

Brachytherapy Treatment for Equine Ocular and/or Periocular Squamous Cell Carcinoma

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STATEMENT OF ORIGINALITY

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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ACKNOWLEDGEMENT OF AUTHORSHIP

I hereby certify that this thesis is in the form of a series of published papers of which I am a joint author. I have included as part of the thesis a written statement from each co-author, endorsed by the Faculty Assistant Dean (Research Training), attesting to my contribution to the joint publications.

Yolanda Surjan

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Peer Reviewed Conference Presentations

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List of Abbreviated Terms

¹⁰³ Pd	Palladium-103
¹²⁵ I	Iodine-125
¹³⁷ Cs	Cesium-137
¹⁹² Ir	Iridium-192
¹⁹⁸ Au	Gold-198
5-FU	5-Fluorouracil
⁶⁰ Co	Cobalt-60
AEVA	Australian Equine Veterinary Association
ALARA	As Low As Reasonably Achievable
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AVA	Australian Veterinary Association
BCC	Basal Cell Carcinoma
Bq	Becquerel
BVSc(Hons)	Bachelor Veterinary Medicine (Honours)
CIS	Carcinoma in Situ
CRT	Conformal Radiation Therapy
CT	Computed Tomography
DNA	Deoxyribonucleic Acid
DXR	Orthovoltage Radiation Therapy
EBRT	External Beam Radiation Therapy
Gy	Gray
HDR	High Dose Rate
ICR	International Congress of Radiology
ICRP	International Commission on Radiation Protection
ICRU	International Commission on Radiation Units and Measurements
LDR	Low Dose Rate
LET	Linear Energy Transfer
MBq	Megabecquerel
MDR	Medium Dose Rate
MeV	Mega Electron Volts
mGy	milliGray
MMC	Mitomycin
MRI	Magnetic Resonance Imaging
mSv	milliSievert
Mv	Mega Volts
NCRP	National Council on Radiation Protection and Measurements
OAR	Organs at Risk
OPG	Orthopantogram
OSCC	Ocular Squamous Cell Carcinoma
PDR	Pulsed Dose Rate
PDT	Photodynamic Therapy
POSCC	Periocular Squamous Cell Carcinoma
R	Roentgen
RBE	Relative Biologic Effectiveness

RO	Radiation Oncology/Radiation Oncologist
RPS	Radiation Protection Series
RT	Radiation Therapy/Radiation Therapist
SCC	Squamous Cell Carcinoma
SI	International System of Units
Sv	Sievert
SXT	Superficial Radiation Therapy
TD	Tumour Dose
TV	Tumour Volume
UK	United Kingdom
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
USA	United States of America
UV	Ultra Violet

ABSTRACT

Squamous Cell Carcinoma (SCC) is the most common tumour of the eye and adnexa in horses representing up to 75% of tumours. The management of equine ocular squamous cell carcinoma (OSCC) and/or periocular squamous cell carcinoma (POSCC) remains a challenge despite its high prevalence among horses. Literature suggests a number of treatment modalities currently exist; surgery, photodynamic therapy, cryotherapy, carbon dioxide (CO₂) laser ablation, radiofrequency hyperthermia, topical or intratumoral chemotherapy, and radiation therapy (RT), predominantly in the form of brachytherapy (implantation of sealed radioactive sources). Whilst no technique can conclusively be identified as the best approach to the treatment of OSCC/POSCC, successful treatment commonly involves one of the above therapies combined with cytoreductive surgery. Furthermore, the value of combining radiation therapy with surgery or using radiation therapy alone has been identified in relation to benefits in decreasing cosmetic and functional defects.

The research presented in this thesis originated following an initial anecdotal source of enquiry suggesting a standardised treatment technique for OSCC/POSCC in horses was non-existent. Simultaneously, a request from a veterinary practitioner for RT expertise input into the development of future RT protocols in veterinary medicine reinforced the value in conducting the research enquiry.

The thesis presents a series of five studies demonstrating transition from the initial anecdotal source to the development of a Treatment Protocol. The interconnected research studies include; three literature reviews, a retrospective study (treatment modelling) and two surveys and concludes with the development of a Treatment Protocol and a supporting summary of the Code of Practice for Radiation Protection in Veterinary Medicine in the form of a flow-chart.

The literature reviews identified the need for radiation therapy/radiation oncology expertise in the field of veterinary oncology and upon investigation of current and past treatment options nationally and internationally, concluded that a consistently favoured treatment option for OSCC/POSCC does not currently exist. An invited

review was published in the Australian Equine Veterinarian Journal to coincide with the launch of the 2015 national survey.

The retrospective study was performed on data collected from medical records from an Australian Equine Clinic. Retrospective treatment modelling was conducted on 75 horse cases treated with brachytherapy implants with radioactive Gold-198 wire between 1999 and 2007. All cases were replicated using Varian BrachyVision™ radiation therapy treatment planning software. Results demonstrated treatments delivered between 1999-2007 were improved in most cases with the advantage of computerised optimisation. However, further analysis of previous treatments demonstrated a lack of consistency in reporting, radiation safety compliance and the absence of a standardised formal protocol.

Surveys conducted with Australian veterinarians explored current and past treatment options for OSCC/POSCC and assessed knowledge and general compliance with radiation safety protection principles and treatment protocol use. This research identified standardised treatment protocols for OSCC/POSCC are clearly non-existent, and that radiation safety compliance and practice is deficient.

In response to the findings of the retrospective modelling and the national surveys, a standardised Treatment Protocol in the form of a process flow-chart and a summarised version (visual-aid) of the Code of Practice for Radiation Protection in Veterinary Medicine were developed. The implementation of these resources will help translate an evidence based treatment approach using brachytherapy to a common neoplasm as well as minimise any unnecessary occupational irradiation.