## *Abstract*

This thesis investigates the feasibility of closing wounds in skin tissue by laser welding as a substitute for suturing. Such a process would provide advantages in some surgical procedures. The investigation revised available theory on the action of lasers on skin tissue as a basis for the experimental program. The results of experiments using rat skin are then reported. In addition a thorough investigation of the normal (uninjured) tensile strength of rat skin was undertaken to provide a base line comparison..

Laser systems permit very high-energy radiation of a single wavelength to be focused on a tiny spot, and have found application in many areas of engineering. They are also currently used in many branches of medicine including ophthalmology, gynaecology, dermatology, otolaryngology, and gastroenterology. These medical applications employ argon, YAG, and carbon dioxide type lasers. In many cases, lasers have been found to be more effective than conventional treatment methods with advantages including reduced blood loss, more accurate removal of unwanted tissue, shorter operating times and less postoperative pain and care (Gibson and Kernohan, 1993).

Tissue welding using laser energy represents a small but growing area of medical research and is largely focused on anastomosis. This thesis investigates, using a specific experimental program, the feasibility of the bipolar contact Nd:YAG laser to weld **cutaneous** tissue. No similar published research has been identified in this area. The available literature focuses on non-contact lasers of various types and settings and mainly in the area of anastomosis. The experimental methodology and the specific technique for the bipolar contact laser is developed, tested and evaluated as part of this project.

The welding techniques developed in this project overcome the previous difficulties of tissue alignment. The use of the bipolar laser probes substantially improves the ability to align the tissue

edges to be joined. The probes give tactile feedback to the user and the pressure effect of the probes may assist with the welding process. The developed technique was no faster or easier than suturing. Viable welds and a useable technique for welding skin on rats were developed and tested. The resultant healing was comparable with published literature and both sutured and welded wounds returned to full strength as compared with the baseline data collected. All wounds had returned to full strength within 91 days. At 75 days there was not significant difference between laser welded and sutured wounds and they had achieved approximately 90% of full strength. Time to half strength was approximately 42 days and there was a larger standard deviation for both laser welded and sutured wounds. The most significant increase in strength and therefore healing occurred in the first 42 days. Simhon et al, 2001 states that a tensile strength of 0.6 N ± 0.4 N was sufficient to hold tissue together. By day 7 the strength of the wound (laser welded) was more than twice the strength needed to maintain closure. There may have been sufficient healing for this to occur earlier but there were insufficient animals to allow for testing of this theory.

In conclusion this experimental program and investigation has reviewed the available literature on the current use of lasers in medicine and their specific laser-tissue interaction which leads to tissue welding. It has provided a large database of tensile strength measurements collected with a reproducible methodology and reported in a standardised format. The developed technique for laser tissue welding using a bipolar contact Nd:YAG laser has been established and verified. It produces viable welds comparable in strength and healing rates to sutures.