COMPARISON OF THE DYNATRONICS 820 HELIUM-NEON LASER WITH THE PEGASUS INFRARED THERALASER ON WOUND HEALING IN PONIES

by

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Submitted in Partial Fulfillment of the Requirements
of the University Undergraduate Fellows Program
1982 - 1983

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CONTENTS

ABSTRACT

Low output lasers have been increasing in usage in human and veterinary medicine, for these lasers have an analgesic action and a vasodilation action. They have been used successfully in the treatment of equine lamenesses such as bowed tendons, pulled ligaments, and bucked shins. They have also been used successfully in Physical Therapy treatments when combined with acupuncture. This study reiterates previous findings showing the stimulative effect of the low output laser on mechanically induced wounds. The research animal used was the shetland pony, and the lasers used were the Dynatronics 820 Helium-Neon laser, a 0.9 mW laser with a wavelength of 632.8 nm, and the Pegasus Infrared Theralaser, a 0.9 mW laser with a wavelength of 904.3 nm. Though both of these lasers were found to significantly stimulate the reparative process of epithelial tissue, there was no significant difference between the three treatments used. These treatments were a pulsed frequency of 80 Hertz on the Helium-Neon, a continuous beam on the Helium-Neon, and a pulsed frequency of 73 Hertz on the Theralaser. Two sets of controls were used: control wound sites on laser-treated ponies, and a control pony that was not treated with laser. At the end of the trial, the wounds on the control pony were significantly larger than the control wounds on the laser-treated ponies. This suggests a possible residual effect of the lasers that needs to examined further. Biopsies taken on the 5th and the 10th days of the experiment were inconclusive.

FIGURES

INTRODUCTION

The trend in the medical and veterinary professions has been to introduce antibiotics and analgesics into the body as therapeutic agents. These products are intended to act only on specific metabolic processes, yet they invariably produce some unwanted side affects -- the addictive effect of morphine for example. With the use of the low output laser, however, use of such drugs may be overcome. One theory about the low output laser states that each specific wavelength of light may regulate particular intracellular particles, thereby allowing each to be energized separately without disturbing the other particles. (12-150) With the use of the low output lasers, laser therapy could be incorporated into medicine, both human and veterinary, as a physical or holistic method of healing, rather than a chemical method.

This has already been shown in physical therapy treatments in humans by reducing pain through laser-acupucture and enabling patients to use the affected limbs again. (3) Also, noted by Mester, was an increase in the regenerative process of muscle fibers after the laser was applied directly to the injury. (9) Aside from these, Mester, et. al. (8), Kana, et. al. (2), and Kovács, et. al. (5) have demonstrated the promotion of wound healing with laser stimulation. Mester found in 1971 that burns and wounds inflicted upon white mice healed much quicker if 1 Joule/cm^2 was used every forth day. (8) In 1981, Kana et. al. compared the Helium-Neon laser (632.8 nm) with the Argon laser (514.5 nm). Using energy densities of

4 Joules/cm^2 to 20 Joules/cm^2, they found the Helium-Neon laser had the greatest effect on the rate of wound healing at 4 Joules per cm^2 of wound area. The Argon laser had little significant effect on the rate of wound closure. (2)

Through these and other studies, the considered Methods of Action of the low output laser have been determined; it acts as

1) An anti-inflammatory agent
2) An analgesic
3) A Vasodilator
4) A Stimulator of the regenerative powers of tissues. (12-150)

These properties are making these lasers ever more valuable in the fields of human and veterinary medicine. For example, the lasers can increase blood circulation and decrease pain to the treated area, thereby stimulating the area to function properly.

Since these findings, the popularity of the low output lasers has grown, especially in equine medicine. To date, the lasers have been used successfully on equine lamenesses such as pulled suspensory ligaments, tendon strain, bucked shins, and bowed tendons. (7) Treatment time of these ailments has been greatly reduced with laser use; this enables the horses to get back into competition faster than they could have with the older, more established treatments.

Two of the lasers used on these ailments are the Helium-Neon laser and the infrared theralaser. These lasers are essentially the same except for the wavelength of light they emit; the Helium-Neon emits a 632.8 nm wavelength whereas the infrared emits one of 904.3 nm. The Helium-Neon laser, however, is the only one that has been declared Grade 1 by the FDA, meaning it

is harmless and has no restrictions on its use.

This study compares the two lasers to determine that there is no significant difference between the healing rate that they enhance. In order to show this, the rate of wound closure in ponies will be documented for 20 consecutive days during which 2 sets of biopsies will be taken to determine if any histological differences are noted.

LITERATURE REVIEW

The low output laser is a relatively new therapeutic tool; the laser itself was invented in 1960. (4-83) Since that time, its use has mostly benefitted the medical industry; this has caused a great deal of the research to be directed toward that industry. This research was at first based on the low output laser's value in acupuncture, but at the beginning of the 1970's, research began turning toward therapeutic uses of the instrument.

One of the more dramatic cases cited was that of Kovinskii. (12-116) In this experiment, 36 patients suffering from severe radiation burns covering 15-40% of their bodies were treated with the Helium-Neon laser. These patients were divided into three groups. Group A consisted of 12 patients with superficial burns (2nd-3rd degree); Group B consisted of 12 patients with deep burns (3rd-4th degree); Group C consisted of 12 patients, 6 with superficial, 6 with deep burns. Group C acted as the control in that they were treated by the medically accepted method of treatment without the benefit of laser. Both the patients in Groups A and B were treated with laser every other day for 20 days at a power of 0.1 mW/cm^2 of wound area for 5-10 seconds. Those in Group B were skin-grafted after 10 days and then continued with treatment. The results of this experiment showed the wounds healed with more speed if irradiated with laser; the healthy tissue formed faster.

Another experiment, showed similar results of stimulated wound healing using the Helium-Neon laser. (8) These scientists

used 5 groups of white mice, allowing each mouse to be its own control by mechanically inducing a burn or a wound 4 mm in diameter on either side of the back. One side of the back was treated with laser, whereas the other was not. Using various energy outputs and various time intervals, it was found that the greatest improvement came with the wounds that had been exposed to the laser every 4th day with 1 Joule/cm^2 of wound area. After 14 days, the wounds that had been laser-treated were completely healed; the untreated wounds remained at 4 mm in diameter.

Not all low output lasers appear to have this effect, however. In 1981 Kana, et. al. (2) found that the Argon laser had little effect on wound closure, but that it did increase fibroblast, lymphocyte, and leukocyte activity. One hypothesis for this is the fact that the Argon laser emits a green line of 514 nm; this may correspond to these particular cells, whereas the Helium-Neon laser may correspond to other cellular functions. This study also found, like previous cases, that the Helium-Neon laser decreases wound size in less time. These scientists chose different levels of energy, 1 Joule/cm^2, 10 Joules/cm^2, and 20 Joules/cm^2. They found that over a period of 2 weeks the 1 Joule/cm^2 had the greatest effect on wound closure and, the 20 Joules/cm^2 actually had a negative effect.

The three cases noted are mainly topical uses of the Helium-Neon laser, but in order to be used knowledgeably in other areas, further studies need to be evaluated. It was Chekurov of the Soviet Union who found the Helium-Neon to spur regenerative processes of bone. (12-76) In this experiment, fractures were

created in the forelegs of dogs, and the legs cast. In one of the legs, a window was cut in the cast directly over the line of the fracture so that it could be treated with 1 Joule/cm^2. At the end of the experiment, the leg that had been exposed to the laser was completely healed; the other was not. Chekurov believes these results were obtained due to the vasodilation of the area, thus causing the initiation of the phases of bone healing.

Aside from bone growth, nerve growth has also been cited. (12-71) In an experiment performed on albino rats, somatic nerve growth was accelerated by Helium-Neon laser exposure. In this procedure, the right sciatic nerve was divided in the middle third of the thigh and then joined by a suture. Afterward, the outer surface of the thigh was irradiated with 5 mW/cm^2 for 5 seconds each. This was continued for 15 days at which time the excitability of the nerve was determined. After 45 days, the number of nerve fibers growing into the peripheral areas surrounding the cut nerve was much greater in the experimental animals than in the control animals.

A number of veterinary case reports also suggest the stimulative powers of the low output laser. McKibbin of Wheatley, Ontario, has been able to improve bowed tendons, pulled suspensory ligaments, curbs, and check ligaments. (7) Working with a 904 nm, infrared laser, these studies concluded that that "F" frequency (73 Hertz) worked best on fresh wounds, "G" frequency (146 Hertz) worked best on chronic injuries, and "A" frequency (292 Hertz) was best for scar tissue.

The Large Animal Clinic at Purdue University has also had success with these lasers -- especially with the equine. (10) They have noticed an increase in normal hoof growth of chronic laminitis cases if the treatment is directed toward the coronary band. They also found old wounds with large amounts of discharge to heal much more rapidly with 3 or 4 treatments using the Helium-Neon laser.

Kleinkort has used the low output laser in conjunction with acupuncture treatment. (3) In his report he suggests a stroking technique for laser-treatment of wounds:

> "... the wand (is) held approximately 0.5 mm from the recipient tissue. This is continued for 15 seconds for each square millimeter of tissue stimulated." (3)

In his various case reports, Kleinkort has not only been able to use the laser to decrease pain, but also to actually decrease the amount of scar tissue in some injuries. His treatments with laser-acupuncture have allowed his patients to live a normal lifestyle that they previously could not have lived due to their ailments.

MATERIALS AND METHODS

The Conditions

Five healthy ponies (2-13 years) consuming sweet feed twice daily plus hay and water ad libitum were used throughout the experiment. The first seven days of the experiment (while the wounds were still acute) the ponies were kept outside; they were kept inside in clean stalls for the remainder. After shaving the right hand side of each pony's neck, 3 cc's of Carbocaine-V[a] was injected subcutaneously at 4 sites 2" apart. Upon these sites, round 12 mm holes were punched on the skin with a stainless steel punch[b]. These wounds were left open without dressing throughout the experiment; they were treated daily with laser for the first seven days and every other day thereafter.

To ensure there were no residual effects from the laser, one pony was left completely without treatment. Also to serve as controls was one of the four wounds on each pony. Thus, with laser-treated wounds being compared with non-treated wounds, individual variations are accounted for. Any residual effect of the lasers will be seen from the difference between the control pony and the control sites on the other ponies.

Also, biopsies were taken on postoperative days 5 and 10 to determine any gross histological differences in the various wounds. These biopsies were done in the same manner as the

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[a] Carbocaine-V; Veterinary Products Division; Winthrop Laboratories, New York, NY 10020

[b] Constructed by E&E Sharpening Company, Bryan, TX 77801

original punches, except the diameter was 4 mm rather than 12 mm. These biopsies were punched on the edge of the wound so that one half of the biopsy would be newly formed tissue while the other half was normal tissue. After each biopsy was taken, it was fixed in a 10% buffered formula and imbedded in paraffin. Then it was sliced into 6 micron sections, stained with Hematoxylin & Eosin (standard histological stain), and viewed by light microscopy.

The Lasers

The infrared laser used was the Pegasus Infrared Theralaser[c], a 0.9mW laser that emits a semi-conducting beam of 904.8 nm in the invisible light spectrum. Since the beam is not viewable, a special light meter is needed to see if the laser is still functioning properly; this was done three times over the duration of the experiment. There are seven different frequencies on this machine, "A" through "G". "F" frequency corresponds to the lowest frequency on the device, 73 Hertz; this was the frequency used throughout the experiment. This laser is rather small; it is this portability that makes it very convenient for veterinary field usage. (see Fig. 1)

The Helium-Neon laser used was the Dynatronics 820 Laser[d]; it is also a 0.9 mW laser, but it emits a wavelength of 632.8 nm in the visible light spectrum. The frequency of the wavelength may be altered by the middle knob on the device. (see Fig. 2)

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[c] Pegasus Theralaser. Dr. C.M. Vonderwell, Delfhos Vet Clinic, 840 W. Ohio St., Delfhos, Ohio 45833

[d] Dynatronics Res. Corp.; 326 South Redwood Rd; Salt Lake City, Utah 84101

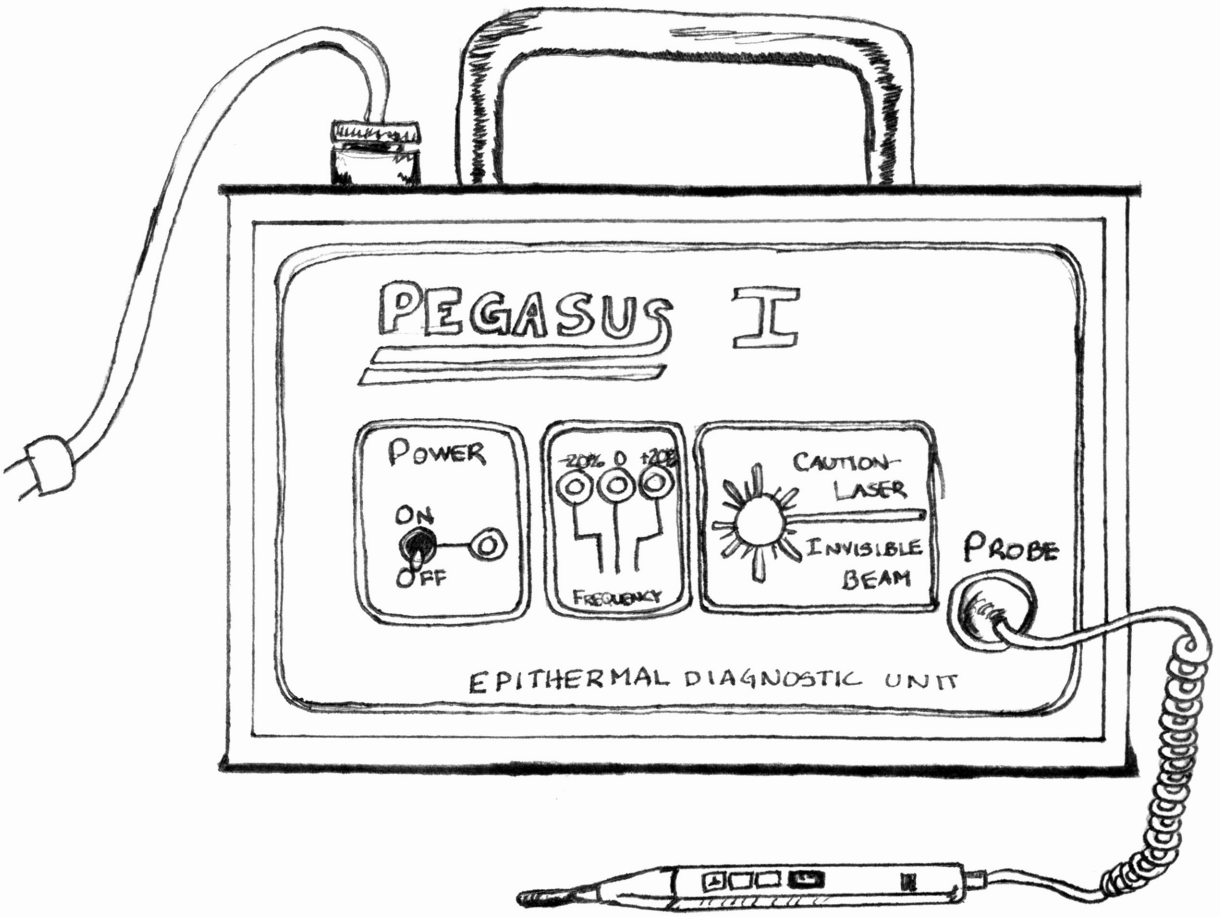

Figure 1

Figure 1. The Pegasus Infrared Theralaser. Wavelength equals 904.2 nm. Power equals 0.9 mW.

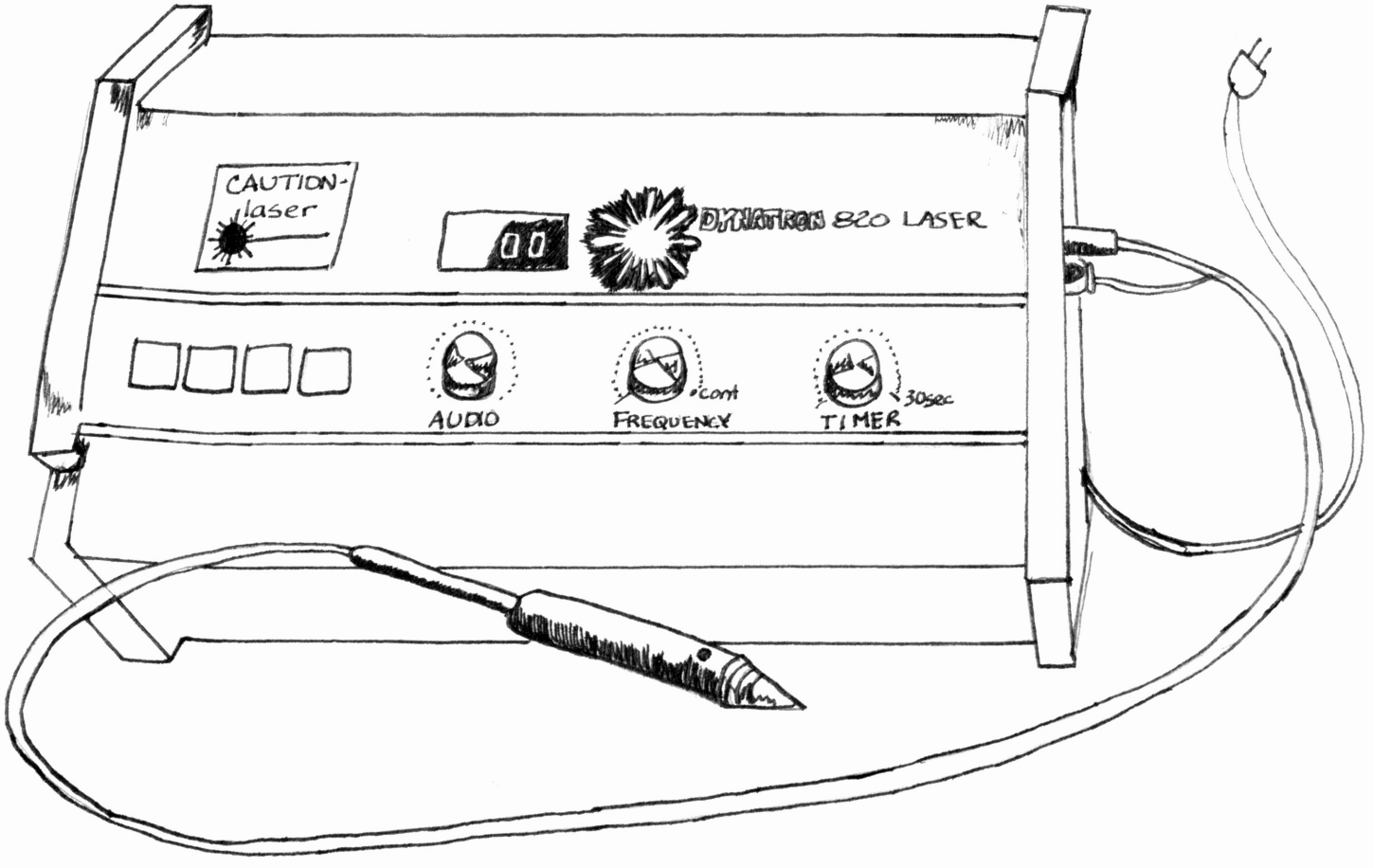

Figure 2

Figure 2. The Dynatronics 820 Helium-Neon Laser. Wavelength equals 632.8 nm. Power equals 0.9 mW.

This experiment utilized the continuous wave frequency and the pulsating, 80 Hertz frequency. This laser is rather cumbersome to carry around; this reduces its field use practicality somewhat. It is quite simple to use, though, being that the beam is visible and that the device has a buildt-in timer. This timer eliminates the use of the stop watch that is needed with the Pegasus laser.

RESULTS

On the 4th day of the reparative process the rate of wound closure in the laser-treated wounds was significantly increased over that of the control sites. ($p<.025$)[e] There was, however, no significant difference between the Helium-Neon laser treatments and the infrared treatment at this time. (see Fig. 3) As the graph in Figure 3 shows, the continuous frequency does not appear to be as effective as the two pulsed frequencies. As Figure 4 shows, however, the laser treatments are more effective than the wounds with no treatment.

The first set of biopsies was taken on the 5th post-operative day; the wound size increased for one day and subsequently decreased. After the second set of biopsies was taken on day 10, however, there was a noticeable decrease in the healing rate of the wounds; it took all the wounds approximately two days to return to their pre-biopsy size. Also noted was the slowing of the wound healing rate after day 7 when the laser treatments began to be given every other day. Figure 4 shows this irregular pattern. It appeared that on the days the ponies were treated (those with *), the wound shrank much more noticeably than on the days they were not treated. There was also a substantial increase in all the wounds size on the 8th day; this was also the day of a severe thunderstorm (the ponies were still outside).

By the 14th postoperative day, the wound healing rate was accelerated in the laser-treated wounds; this continued until

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[e]All statistics were done using the t-test.

the 20th postoperative day. On this last day of the experiment, wound closure was practically complete on all but the control pony. Also on this day, the laser-treated wounds were significantly more healed than the control sites. ($p<.05$) There was at least 3 mm difference between the laser-treated wounds and the control sites; there was at least 5 mm between the control pony and the treated wounds as Figure 3 shows. The various laser treatments (He-Ne 80 Hz, He-Ne continuous, and Pegasus), however, were nearly identical in healing on this day. Figure 3 shows that all three of the treatments have an average width between 2 and 3 mm on day 20.

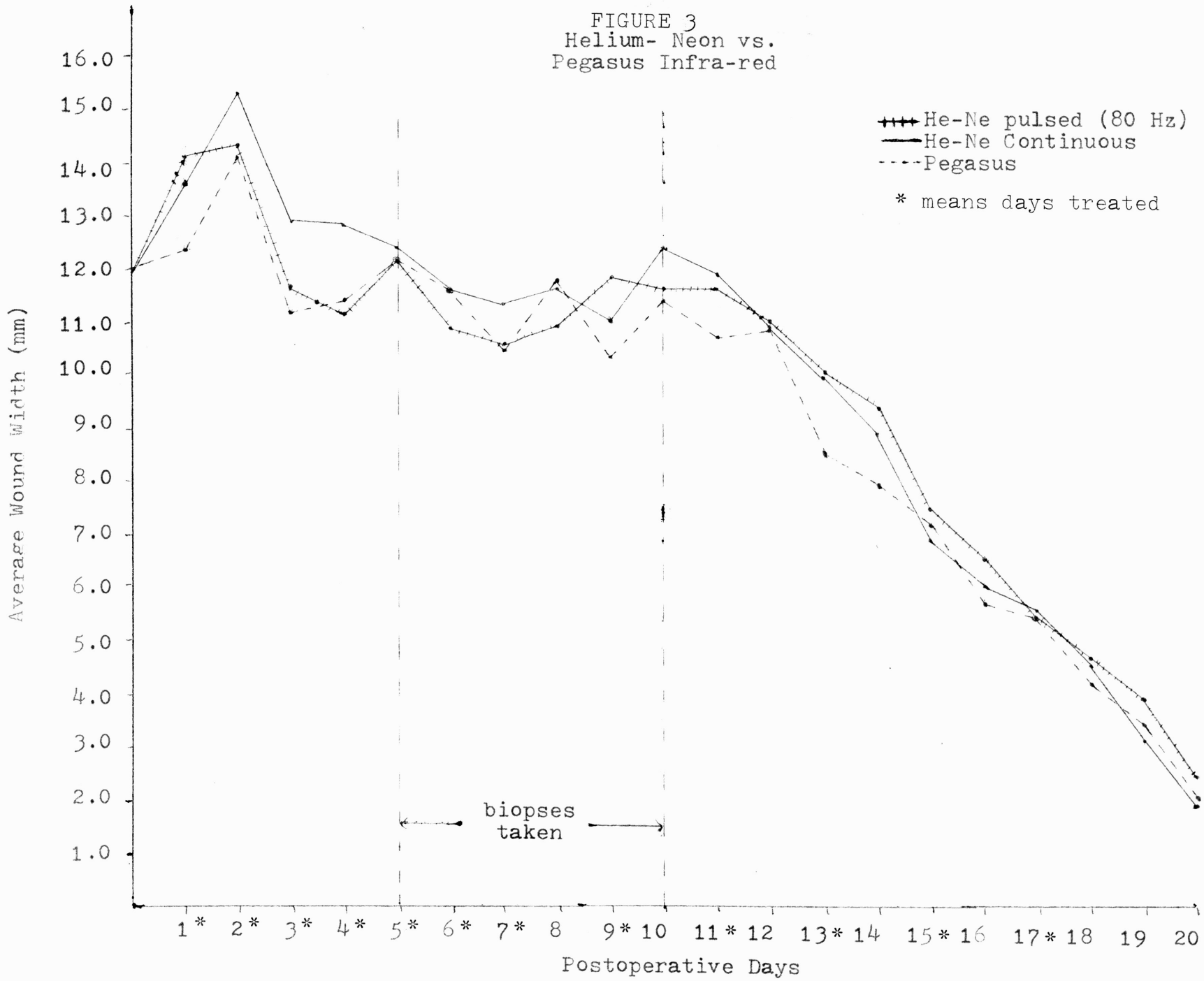
Also, the wounds on the control pony were significantly larger than the control sites on the other ponies. ($p<.01$) Figure 4 shows this difference of almost 3 mm between the control sites and the control pony. None of the control sites on the treated ponies nor the wounds on the control pony were completely healed by the last day of the experiment. One-half of the wounds treated with infrared laser were healed, as were one-half of the wounds treated with the continuous beam of the Helium-Neon laser. One-forth of the wounds treated with the 80 Hertz frequency of the Helium-Neon laser were completely healed.

The histopaths performed on the biopsies were inconclusive. There was definite difference between the biopsies taken on the 5th day and those taken on the 10th day in that there was increased healing in the second set of punches. However, there was no significant difference noticed between the treated and

the non-treated wounds when viewed with the naked eye or with a light microscope.

The age of the ponies ranged from 2 years old to 13 years old. One pony was 2 years old; one was 13 years old; three were 7 years old. As expected, the 2 year-old had the fastest rate of wound healing by the end of the experiment; all but its control wound had healed. The 13 year-old, however, had the second best healing rate; both the He-Ne continuous treated wound and the Pegasus treated were completely healed. Of the three 7 year-olds, one was the control pony, and the other two had approximately equal healing rates.

FIGURE 3
Helium- Neon vs.
Pegasus Infra-red



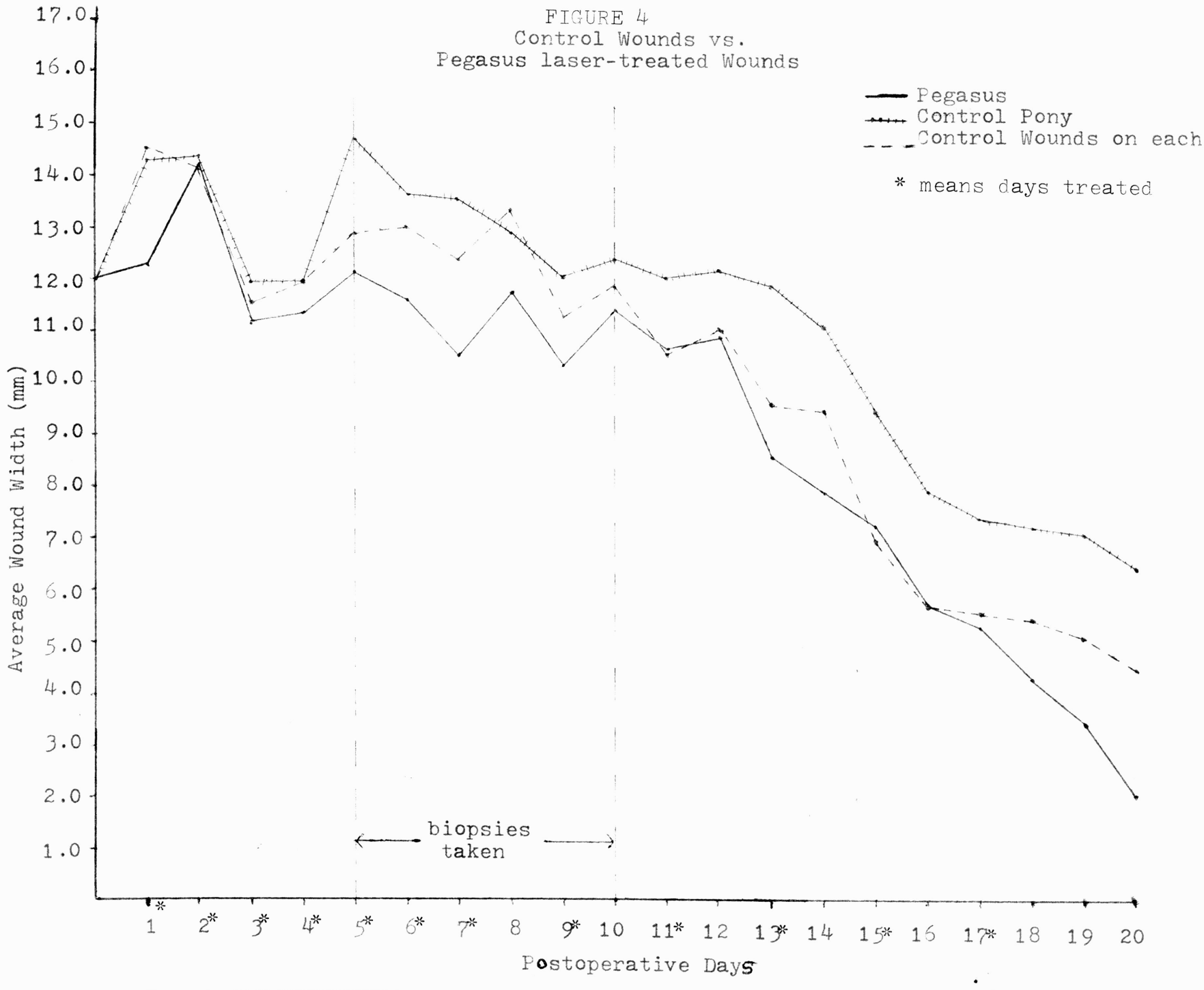


FIGURE 4
Control Wounds vs.
Pegasus laser-treated Wounds
Pegasus
Control Pony
Control Wounds on each
* means days treated
Average Wound Width (mm)
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
biopsies
taken
1* 2* 3* 4* 5* 6* 7* 8 9* 10 11* 12 13* 14 15* 16 17* 18 19 20
Postoperative Days

DISCUSSION

The use of the low output laser appears to substantially increase the rate of wound healing in ponies. This was shown in two ways in this experiment. The first way was the comparison of the laser-treated wounds with the control sites on the same ponies. By the 4th day of the experiment, there was already a significant difference between the control sites and the treated wounds. ($p<.025$) This difference held for the duration of the experiment; the control sites were significantly larger than the treated wounds at the end of the experiment. ($p<.05$)

The second determining method was the comparison of the control pony's wounds and the control sites on the other ponies. When these values were compared at the end of the experiment, the wounds on the control pony were significantly larger than the control sites on the other ponies. ($p<.01$) These two results show the low output lasers positive effect on wound healing. Furthermore, the second result comparing the two types of control wounds suggests that the laser may indeed have some residual effect on areas of the body in close proximity to the area treated. This resulted from the control sites on the laser-treated ponies healing much better than the wounds on the control pony. This residual effect of the low output lasers may partially explain the success of the treatments of bowed tendons and other non-epithelial disorders.

In the comparison of the two lasers, the lack of difference between the various laser treatments used in this experiment suggests that the Pegasus Infrared Theralaser is just as

viable a therapeutic tool as the Helium-Neon laser is. From the beginning of the laser treatment, both lasers significantly decreased wound size over that of the non-treated wounds. There was, however, no significant difference between the various treatments used. Also, at the end of the experiment the wounds treated by the three laser treatments performed quite similarly; they were either completely healed or were small in relation to the control wounds. Since this increase in wound closure was observed throughout the experiment with both lasers, there appears to be an equal stimulation of the reparative processes of the injured tissue by both lasers.

When the laser treatments started to be given every other day, there was a decided decrease in the wound healing rate -- especially when using the two pulsed laser treatments. Both the Pegasus laser (73 Hz) and the Helium-Neon, 80 Hz appeared to perform much better than the continuous Helium-Neon beam until the 8th or 9th postoperative day. Prior to this time the lasers had been used every day, and the results using the continuous Helium-Neon beam seemed to lag behind the other two treatments. After, when being used every other day, the wounds using the two pulsed frequencies began to increase in size on the days not treated and to decrease in size on the days treated. The continuous beam, however, acted slightly better after the treatments were changed to every other day.

The weather also seemed to play a role in the healing of all the wounds. During the time the ponies were outside, a severe thunderstorm caused the wounds in all of the animals to

increase in size; some even got infected, though the wounds treated with laser seemed to be less prone to this infection. After this severe thunderstorm, the ponies could be kept inside, but the time lost in the wound healing could have been substantial.

The Histopaths on the biopsies taken were, unfortunately, not substantial to the results of this experiment. This may have been due to the type of tests performed on the tissue samples; no collagen tests were run, the skin samples were merely viewed. For this type of observation, the biopsies needed to have been more uniform in thickness and in diameter. If they had been viewed with electron microscopy instead of light microscopy, the results may have been more conclusive.

CONCLUSIONS AND RECOMMENDATIONS

From the data obtained in this experiment, there is a significant difference between the laser-treated wounds and non-laser treated wounds. This is supported by studies done by others previously. The differences between the Dynatronics 820 Helium-Neon laser and the Pegasus Theralaser, however, do not appear to be significant in the rate of wound healing at this time. If the treatment had been continued on a daily basis, the pulsed frequencies may have done better than the continuous beam. But for the more convenient treatment of every other day, all three laser treatments appear to be approximately the same.

In further studies done on this topic, treatment should be continued daily to see if there is any difference between the pulsed and continuous treatments. Also, as the weather may have adversely effected the results at the beginning of the experiment, the ponies should be kept inside for the entire experiment in further studies. Furthermore, since the biopsy results were inconclusive, they should not be taken on the same ponies that gross measurements are being taken on. If biopsies are taken, tests for levels of collagen and perhaps for levels of leucocyte activity should be done to determine any differences in this area. This may be more conclusive than simple histological tests.

The ages of the animals treated seems to have no effect on the results obtained since the youngest and the oldest pony healed with a faster rate than the ponies of 7 years.

However, if ponies of equal age can be obtained, the results might be more uniform.

Another area that might be examined further is the residual effect the lasers may have. The fact that the control pony's wounds were significantly larger may have merely been due to individual differences. Since, however, all four of the controls on the treated ponies were significantly smaller at the end of the experiment strongly suggests there may indeed be a residual effect of the low output lasers. This residual effect may stimulate the entire physiological system; this would help explain why the low output laser can affect areas that the light cannot reach.

The lasers used in this experiment both have good and bad aspects about them. The Pegasus Infrared laser was easier to handle than the Dynatronics laser, but it has two factors against it. The first is that there was no timer on this particular machine; this required the use of either a stop watch or a watch with an accurate second hand. The second drawback was the fact that a light meter had to be used to check if the laser was working. If a timer was installed in this unit as well as a warning device telling of malfunction, this unit would be ideal for field veterinary use.

The Dynatronics, however, is not quite ideal in its present form either. This model is much larger than the Pegasus laser, and it requires much gentler handling. The Pegasus laser may be placed on the ground, whereas this is not recommended with the Helium-Neon.

Consequently, an ideal unit for laser treatment would be as portable and as sturdy as the Pegasus Infrared Theralaser. It would also have a timer setting incorporated into it as well as a malfunction warning device. It does not appear that the type of laser beam makes any difference; it could be either a Helium-Neon continuous beam, a Helium-Neon pulsed beam, or a Theralaser pulsed beam. This observation does need further examination, though.

The research I was able to do through the University Undergraduate Fellowship Program and the Large Animal Veterinary Clinic here at Texas A & M had been a rewarding experience. It has taught me the process of performing research as well as the best methods with which to get things done in this area. I am glad I had the opportunity to participate in this program.

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FIGURE 3
Helium- Neon vs.
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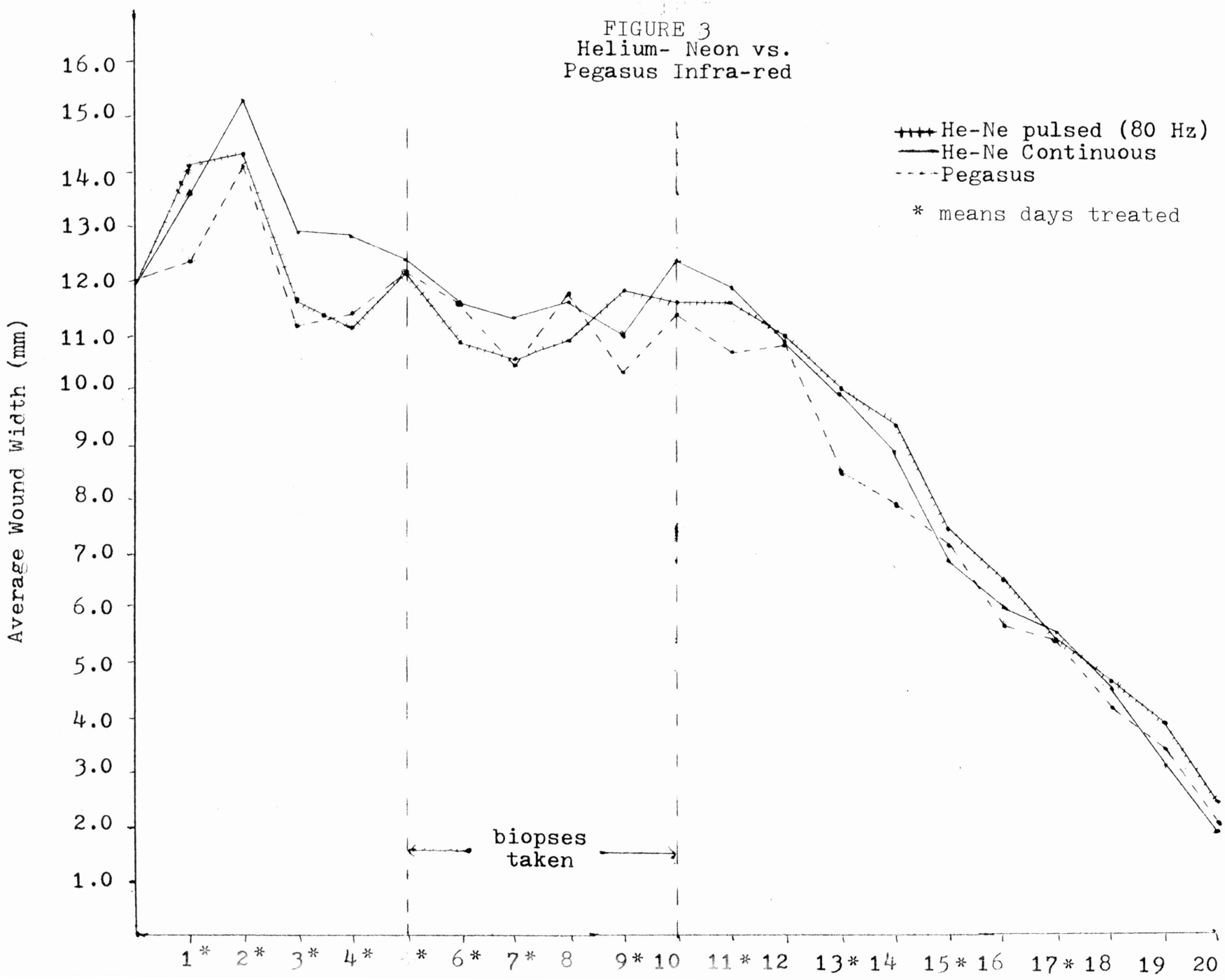

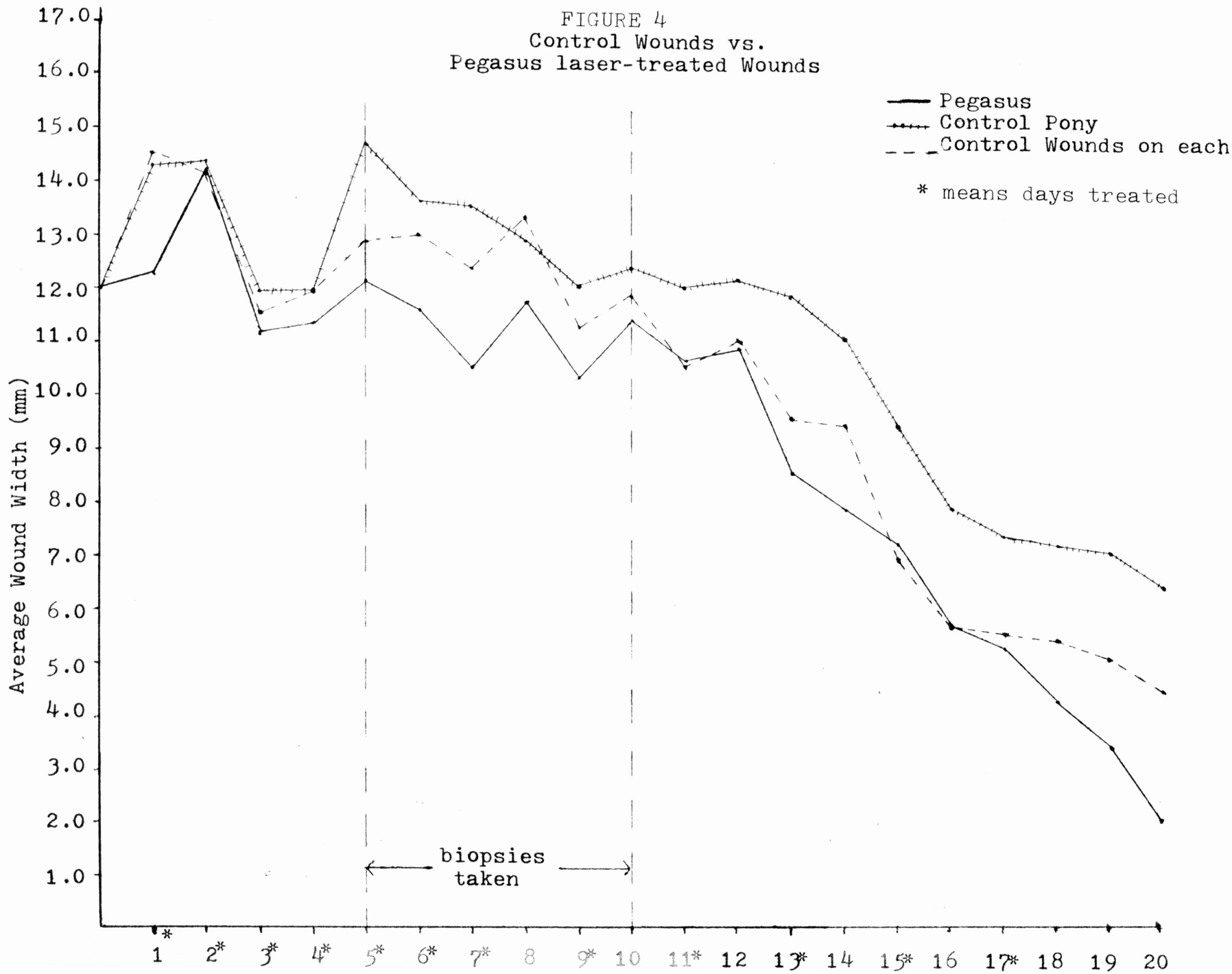
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Control Wounds vs.
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11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
biopsies taken
1* 2* 3* 4* 5* 6* 7* 8 9* 10 11* 12 13* 14 15* 16 17* 18 19 20