

STUDY AND PREPARATION OF PORCINE XENOGRAFT DRESSINGS

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Temporary biological dressings used for burns are highly effective and important. In this paper are discussed the effects of dose, dose rate, storage temperature, death time and enzyme survivors on the properties of porcine xenografts. In addition the porcine xenografts impregnated with silver ions, possessing both bacteriostatic and bactericidal properties, have been detailed.

Keywords: Xenograft Homograft Burns Biological dressing Porcine-xenograft impregnated with silver ions Oxygen consumption

Temporary biological dressings are essential and life saving for large skin defects, such as extensive burns, until permanent repair with autografts can be instituted. Skin homografts are useful for temporary resurfacing of wounds and constitute a valuable method of therapy. However it is often difficult to obtain an adequate supply of suitable tissues, whether from living donors, cadavers or tissue banks. For example, about 6000 cm² of skin is required for coverage in an adult with a 50% full-thickness burns. This need for human skin substitutes promoted many investigators to search for materials from animal sources. It was reported that porcine xenograft dressings to be of great value in the treatment of partial-thickness burns by many investigators^[1~3]. The fresh pigskins have been in use at the Burns Treatment Center in Rei Jin Hospital in Shanghai China since 1970. But the application of irradiated pigskins began only several years ago. Now we are in collaboration with Rei Jin Hospital to produce porcine xenografts and porcine xenografts impregnated with silver ions. The latter is used for treatment of contaminated wounds. The porcine xenografts impregnated with silver ions provide the antibacterial effects of silver ions and the physiologic skin replacement effects of porcine xenograft combined in a single material. The antibacterial effects are fast acting and continue on a timed-release basis. The porcine xenografts impregnated silver ions also prevent evaporation and fluid loss, reduce heat loss, decrease pain and increase motion.

I. PROCESSING, STORAGE AND APPLICATION OF PORCINE XENOGRAFTS

Clean hides collected from freshly killed domestic swine are flown in refrigerated container from breeding-ground.

The treatments of shaving and removal of the fatty layer are carried out after slaughter.

Within two hours of treatment the hides are processed in the skin bank in Rei Jin Hospital, where they are first washed with neutral soap, then rinse with water.

To facilitate handling the hides are cut into sheets of 30×60 cm. Split-thickness sheets of skin are removed by a dermatome set with thickness of 0.5—0.6 mm. The sheets are soaked in a iodophor solution for at least half an hour and thoroughly washed with sterile water before packaging.

In a sterile chamber the skins are individually packed in heat-sealed inner and outer plastic foil packets in different sizes. After sterilization by radiation the packets are kept in freeze storage at -18°C until used. Grafts are removed from the package using sterile precautions to the cleaned burned wound. No suturing is needed since the grafts adhere readily.

II. RESULTS

Successful clinical evaluations of porcine xenograft dressings have been obtained by many physicians who used them in the world. Here we need to have an understanding not only of the technical facts that lead to the success of an operation but also of the underlying biological mechanisms. In this section the radiation doses we used are in the range of 15—40 kGy. These radiation doses sterilize biological tissues, but they have been other effects that may well be more important. The facts that appear to be responsible for rejection reactions in transplantation seem to be inactivated. Cell are killed. In the preparation of tissue grafts there are a number of variables that have to be considered.

1. Type of radiation, dose and dose rate

After selection of products what type of radiation source has to be considered. There are two types of radiation sources to be used, electron beam and γ -rays.

When tissues are taken from the body the time that individual cell can survive varies. In some tissue cell death occurs within a few minutes of their being deprived of their blood supply. Other cells can survive longer so the direct effect on cells is concerned. It is reported for erythrocytes when a dose of the order of 10^2 — 10^3 Gy of X-rays was administered cells were hemolysed, the mechanism of hemolysis being the production

of tears in the cell membrane. A dose of 10^4 Gy delivered sufficiently rapidly to avoid haemolysis fixed the cells and once their protein had been fixed, they could no longer be haemolyzed. This dose of 10^4 Gy probably represents the maximum beyond which a mammalian cell could not survive. There remains the choice of radiation dose for any particular tissue taken as a graft provided that uninfected tissue is taken under surgically clean conditions. It was reported that doses of 10^4 Gy are sufficient to ensure adequate sterilization and possible changes in antigenic properties.

In dose range from 15 to 40 kGy and dose rates from 1.5 to 3.6×10^2 kGy/h (both electron beam and ^{60}Co γ rays) no adverse effects were observed in clinical use in our experiments. Above 5×10^4 Gy autolysis phenomena occur. This is due to bonds are broken particularly hydrogen bonds and $-c-c-$ links. Irradiation has a number of effects on tissues and in choosing the optimum radiation dose they must be carefully balanced. According to the standards of sterilization by health authorities we select the dose of 25 kGy for either ^{60}Co γ ray or electron beam.

2. Temperature of storage

Adequate temperature of storage can keep the porcine xenografts dressings longer. It was reported that storage at -18°C can keep the porcine xenografts fresh as long as one and half years. This storage condition is convenient to physicians in hospital in China since there are refrigerator facilities in the outpatient department.

3. Time between death and irradiation and between irradiation and use.

In moribund tissue enzymes continue to function for a while after death or removal from the body so that autolysis may be fairly rapid in a tissue with a high enzyme content. These compounds are inactivated by irradiation and so further autolysis is prevented. Depending on the nature of the graft, some preliminary autolysis may be helpful in breaking down matrix constituents to compounds that will stimulate proliferation of host tissue. For interval of six hours of processing before irradiation the porcine xenografts show clinically to have promotion of reepithelialization.

Within 18 months storage at -18°C after irradiation no adverse effects, noted in the clinical use of porcine Xenografts.

4. Effect of irradiation on enzymes

As above mentioned enzymes are inactivated by radiation, but in our oxygen consumption tests it was found that the oxygen consumptions of porcine xenografts increase a little with the increase of doses and dose rates and are independent of the tissue thickness (see Table 1).

5. Effect of porcine xenografts impregnated silver ions on bacteria

The porcine xenografts impregnated silver ions are both bactericidal and bacteriostatic. In agar plate tests the samples showed a wide zone of inhibition after 24 hours incubation with staphylococcus aureus or pseudomonas aeruginosa at 35°C . Table 2 shows the results of porcine xenografts impregnated silver ions applied to contaminated agar

Table 1 The effects of doses and dose rates on oxygen consumption of porcine xenografts

Dose rate (kGy/h)	Dose (kGy)	(Oxygen consumption($\times 133.3$ pa/s))		
		5"	65"	$\Delta 60"$
1.5	15	138	118	20
		140	120	20
		140	122	18
	25	135	119	16
		138	120	18
		138	120	18
	35	135	107	28
		139	113	26
		139	114	25
	45	113	97	36
		134	100	34
		134	101	33
	50	139	116	23
		140	119	21
		140	120	20
15	15	139	117	22
		141	119	22
		140	120	20
	25	138	100	38
		136	102	34
		136	101	35
	35	134	95	39
		136	100	36
		134	101	33
	45	139	103	36
		138	104	34
		138	107	31
	50	138	110	28
		138	108	30
		139	108	31
0	0	138	118	20
		140	120	20
		140	122	18

plates and passed to additional contaminated agar plates. The loose association of silver ions with the collagen in porcine xenografts provides a release timed in agar plate tests that lasts for 7 days.

Table 2 The diameters of inhibition zone in agar plate tests*

Time(d)	1	2	3	4	5	6	7
Diameter(mm)	22.64	26.68	26.98	19.40	16.88	16.5	14.9

* Sample diameter:14mm

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医用猪皮生物敷料的研究和制备

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摘要 烧伤病人使用的临时性生物敷料能有效地保护创面和促进创面愈合。本文讨论了辐照医用猪皮在制备过程中, 剂量、剂量率、贮藏温度、死亡时间和存活酶对其性能的影响。另外对具有抗菌性的含银离子医用猪皮进行了初步的探讨。

关键词: 异种移植皮 同种移植皮 烧伤病人 生物敷料 含银离子医用猪皮 氧耗

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