Infection and Tumor Formation in Chickens By Avian Leukosis Virus

By TAKEHIKO SHIMIZU

Chief, 3rd Research Section, Equine Infectious Anemia Division,
National Institute of Animal Health

Lymphoid leukosis in chickens is a disease which arises from the result of complicated interaction between avian leukosis virus (ALV) as a pathogenic organism and chicken as a host. This report is intended to outline our present knowledge about genetic resistance of chickens in lymphoid leukosis.

The defense of host in infectious disease could be considered dividing it into two: one as a working defense when a virus infects and the other as a working defense when a disease arises.

Also in the case of lymphoid leukosis it could be considered in dividing into two by recent progress of study on avian tumor virology.

ALV is closely related to Rous sarcoma virus (RSV) in chemical as well as biological properties, and they are the members of avian leukovirus as classified by Fenner.[4]

The recent studies have revealed that all the avian leukovirus share common antigen of core proteins and they could be divided into four subgroups (A, B, C, D,) by the difference in characteristics of the envelope: these four subgroups are classified by the neutralizing test which reflects the function of surface of virion, and by the specificity in host range and in interference pattern.

It is also an important feature of avian leukovirus that they readily produce phenotypic mixers between the viruses belonging to different subgroups by their coinfection.

For example, if subgroups A and B virus infect together a single cell, a virus which has genome of subgroup A and envelope of subgroup B, and a virus which has genome of subgroup B and envelope of subgroup A etc. are formed, not to mention that each virus is formed independently, of which a special example is a virus called pseudotype of RSV which has genome of RSV and envelope of ALV of each subgroup.

As the characteristics of the virus controlled by envelope are all the same with those of ALV which offers envelope, they are used as indicator viruses to examine the antigenicity and the host range of each ALV.

Genetic resistance of chickens to virus infection

It has been known for a long time that the susceptibility to ALV depends largely upon the kind of chickens used. It has been considered that the difference of susceptibility is related to the genetic factor, but it has not been known whether it works on a defense when a virus infects or the one when a disease arises.

With a discovery of subgroups A and B of ALV, a cell line (it is expressed by C/B) with resistance has been found selectively in subgroup B, and it has been clarified by the progeny test that the resistance is controlled by a single pair of autosomal gene, and the susceptible factor is dominant and the resistant factor is recessive.[6]

Then the existence of chicken cell (C/A)

with a phenotype which shows a resistance selectively to infection with subgroup A has been discovered, which is also controlled by the similar genetic rule, but independently from the genetic resistance to subgroup B.

It is known at present by the subsequent study that there exist many cells which show phenotypes such as C/A, C/B, C/AB and C/BC, besides a chicken cell with susceptibility to the infection with all subgroups (C/O).

However the genetic susceptibility to this infectious disease was recognized in the case of cell culture; it is still necessary to make sure of it with intact chicks. Waters et al.[7] have observed that all chickens of six lines show susceptibility to RSV of subgroup A, those of seven lines do resistance and all F_1's do susceptibility.

Similar observation has been also confirmed by Crittenden et al. who used an antibody production after inoculation of RPL-12 strain of ALV as a criterion of infection. As a result, it has been clarified that chickens of all six lines show homozygous susceptibility to infection of subgroup A and those of seven lines of homozygous resistance.

It was observed by our susceptibility test that all chickens of B line with a phenotype of C/AB showed resistance while those of I line with a phenotype of C/O did susceptibility by inoculating subgroup A virus. Thus, it is clear that the genetic control of susceptibility to the infection of ALV, which has been discovered by the susceptibility test of cultured cell, could apply to chicks as it is now.

Then, how about the susceptibility to ALV of general commercial chickens? Calnek in the United States has examined the distribution of genetic susceptibility of the layer, using more than 1,000 fertile eggs and showed a result that 48.1% of the eggs show a phenotype of C/O, 1.3% do C/A, 42.0% do C/B and 8.6% do C/AB. Our result of the layer in Japan also showed the similar tendency to the above mentioned.[5]

Thus, if chickens with genetic resistance to infection of subgroup B virus occupy considerable proportion of chicken population in the fields, it could be considered that it may well influence upon the dissemination of subgroup B virus.

Actually, according to the results of the antibody survey of layers in Japan, about 50% of chickens had antibody to subgroup A, while a low incidence (about 10%) of antibody was found to subgroup B. Virus has been attempted to isolate from abnormal chickens.

As a result, from 50 examples (35%) out of 141 examples examined subgroup A virus has been isolated, while there were only eight examples (6%) from which subgroup B has been isolated, indicating that the infection of subgroup B virus is under the condition of being hard to be spread.

Moreover, out in the field there was no example which subgroups C and D virus isolated. Consequently, subgroup A virus plays the lead of ALV infection out in the field.

Genetic resistance of chickens in tumor formation

As mentioned above, when the infection has made an index, most of the commercial chickens may be susceptible to subgroup A virus, and maybe more than half will be infected by the virus. Nevertheless, actual loss due to lymphoid leukosis is estimated to be about 3% of hatched chickens, which means that most of them remain subclinical after infection. It could be easily imagined that some factors are required for tumor formation, besides genetic susceptibility of chickens to virus infection.

Burmester et al.[1] have clearly proved that the morbidity depends on the kinds of chickens: when RPL-12 strain of subgroup As is inoculated into chicks of lines 6 and

15, almost all of them are infected while the morbidity of line 6 is 15-40% and that of line 15 is 77-95%.

It is difficult to analyze the genetic resistance to the development of disease, since the pathogenesis of lumphoid leukosis is not sufficiently understood at present, but it is considered that the development of disease will be inversely related to the strength of transplantation immunity of the host for tumor cells, if it will be decided by whether the primary microtumor regresses or develops to make metastases after its formation in the follicle of the brusa of fabricius.

The observations that chickens are rather apt to be attacked with a disease when they are infected at the early time after birth or at the embryonic stage, may be compatible with the concept that the disease is apt to arise more, if a virus infects at the earlier time when defense mechanism of an individual is not yet developed.

But as there is no difference in the incidence of neutralizing antibody between attacked chickens and the unattacked ones, it is considered that the strength and weakness of neutralizing antibody production for virus is not much related to the development of disease.

At all events, the chicks of line 15 developed as the line susceptible for avian leukosis show a morbidity of above 90% by experimental inoculation and as high as 40% even by natural infection, while commercial chickens show a morbidity of about 3% at the most, which suggests that commercial chickens with high resistance to development of disease have been selected as the result of breeding for many years.

While chicks of four weeks old of several lines have been infected with RSV, most of the chickens with tumor produced have died of its malignancy, but about 70% of the chickens of special lines have regressed after the formation of tumor.

It is presumed that this type of resistance to disease acts not only for RSV infection and lymphoid leukosis but also for the preventions and the regression of the other infectious diseases which will be noticeable in the future.

The construction of the genesis is not proved at all at present, but it will be possible to make a breeding experiment if only some proper index should be obtained.

The genetic resistance to infection is already being accepted for the actual breeding and it is expected that genetic resistance to the attack of disease is positively introduced for the breeding of pure breed of chickens.

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Table 1. Incidence of genetic resistance to subgroups A and B virus in chick embryos from commercial flocks

Flock code	No. tested	Phenotype classification			
		C/0	C/A	C/B	C/AB
C-1	30	23	0	7	0
C-2	40	22	0	18	0
C-3	79	58	3	18	0
Totol (%)	149	103 (69. 1)	3 (2. 0)	43 (28. 8)	0 (0)

Table 2. Tumor formation and regression after RSV (RAV-1) infection in chickens

Line	Tumor formation (%)	Regression (%)
A	77/96 (82. 2)	57/77 (74. 0)
B	17/17 (100)	13/17 (76. 4)
I	17/17 (100)	0/17 (0)
Y	93/98 (94. 8)	0/93 (0)