration and Cell Multiplication [in Russian], Moscow (1960), p. 89.
13. I. V. Uryvaeva and M. E. Lange, Ontogenez, 2, 26 (1971).
14. J. James, P. Pel, K. S. Bosch, et al., Eur. J. Cell Biol., 23, 137 (1980).
15. C. Nadal and F. Zajdela, Exp. Cell Res., 42, 99 (1966).