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Experimental Research on Role of Traction Tension Affecting Wound Healing during Skin Traction Technique Performed on Pigs Specimen as Animal Models

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Objective is to investigate the role of traction tension on wound healing during skin traction experiment performed on pigs as animal models. The experimental group comprises sixteen pigs with traction tension while sixteen pigs in control group without traction tension. All healthy specimen were procured from the Experimental Animal Center of Zhengzhou University. All methods were performed in accordance with relevant guidelines of Ethics Committee of the First Affiliated Hospital of Zhengzhou University. The wound of 5-10 cm x 10 cm size was made surgically on back of pigs. Wound healing has been analyzed based on traction tension and histological staining method. Traction tension applied during skin traction technique on pig models are 1kg, 2kg, 3kg, 4kg and 5kg to analyze the wound healing speed. Data were evaluated by SPSS software. Elevated rates of skin marginal necrosis were observed under traction tension of 4 kg and 5 kg, whereas a traction tension of 3 kg is appeared to expedite wound healing. Minimal collagen fiber disruption was seen under 3Kg, whereas substantial degradation was noted under traction exceeding 3Kg. Furthermore, the applications of traction tension correlated with a discernible reduction in postoperative complications compare to specimen without traction. The magnitude of traction tension significantly modulates the wound healing speed. Pig models subjected to traction exhibited a lower incidence of complications such as necrosis, infection, inflammation, and skin scar compared to without traction.

Keywords: Skin Traction, Wounds, Skin Necrosis, Traction Tension, Wound Healing.

INTRODUCTION

Skin is exposed to the external environment that makes it vulnerable to damage and leads to skin wounds[1]. The viscous-elastic properties of the skin itself is the histological basis of skin and soft tissue expansion. Gibson delineated four principal modalities of skin extension as intrinsic elasticity, mechanical extensibility, biological extensibility and chemical extensibility[2]. Collagen fibers is the predominant structural component of the skin existing as healthy and wavy under physiological conditions. Elastic fibers are synthesized and secreted by dermal fibroblasts, maintain collagen fiber in a wavy state and makes the skin with good elasticity[3]. Many similarities between humans and pigs regarding skin structure, hair density, skin thickness, fat layer, shape and skin wound healing mechanism which lead many researchers to believe that pigs should become excellent and standard animal models for human wound healing[4].

The applications of traction device on injured extremities has been integral to fracture management, dating back to the Ancient Greek physician, Hippocrates. To minimize the disability of limbs and preserve the function of limbs, it provides a new treatment method for the repair of severe wounds that are on the essence of traction tension[5]. The purpose of this section is to create a large area skin wound model in experimental animals and use adjustable skin traction equipment to explore the most suitable traction tension required for enhancing wound healing. And it is also important to investigate the histopathological staining method on wound healing speed on pigs specimen as animal models.

METHOD

Experimental Animals Selection

The experimental group comprised 16 pigs subjected to traction tension while the control group consisted of 16 pigs without traction tension. All healthy white domestic pig models were provided by the Experimental Animal Center of Zhengzhou University. The experimental pigs were further allocated into small groups based on the traction tension. Each three pigs were allocated for each traction tension ranging from 1 kg to 5 kg. Remaining one pig is kept to use if traction tension of any pig is failed or slipped. Each pig has single wound and constant traction tension which were adjusted over the time to promote wound healing in experimental group. All methods were performed in accordance with relevant guidelines and approved by the Ethics Committee of the First Affiliated Hospital of Zhengzhou University. All procedures were complied with national and institutional guidelines on animal welfare. No pigs have been dead during this study and all pigs have been treated well and survived. It's an experimental research, not clinical trial. Safe surgical wounds were made on the back of pigs of both groups with 5-10 cm x 10 cm size. The experiment pigs were further applied with traction tension to achieve the role of traction tension on wound healing while control group pigs were not applied with traction tension, and the wound was merely covered with iodophor gauze and wrapped with sterile dressing. Thus, to compare wound healing speed between groups, the effects of traction tension on skin necrosis rate and wound healing speed have been measured for experiment group. But in control group, the wound healing were continued and these parameters including skin necrosis and wound healing speed were measured under normal circumstances without traction tension. And in this fashion, wound healing differences based on with and without traction has been successfully analyzed. The specimens were fed with mixed pig feed. The temperature of the pig house was 21°C - 27°C. The relative humidity of the pig house was 40% - 65%. The pig house was washed with tap water four times daily to maintain cleanliness. And on the day of operation pigs were kept on fasting more than 12 hours before the operation. Data were evaluated by SPSS software. The inclusion and exclusion criteria of pigs for experiment as follows:

Inclusion criteria for animal models:

- Healthy white domestic pigs
- No serious subcutaneous infection of diseases,
- Healthy skin at traction sites
- Wound sample size lesser than 10cm x 10 cm.

Exclusion criteria for animal models:

- The skin at the traction pinhole was completely torn,
- Serious subcutaneous infection, accidental death and
- Broken fixation and other factors affecting the wound healing.

Skin Wounds Making

The back of pigs was used to make large skin wound. The targeted skin was shaved and fixed and pentobarbital sodium was also injected into the abdominal cavity for anesthesia (30mg/kg). Routine disinfection and scarfing were carried out. The full layer of skin on the back of each pig was removed surgically, and the skin wound was made. The size of the wound was 5-10cm x 10cm. The small clamp was used to stop bleeding. The site of skin wound of each pig was the same and the mid-line was symmetrical on both sides. After operation, the pigs were routinely administrated pain killer to minimize pain and also injected with penicillin 2.4 million U intramuscular for 3 days to prevent infection. The skin retractor of diameter 2 mm with adjustable traction tension was placed on both sides of wound, skin margin 1.5 cm from the edge, penetrating the skin intermittently every 3 cm wide, deep to the superficial fascia layer, and the exposed length of the traction needle interval is about 2 cm. The traction needle on the traction hook was fixed to adjust traction tension. The needle hole was washed every day with hydrogen peroxide and normal saline. The following Fig. 1 represents the cage preparation for animal model making where the experimental pigs were stored. The Fig. 2 shows the large skin wound model making on pigs where experiment has been performed.

Wound Size Assessment

One of the most effective methods for predicting whether a wound is likely to heal in a normal way is to calculate the reduction in wound size over a period of time. The contour of the wound edge should be depicted on a transparent acetate fiber sheet and the surface area should be estimated. The percentage of wound reduction was calculated using the following formula:

$$\text{Wound Reduction \%} = \{(OWA - NWA) \div OWA\} \times 100 = \{(21.75-14) \div 21.75\} \times 100 = \mathbf{35.6\%}$$

This means that 35.6% reduction in wound area compare to original surface area.

Fig. 1 — Cage Preparation for Model.

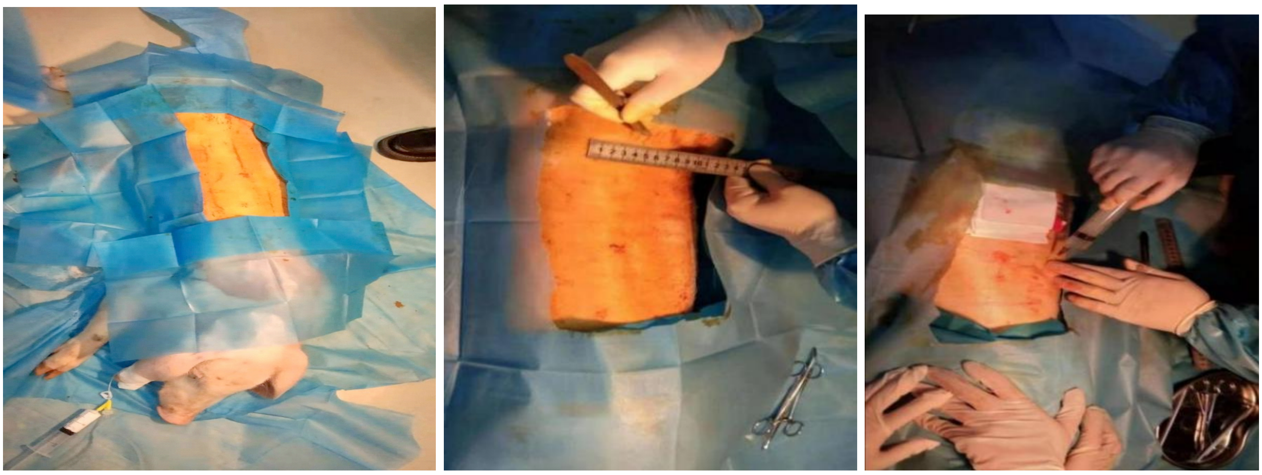

Fig. 2 — Large Skin Wounds Model Making.

(OWA=Original Wound Area, NWA=New Wound Area. OWA and NWA value were taken as an example).

Wound Healing Analysis Methodologies

1. Traction Tension Methodology

An adjustable skin traction technique is used and the pressure adjusting nut applies pressure to the spring of the skin retractor which can be read by the pressure scale. The spring applies tension to the traction hook and traction needle which can give the traction tension in the direction from edge of the skin to the center of the wound. The traction needle on the traction hook can be fixed to adjust the traction tension. After adjusting the traction tension every day, disinfection and cover with iodophor gauze was done, and bind it with sterile dressing. It is also important that decline of traction tension shall not exceed 10% of the previous pressure and give continuous to maintain the traction. The Fig. 3 is showing the installation of skin traction equipment for the experiment purpose.

2. Histological Staining Method

- The paraffin section is dewaxed in xylene I and II for several minutes respectively;
- It is passed via 95% and 80% ethanol for a few minutes respectively then rinse with tap water
- Hematoxylin-eosin staining solution (H-E) mixed for several minutes and rinse with tap water to return to blue for several minutes
- Dehydrate anhydrous ethanol I and II used for several minutes, then xylene I and II are used for several minutes and then microscopic inspection performed.

For histopathological purpose, after the wound skin margin is closed, 2 samples of skin tissue of 1cm x 1cm size has been taken from the skin margin area and the midpoint area between the skin margin and the original wound skin margin area. And it is kept in a unified fixed container for histopathological inspection.

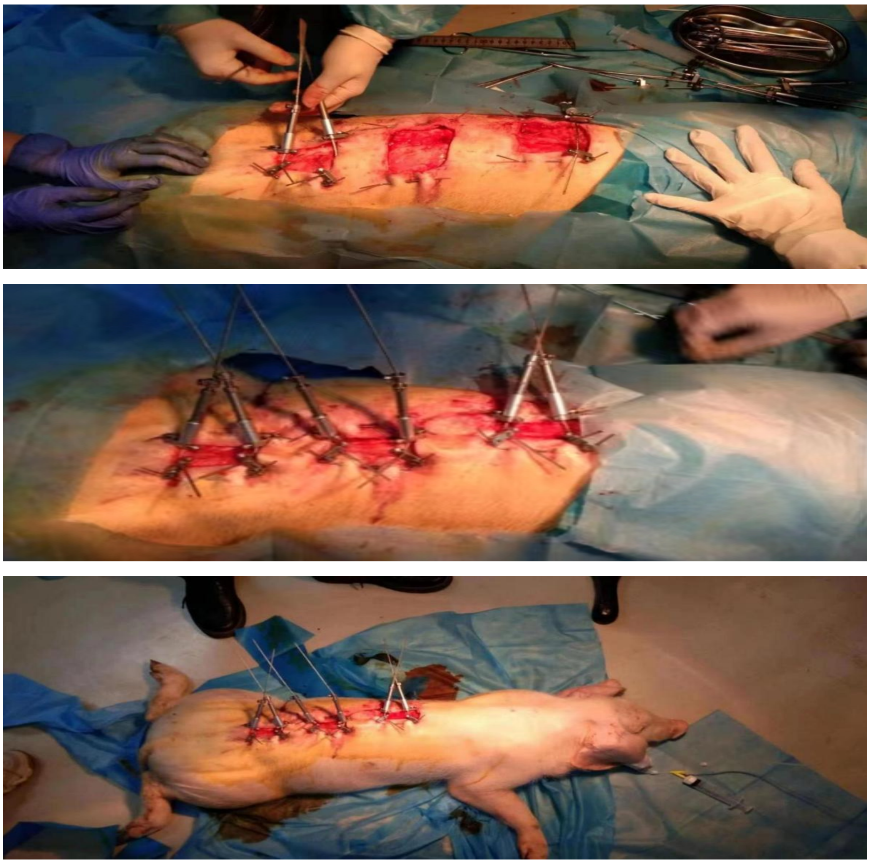

Fig. 3 — Installation of Skin Traction Equipment.

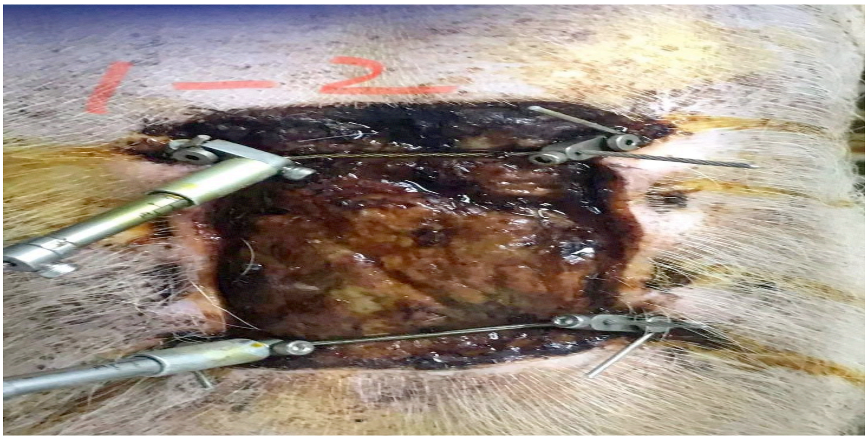

Fig. 4 — Skin Margin Necrosis Causing Retractor to Fall off during Traction.
Skin necrosis is precipitated by the detachment of the skin traction equipment, attributable to excessive traction tension exceeding tolerable limits, thereby engendering an elevated incidence of skin necrosis upon disembodiment of skin traction equipment from sites as explicated in Figure 4. Per Table II and Fig 4, the incidence of skin necrosis is markedly elevated when traction tensions of 4-5 kg applied, whereas wound healing proceeds most expeditiously under a traction tension of 3 kg.

Data Collection

Subject-specific data was collected. Initial data collection incorporated the number of pigs specimen house temperature measurement, relative humidity, wound dimensions, and healing duration. Skin margin necrosis rates (%) were analyzed under varying traction forces (1 kg to 5 kg). Concurrently, the residual wound surface area and percentage of wound reduction (%) were calculated. The area of healed wound (cm²) under different traction tension from 1 kg to 5 kg were noted daily. Furthermore, skin biopsies were subjected to histological analysis

RESULTS

Table I. — General Information Summary of Pigs and Experimental Surrounding.

Variables	Experimental Group with Traction (n= 16)	Control Group without Traction (n=16)
No. of Pigs model	16	16
Age in months (Mean ± SD)	(10.5±1.5)	(10.5±1.5)
Age Ranging (months)	9-12	9-12
Gender		
Male	8	8
Female	8	8
Weight (kg)	25 ± 5	25 ± 5
Pig House Temperature (°C)	21 - 27	21 - 27
Relative Humidity (%)	40-65	40-65
Wound Area (cm ²)	50-100	50-100
Wound Healing Duration (days)	15±3	25±3

Table I shows the basic information of pigs model in both experimental and control group including number of pigs, age, weight, gender, pig house temperature, relative humidity etc. SD = Standard Deviation; Kg = Kilogram; °C = Degree Celcius; % = Percentage; cm ² = Square Centimeter.

Table II. — Comparison between Traction Tension and Skin Margin Necrosis Rate %.

Traction Tension (Kg)	1	2	3	4	5
Skin Margin Necrosis Rate (%)	0	0	13	76	92

Table II shows 0% skin margin necrosis rate under 3 kg traction tension while 76% for 4 kg and 92% for 5 kg. As traction tension is increasing more than 3 kg, the skin margin necrosis rate is also increased drastically.

Table III. — Comparison of Residual Wound Size during Wound Healing in Experimental Group.

Experimental Group With Traction Tension	Residual Wound Area (cm²)								
	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9
1kg	65	60	55	50	46	40	35	35	35
2kg	60	53	45	40	35	29	29	26	25
3kg	60	50	47	40	34	26	23	19	19
4kg	58	50	45	39	33	24	22	18	18
5kg	56	48	44	38	30	22	20	18	17

Each three pig models were undergone traction surgery with different traction tension ranging from 1 kg to 5 kg. The wound area was gradually decreased with time as shown in Table III. For the purposes of monitoring the wound healing trajectory, an average initial wound area of 70 cm² was standardized. Based on Table II, Table III and Fig 5, even though the residual wound area under 4 and 5 kg traction was slightly less compared to a traction tension of 3 kg, the incidence of skin margin necrosis and collagen disruption were significantly higher under 4/5 kg compared to 3 kg. And it was observed that 3 kg traction stimulated heightened metabolic activity, augmented cell biosynthesis, and accelerated tissue proliferation which finally enhances wound healing abundantly. Thus, 3 kg traction tension is the best and the most suitable traction for wound healing in this study while 1 kg or 2 kg traction tension exhibited a pronounced deceleration in wound healing.

to assess collagen deposition under different traction tension.

Statistical Analysis

Statistical analysis was carried out by using SPSS version 28 for Windows (SPSS, Inc, Chicago, IL, USA). Primary variables including traction tension, mean values, standard deviation (SD), and associated p-values were meticulously calculated and analyzed SPSS software. Meanwhile, the complication

Table IV. — Comparison of Remaining Wound Size in Control Group.

Variable	Residual Wound Area (cm²)								
	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9
Control Group Without Traction Tension	68	65	63	61	55	52	50	47	44

Table IV is demonstrating the wound healing on daily basis under normal circumstance without traction tension. The wounds of these models were merely covered with iodophor gauze and wrapped with sterile dressing.

Table V. — Comparison of Complications between Pig Models of Both Groups.

Variables	Experimental Group With Traction (n= 16)	Control Group Without Traction (n=16)	x^2	P-value
Skin Infection	2	6	0.40	0.03
Skin Necrosis	0	4	0.28	0.02
Inflammation	4	5	0.90	0.30
Long-term Pus collection	2	10	0.35	0.001
Altered Pigmentation	1	8	0.06	0.001

Table V shows the complications seen in pigs models during the experiment. Chi-square test and p-values of each variables have been analyzed by using SPSS software. The pig models in experimental group show less complications including skin necrosis (0 case), infection (2 case), inflammation (4 case), long-term pus collection (2 case), altered and abnormal pigmentation (1 case) while 4, 6, 5, 10 and 8 respectively in control group. P-value <0.05 shows the significant relationship.

Table VI. — Comparison of Postoperative Advantages seen in Pig Models of Both Group.

Variables	Experimental Group With Traction (n= 16)	Control Group Without Traction(n=16)	x^2	P-value
Less Skin Scar	15	2	0.50	0.01
Fair & Satisfactory pigs Condition	14	1	0.30	0.01
Faster Wound Healing Speed	15	1	0.50	0.40
Average Wound Healing (days)	15±3	25±3	0.35	0.001

Table VI shows the postoperative advantages of pig models demonstrating in both groups. Chi-square test (x^2) and p-values of each variables which obtained from SPSS software has mentioned in Table VI. Pigs in experimental group with traction presenting huge benefits such as less postoperative skin scar (in 14 pigs), more fair and satisfactory postoperative pigs condition (14 pigs), faster wound healing (15 days) than pigs in control group.

including skin Infection, skin necrosis, pus collection, pigmentation have been analyzed carefully. Furthermore, wound healing duration and wound reduction percentage (%) has been studied by using SPSS statistical data analysis. And P-value between those variables were calculated where value of $p<0.05$ represents the significant difference between them.

Wound Healing Analysis Methods

1. Traction Tension Method

1.1 3 Kg Traction Tension as Best Traction

Analyzing the data presented in Tables 2 and 3, traction tensions of 1-2 kg is demonstrating 0% incidence of skin margin necrosis (Table II) but comparatively attenuated wound reduction rates (Table III). Conversely, although the 3 kg traction tension exhibited a marginally elevated skin margin necrosis rate compare to 1-2 kg traction tension, but it catalyzed superior wound reduction. Analogously, the 3 kg traction tension manifested a markedly reduced skin margin necrosis rate (13%) and higher percentage of wound reduction compared to traction tensions of 4 kg (76%) and 5 kg (92%), which makes wound eventually healed faster under 3kg traction tension than any other traction tension. Furthermore, histological assessment corroborated that a 3 kg traction tension induced minimal disruption to subcutaneous collagen fibers, preserving their inherent elasticity and crimping capacity. Conversely, traction more than 3

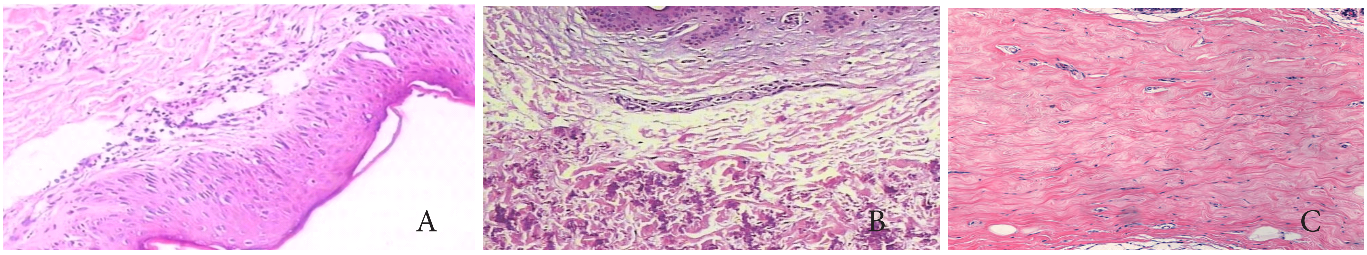

Fig. 5 — Collagen fibers altering under different traction tension; A: Less Collagen Broken by 3kg Traction, B. More Collagen Broken by 4-5kg Traction, C. Collagen Arrangement after Healing.
Fig. 5 illustrates the damage of collagen fibers in subcutaneous tissue was more obvious with the increment of traction tension. A small amount of collagen fiber break down in subcutaneous tissue seen in under 3Kg tension while large amount of collagen fiber break down in subcutaneous tissue seen in under 4-5Kg traction tension. It also shows arrangement of collagen fibers after healing.

kg, compromised the integrity of these elastic fibers which diminished the collagen fibers' crimping ability and impaired full dermal retraction. Therefore, a 3 kg traction tension is found to be the most effective and best for wound healing in this current study which might be differed from other research outcome.

2. Histology Staining Method

Fig. 5 illustrates the damage of collagen fibers in subcutaneous tissue was more obvious with the increment of traction tension. A small amount of collagen fiber break down in subcutaneous tissue seen in under 3Kg tension while large amount of collagen fiber break down in subcutaneous tissue seen in under 4-5Kg traction tension. It also shows arrangement of collagen fibers after healing.

DISCUSSION

Skin traction technique uses the mechanical extensibility and stress relaxation of the skin to repair the wounds faster[6]. Skin traction technique has been proven to have huge clinical applications and an effective treatment option to promote wound healing[7]. The pigs in control group were not applied with traction tension, and the wound was only covered with iodophor gauze and wrapped with sterile dressing. Only adjusting the traction tension in experimental group according to the skin blood supply can still achieve the goal of better wound healing ability compared to control group. Pig skin is structurally to be the most similar to human epidermal and dermis thickness. And pig skin is relatively hairless and has a fixed subcutaneous layer and dermal hair follicles like human skin. Thus, many researchers believe that pigs should become excellent and standard animal models for human wound healing. The investigation elucidated the role of different traction tensions on wound healing. Histological analysis revealed that skin traction induced elongation of subcutaneous tissues and fibrous tissue rearrangement[8].

Collagen fiber is the main mechanical element and component of the dermis of the skin. Type I collagen fiber is relatively thick which forms the main body of the skin to maintain the tension and bearing capacity of the skin. During wound healing, it can resist wound tension and skin retraction, mainly expressed in the late stage of wound healing. And type III collagen fiber has strong extensibility, making the skin more flexible[9]. It is mainly expressed in the early stage of wound healing. At the early stage of skin extension, type III collagen fibers increased and type I collagen fibers decreased. With continuous traction, type I collagen fibers starts increasing significantly where the density of collagen fibers increased and arranged in parallel with each other[10]. If the external force does not exceed the original bearing capacity of the skin, the skin can retract in situ after the external force is relieved[11]. However, once the external force exceeds the original bearing capacity of the skin and especially when constant and large tension is pulled, the liquid components in the matrix are redistributed in the fiber mesh, the elastic fibers are slightly broken, the crimping ability of the collagen fibers is reduced, and the skin can not fully retract to the original position. Thus, generating the mechanical creep effect of the skin occurs. Similar result was achieved by Marquardt, C[12] and other studies that traction tension exceeding physiological endurance will lead to blood supply destruction, hypoxia and vascular bundle destruction.

Skin traction is used to prevent skin infection and necrosis. Zhuo Chunfang et al.[1]3 treated 23 patients with limb fracture combined with skin defect by skin traction with Kirchner wire with wound area from 3cm × 4 cm to 19 cm × 9 cm, that shows no infection and no necrosis of the skin margin, and the wound healing time is 7-18 days. Similar result was seen in our experiment that 3kg traction tension is the most suitable to treat pigs wounds with a minimum infection and necrosis of skin.

Moreover, Zhou Zhenbin[14] performed skin extension with Kirchner wire, steel wire and rubber band self-made skin retractor to prevent skin infection and necrosis. Skin stretching not only promotes the division and proliferation of skin epidermal cells and fibroblasts and the synthesis of collagen fibers, but also causes the proliferation of blood vessels. The skin obtained by biological proliferation is of great significance in skin traction. The limitations of our study include small sample size, the limited availability of models follow up and qualitative nature of the histological assessment. And this study has also not investigated the other wound healing factors such as age and gender of pigs models, irregular wound size, nutritional status, other various wound sites, skin vascular structure, etc. Since it has been proven the importance of traction tension on wound healing speed, wound healing is found to be slower and poor in control group without traction compared to experimental group with traction. Our experimental results indicate that a traction tension of 3kg is the most suitable for promoting and enhancing wounds healing on selected models.

CONCLUSION

The role of traction tension on wounds healing on pigs specimen were experimentally verified. The wound healing is found to be accurate and faster under 3 kg traction tension with less complications including skin necrosis, infection, inflammation and postoperative skin scar.

List of Abbreviations:

SPSS: Statistical Package for the Social Sciences; SD: Standard Deviation; °C: Degree Celcius; cm²: Square Centimetre; OWA: Original Wound Area; NWA: New Wound Area; P-value: Probability value; x²: Chi-square Test; Kg : Kilogram; % : Percentage.

Author Contribution: The entire paper writing has been performed by Dr. Md Israil Nadaph under the supervision and guidance of corresponding author Dr. Xuejian Wu. Dr. Md Israil Nadaph has accomplished the extensive research and formulated the research design. Meanwhile, Dr. Meng Chong has reviewed and helped to make changes during paper writing.

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REFERENCES

1. Nadaph, M.I., Meng, C. & Wu, X. Clinical applications of skin traction technique with adjustable tension in treatment of large area skin defects. BMC Musculoskelet Disord 24, 556 (2023). https://doi.org/10.1186/s12891-023-06628-y
2. T Gibson, R M Kenedi. Biomechanical Properties of Skin. https://doi.org/10.1016/S0039-6109(16)38180-4.
3. Wang, Gaofei MSca; Zhang, Xiuli MScb; Zhang, Zhufeng MBa; Wei, Zhuang MDa,*. Clinical study on a skin stretching technique with adjustable external fixators to treat skin defects. Medicine 99(37):p e22144, September 11, 2020. | DOI: 10.1097/MD.0000000000022144
4. Dis Model Mech (2017) 10 (7): 869–880. https://doi.org/10.1242/dmm.028662
5. Keylock KT, Vieira VJ, Wallig MA, DiPietro LA, Schrementi M, Woods JA. (2008). Exercise accelerates cutaneous wound healing and decreases wound inflammation in aged mice. Am J Physiol Regul Integr Comp Physiol 294:R179-R184.
6. Lei Y, Liu L, Du SH, Zong ZW, Zhang LY, Guo QS (2018) The use of a skin-stretching device combined with vacuum sealing drainage for closure of a large skin defect: a case report. J Med Case Rep 12(1):264.
7. Nadaph, M.I., Meng, C. & Wu, X. Clinical applications of skin traction technique with adjustable tension in treatment of large area skin defects. BMC Musculoskelet Disord 24, 556 (2023). https://doi.org/10.1186/s12891-023-06628-y
8. IANG Xin,XIANG Heng,LIU Li-jun,YANG Xiao-dong,and YANG Pan-yi.Therapeutic application of skin stretch closure device for treatment of limbs skin wound defects in children[J]. zhongguo gu shang / China J Orthop Trauma,2020,33(8):757-760.
9. Verhaegen P D, Schouten H J, Tigchelaar-Gutter W, et al. Adaptation of the dermal collagen structure of human skin and scar tissue in response to stretch: an experimental study[J]. Wound Repair Regen, 2012,20(5):658-666.
10. Kopcewicz M., Walendzik K., Bukowska J., Kur-Piotrowska A., Machcinska S., Gimble J.M., Gawronska-Kozak B. Cutaneous wound healing in aged, high fat diet-induced obese female or male C57BL/6 mice. Aging. 2020;12:7066–7111. doi: 10.18632/aging.103064.
11. Liang M D, Briggs P, Heckler F R, et al. Presuturing--a new technique for closing large skin defects: clinical and experimental studies[J]. Plast Reconstr Surg, 1988,81(5):694-702.
12. Marquardt C, Bölke E, Gerber PA et al. Correlation of cutaneous tension distribution and tissue oxygenation with acute external tissue expansion. Eur J Med Res. 2009;14.
13. Zhuo Chunfang, Qi Hairu, Chen Yaying Fracture fixation and simple skin traction for the treatment of limb fracture combined with skin and soft tissue defect [J] Contemporary Medicine, 2010 (7): 57.
14. Zhou Zhenbin, Li Youde, Xia Jiangni, etc Application of skin extension in large area skin defect after infection and necrosis [J] Chinese Journal of Repair and Reconstruction Surgery, 2006,20 (2): 202-203.