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APPLICATION OF THE EGG TRANSFER TECHNIQUE IN CATTLE AND SHEEP

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SUMMARY

The surgical egg transfer technique is useful for the multiplication of cattle and sheep. The present impetus for its application is the financial gain to be made from the multiplication of expensive animals and so commercially its use is mainly confined to cattle.

Experiments to improve the efficiency and therefore the application of the technique should be directed towards the development of successful non-surgical recoveries and transfers in cattle, and, in both cattle and sheep, towards greater production of fertilized eggs from individual donors and techniques for the long-term storage of eggs.

INTRODUCTION

The egg transfer technique has potential as a useful tool in livestock improvement since it enables the genetic exploitation of the female to a much greater extent than is at present possible. The average New Zealand dairy cow gives birth to between 4 and 5 calves during her productive life and similarly an average sheep gives birth to about 5 lambs. However, by repeatedly superovulating animals and then transferring the recovered fertilized eggs to recipient animals, the number of offspring born to an animal could be substantially increased. This would enable the rapid multiplication of desirable individuals and, with refinement of the technique, could mean that females, as well as males, could be given a merit score based on the performance of their progeny.

SURGICAL EGG RECOVERIES AND TRANSFERS

Under research conditions the surgical recovery and transfer of cattle and sheep eggs gives satisfactory recipient calving or lambing rates provided the onset of oestrus in the donor and recipient animals is closely synchronized (cattle, Rowson *et al.*, 1972a; sheep, Moore and Shelton, 1964).

The present impetus for the application of the technique is the financial gain to be made from the rapid multiplication of expensive animals. The individual cow is usually more expensive than the sheep; for this reason the cow is currently

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attracting most interest and surgical egg transfers are being done commercially in Britain, Canada, United States, Australia and New Zealand. The technique is limited mainly to exotic cattle since the financial return from the additional calves produced should offset the expense of surgery, the possibility of adhesions of the reproductive tract and the refractoriness of the donor to repeated injections of pregnant mares' serum gonadotrophin (PMSG). In a commercial situation, a combination of a satisfactory batch of PMSG, close synchronization of onset of oestrus in donor and recipient animals, careful surgery (where the eggs are flushed from the donor uterus and where the ovaries and fallopian tubes are not manipulated and therefore do not develop adhesions), and possibly allowing the donor to conceive and calve between operations (to allow the refractoriness to PMSG to decline and perhaps allow some adhesions to break down), could mean that a donor could undergo up to 5 egg-recovery operations. On average, these should furnish a total of 25 fertilized eggs and result in the birth of about 15 calves. Results from commercial firms are not readily available. However, the recipient conception rates, which should approximate 60%, are between 27% and 57%, while donor animals undergoing their third or fourth laparotomy have been observed to be virtually adhesion-free (Tervit, personal observations).

The commercial application of the egg transfer technique has indicated areas for further research. The results of research into methods of achieving more reliable superovulation of cattle (Elsden *et al.*, 1973; Moore, 1973) and more exact synchronization of oestrus (Tervit *et al.*, 1973) will assist the application of the technique. Information on the number of times a donor can be subjected to egg recovery should be available in the next two years. Commercial results also show that, while the technique is essentially a simple one, much practice is necessary before reliable results can be achieved.

Before the egg transfer technique can be used widely in commercial herds it must involve non-surgical egg recovery and transfer techniques and successful techniques for the long-term storage of eggs.

NON-SURGICAL EGG RECOVERY

Apparatus is available for the non-surgical recovery of eggs (Sugie *et al.*, 1972a) but the recovery rate is low (estimated at 40%). Similar apparatus has given better recovery rates in the horse (Oguri and Tsutsumi, 1972). This suggests that, since the uterine horns of the horse have less marked ventral curvature than the cow, the problem of egg recovery in the cow

may be related to the shape of the uterus and the difficulty in developing apparatus to flush the uterine horns effectively. New apparatus is being developed and it is hoped that the recovery rate can be substantially increased with the use of different apparatus.

NON-SURGICAL EGG TRANSFER

The first calf to be born after a non-surgical egg transfer was reported by Mutter *et al.* (1964). This calf was born after a 16-cell egg had been transferred to a recipient which received no medication at the time of transfer. Subsequently, several workers have reported pregnancies after the non-surgical transfer of eggs into recipients whose uteri had been inflated with CO₂ either before or after the deposition of the egg (Sugie, 1965; Rowson and Moor, 1966; Rowson *et al.*, 1969; Vincent *et al.*, 1969; Sugie *et al.*, 1972b). As pregnancy rates were usually low (< 30%) it has been proposed that the failure of non-surgical transfers during the early luteal phase was due, in part, to expulsion of the eggs from the uterus and that this expulsion may have been a result of uterine contractions induced by the oxytocin release following stimulation of the cervix during the actual transfer (Harper *et al.*, 1961). However, further experimentation (Rowson *et al.*, 1964; Rowson *et al.*, 1972b) and the results of Sugie (1965) and Sugie *et al.* (1972b) where the cervix was by-passed during the non-surgical transfer, suggest that it is unlikely that oxytocin is involved in the ejection process and so the uterine contractions causing egg expulsion could be the result of a local action of the transfer procedure *per se* on the uterus and cervix.

Experiments with radioactive gold spheres, approximately the same size and density as cattle eggs, have shown that when the non-surgical transfer was delayed until day 7 or 8 (oestrus, day 0) of the oestrous cycle, significantly more spheres were retained in the uterine horns compared with when the transfer was done on day 4 or 5 (Tervit *et al.*, unpubl. data). It is thought that the increased endogenous progesterone levels occurring in the cow on days 7 and 8 cause this increase in sphere retention by reducing uterine motility. When eggs were transferred non-surgically at two stages of the oestrous cycle (early, days 3 to 5; late, days 6 to 10) the highest conception rate, 40% (8/20), was achieved in a late-stage treatment (Lawson *et al.*, unpubl. data). However, the late-stage treatment conception rates were lower than those predicted from the "sphere" results. A possible cause of this discrepancy could have been the introduction of organisms into the uterus

at a stage in the oestrous cycle when the uterus was extremely susceptible to infection (Rowson *et al.*, 1953). The resulting infections may have caused embryonic mortality. While this work is encouraging, since, except for a 100% (2/2) conception rate reported by Sugie (1965), the 40% conception is the highest yet reported from non-surgically transferred ova, more experimentation is necessary to achieve higher conception rates.

DEEP-FREEZE EGG PRESERVATION

The report, by Wilmut and Rowson (1973), of the birth of a calf after a blastocyst had been stored for 6 days at -196°C and then thawed and transferred to a recipient cow, offers great hope that it will be possible to develop techniques for the routine deep-freeze preservation of cow eggs. A second calf has now been born from a frozen egg (Wilmut and Rowson, pers. comm.) but it is obvious, from the poor survival of the embryos, that marked improvement in the technique is necessary before it can have any practical application. However, once perfected, the freezing technique will have enormous benefits. Eggs from rare breeds and strains could be preserved, eggs could be transported from country to country in a frozen state and the technique could become an integral part of any commercial egg transfer service.

FUTURE DEVELOPMENTS

Ultimately the egg transfer technique in cattle may involve non-surgical egg recoveries; the recovery of large numbers of immature eggs from the ovary followed by the maturation (Hunter *et al.*, 1972), fertilization and culture (Tervit *et al.*, 1972) of the eggs to a stage where they can be sexed and deep-frozen; and non-surgical transfer of the thawed eggs to produce single or twin offspring.

When one egg is transferred surgically to each uterine horn of recipient cattle, approximately 50% of the recipients give birth to twin offspring (Rowson *et al.*, 1971). If this twinning could be done non-surgically it could be useful in the beef industry since the problem of freemartins is not important. However, it may be necessary to establish experimentally the uterine capacity of the various breeds of cattle since, in the sheep, it has been established that different breeds have different uterine capacities (Lawson and Rowson, 1972).

Despite the demonstration of the ability of the surgical egg transfer technique to rapidly multiply individual sheep (Rowson and Adams, 1957) or groups of sheep (Moore and Shelton,

1962; Clark and Allison, pers. comm.), the technique has seldom been used in commercial flocks. The technique has similar requirements and difficulties to that described in the cow and it is considered that it would be useful in the multiplication of valuable exotic animals and superior individual animals.

It is not practical to perform the non-surgical recovery and transfer of sheep eggs. To improve the surgical technique, further experimentation should be directed towards methods of increasing the number of fertilized eggs available for transfer and by developing techniques for the successful long-term storage of eggs.

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