

Technological Advances in Radiotherapy for the Treatment of Localized Prostate Cancer - A Systematic Review

Jayatissa R.M.G.C.S.B. (B.Sc.)

Department of Radiography/Radiotherapy, Faculty of Allied Health Sciences University of Peradeniya Sri Lanka, Sri Lanka.

Abstract

Prostate cancer is one of the most common cancers among males and is the second leading cause of cancer-related death in males.

Objectives;

The aim of this study is to find out the technological advances in the treatment of localized prostate cancer, to find out the side effects for each of the researched technological changes and to determine the outcomes of each change in technology.

Methods and Materials

A systematic review was undertaken to provide evidence relevant to the above objectives.

Results;

it has been recognized that the most widely used treatment modality as new Intensity modulated radiotherapy, the RapidArc has also being used in current radiotherapy, delivering the treatment using the cyber knife since 2008 (26).

The side effects observed are different for each change in technology, some side effects are common to more than one treatment option such as urinary incontinence observed with cryotherapy, surgery, conventional radiotherapy, brachytherapy, and High Intensity Focused Ultrasound. Some are observed with a single treatment method such as urethral sloughing observed only with cryotherapy.

The best five-year outcome was observed with Intensity Modulated Radiotherapy (100%) and worst five year outcome identified was with cryotherapy (36%) for low risk cancers. For intermediate risk cancers the best was with Brachytherapy (100%) and worst with conventional radiotherapy (26%).

Conclusions

The most advanced treatment in radiotherapy for localized prostate cancer is based with four dimensional treatment planning systems.

Side effects were varying in each change in technology and there was no common side effect to all treatment method on the published data studied.

From the published data IMRT appears to be a favorable treatment method for localized prostate cancers. However, establishing the optimal mode of therapy for prostate cancer remains controversial.

Introduction

Prostate cancer is one of the most common cancers among males and is the second leading cause of cancer-related death in males (46). In western societies and those who are emulating western lifestyles and diet there has been an increase in prostate cancer. In 2001 in the United States there were 31,900 reported deaths among the 198,100 new cases, where approximately one out of three persons is diagnosed with prostate cancer during their life time (13). In simple terms, prostate cancer can be divided into cancer that has not spread, which is called 'localized disease', and cancer that has spread, either "locally extending outside the prostate itself" or involving distant organs, such as lymph nodes or bone ("distant" or metastatic disease). Localized prostate cancer is classified into risk groups as low risk, intermediate risk and the high risk group, for the purpose of deciding on a treatment method. The side effects and expected outcome of each treatment method will also depend on the external factors in deciding the best treatment modality for a localized prostate cancer. Standard treatments for localized prostate cancer include surgery, radiation therapy (external beam or brachytherapy with or without androgen ablation), or observation, which is also termed watchful waiting (46). The most adverse effect caused by irradiation of normal organs (38) in conventional radiotherapy methods are gastrointestinal, genitourinary, and sexual side effects. These effects should be reduced with the advances in radiotherapy technology. Several technical advances in radiotherapy have occurred over the last 20 years, conventional external beam radiotherapy (EBRT), three-dimensional radiotherapy (3DRT), intensity modulated radiotherapy (IMRT), image guided radiotherapy (IGRT), the cyber knife and the Rapid Arc techniques have all enhanced the precision of EBRT outcomes with minimal side effects.

Methods and Materials

A comprehensive review of the literature pertaining to technological advances in the treatment of localized prostate cancer was conducted using the Pubmed and Medline databases, and was supplemented with a data extraction from other key references/reviews, including the studies referred to in a recent literature articles. With the key terms there were 225 English language journal articles but all of them didn't fulfill the inclusion criteria of the research or provided relevant information to the research. There were only 75 journal articles found with informative data pertaining to the study among them. With the key terms there were 225 English language journal articles but all of them didn't fulfill the inclusion criteria

of the research or provided relevant information to the research. There were only 75 journal articles found with informative data pertaining to the study among them.

Results and Discussion

1. Technological advances in the treatment of localized prostate cancers

1.1. Brachytherapy

There have been several changes added to the practice of Brachytherapy for prostate cancers over the last 100 years. In the first attempt radium needles were used and there was a period in the 1920s when radon seeds were also used (2). Currently it is possible to implant the radioactive materials such as iodine-125 or palladium-103 seeds permanently or high dose iridium-192 sources temporally through catheters (38).

1.2. High Intensity Focused Ultrasound

In 1942 HIFU (High Intensity Focused Ultrasound) had been introduced for treatment of cancers but its actual implementation for prostate cancers was in the early 1990s and in 1996 for benign prostatic hypertrophy (40).

1.3. Conventional radiotherapy

Conventional radiotherapy has been used since the 1950s (9). New treatment machines such as linear accelerators, having more than 4MV energy, have replaced the Co-60 machines used throughout the past decades.

1.4. Cryotherapy

In the 1960s liquid nitrogen in the form of ice packs was used for cryotherapy but in earlier times low temperatures had been used for this technique (46). Most recently the development of a temperature feedback automated freezing system have indicated its' potential use in patients with localized prostate cancer (40).

1.5. Three Dimensional Conformal Radiotherapy

In the last past 5-10 years, major advances in planning and delivery of external beam radiotherapy occurred (33). In the mid 1980s 3D-CRT was first available, and now 3D-CRT has combined CT and MRI imaging with computerized planning to optimize prostate localization, delineation and dose distribution (5).

1.6. Surgery

According to the publication in 2003, the surgical perspective nerve sparing radical prostatectomy was the fundamental concept for localized prostate cancer treatment.

1.7. Rapidarc

Since 2008 a form of new IMRT, the RapidArc is also been used in current radiotherapy, delivering the treatment using the cyber knife (26). It has the ability to deliver non coplanar non isocentric arcs to maximally conform isodoses. Fiducial markers are implanted in the prostate to verify the organ position and planning is provided by inverse planning.

1.8. Intensity Modulated Radiotherapy

According to the published literature in 2006, the next generation came with the development of IMRT (18). In addition the imaging of implanted fiducial markers with computed tomography has been developed (18). The ability to image the daily prostate position has allowed the development of the IGRT technique.

1.9. Image Guided radiotherapy

During the last decade, improvements in imaging with CT, MRI and PET scanning have allowed better localization of tumour volumes and more accurate treatment planning. Recent studies have demonstrated that treatment accuracy in delivery could be improved with the use of online imaging.

1.10. Proton therapy

In 2010 a treatment method opposed to conventional photon therapy, in the form of particle therapy (proton therapy) is used to treat prostate cancers (33). This is a very new technique in the treatment of prostate cancers.

1.11. Stereotactic radiotherapy

It is a new technique, so there is limited published data (33).

2. Side effects for each of the researched technological changes.

2.1. Gastrointestinal side effects

2.1.1. Recto urethral fistula

Longa J, P. in March 2001 had presented their research data on cryotherapy (24).

Table 1. Prevalence of Recto urethral fistula

References	Treatment modality	Study sample	Results
(24)	cryotherapy	575	0.5%

2.1.2. Acute proctitis

According to the data and their sample the most valid data were produced by the U.S National Institute of Health, because their study sample size is large than the study in US by Perez, C A, 2000 (37).

Table 2. Prevalence of Acute proctitis

References	Treatment modality	Study sample	Results
(39)	Surgery	1156	1.6%
	Conventional radiotherapy	435	18.7%
(37)	Conventional radiotherapy	131	8%
	3DCRT	146	12%

2.1.3. Diarrhoea

The most valid data (20.9%) being treat by the U.S. National institute of health compared to the other researchers because of their study sample (901 patients) is large.

Table 3. Prevalence of Diarrhoea

References	Treatment modality	Study sample	Results
(39)	Conventional radiotherapy	286	37.2%
	Surgery	901	20.9%
(37)	3DCRT	146	1.7%

2.1.4. Bowel urgency

The U.S. National Institute of Health published data (14.5%) on surgery proven to be more valid than the conventional radiotherapy data (35.7%) due to the large sample (901 patients) size in surgery.

Table 4. Prevalence of Bowel urgency

References	Treatment modality	Study sample	Results
(39)	Surgery	901	14.5%
	conventional radiotherapy	286	35.7%

2.1.5. Late grade 2 rectal toxicity

The most valid data (2.9%) may be from Katz, A J, in 2010 due to the large sample size (206 patients) than the other treatment methods.

Table 5. Prevalence of Late grade 2 rectal toxicity

References	Treatment modality	Study sample	Results
(49)	3DCRT	61	14%
(35)		116	8%
(52)	Brachytherapy	145	11%
(49)	IMRT	189	2%
(35)	IMRT	166	5%
(19)	Stereotactic radiotherapy	206	2.9%

2.1.6. Rectal injury

Rectal injury was only identified with Brchytherapy and it was published in UK by Ash, D, 2005 (2).

Table 6. Prevalence of Rectal injury

References	Treatment modality	Study sample	Results
(2)	Brachytherapy	667	0.2%

2.1.7. Acute grade 2 rectal toxicity

In the published journal articles more valid statistics may have been produced by stereotactic radiotherapy by Schulte RW, in 2000, because of the large sample of patients been studied.

Table 7. Prevalence of Acute grade 2 rectal toxicity

References	Treatment modality	Study sample	Results
(5)	IMRT	772	4.5%
(51)		772	4.5%
(19)	Stereotactic radiotherapy	253	3.6%
(41)	Proton therapy	870	3.5%

2.1.8. Acute GI toxicity

Acute GI toxicity could be found only from IMRT and it was reported on a single journal article by Ghadjar, P in 2008 in Switzerland.

Table 8. Prevalence of Acute GI toxicity

References	Treatment modality	Study sample	Results
(12)	IMRT	39	3%

2.1.9. Late grade 2 GI toxicity

The more valid data may have been produced with the IGRT treatments, the research had conducted by Martin,M,J, in 2009, because their study sample being larger than the other research study.

Table 9. Prevalence of Late grade 2 GI toxicity

References	Treatment modality	Study sample	Results
(12)	IMRT	39	8%
(28)	IGRT	222	13.7%

2.1.10. Grade 2 rectal bleeding

By Zelefsky, M, J, in October 2006 observed Grade 2 rectal bleeding with the treatment of IMRT and they had resulted 1.6% of grade 2 rectal bleeding among 561 patients.

Table 10. Prevalence of Grade 2 rectal bleeding

References	Treatment modality	Study sample	Prevalence
(49)	IMRT	561	1.6%

2.1.11. Grade 3 rectal toxicity

More accurate data was obtained by Zelefsky, M J, in August 2002, because they had taken a larger sample size than the other studies.

Table 11. Prevalence of Grade 3 rectal toxicity

References	Treatment modality	Study sample	Prevalence
(49)	IMRT	561	0.1%
(51)		772	0.1%
(41)	Proton therapy	870	0%

2.1.12. Grade 2 late rectal bleeding

The more valid data may have produced by Zelefsky, M, J, in 2002 because their sample size larger than the other study.

Table 12. Prevalence of Grade 2 late rectal bleeding

References	Treatment modality	Study sample	Prevalence
(51)	IMRT	772	1.5%
(35)		166	2%

2.1.13. Late grade 3 GI toxicity and Late grade 2-3 GI toxicity

According to the sample size the more valid data not obvious, due to the study sample size on both studies become equal.

Table 13. Prevalence of Grade 3 late GI toxicity and Grade 2-3 late GI toxicity

References	Treatment modality	Study sample	Prevalence
(28)	IGRT	222	10.1%
		222	13.7%

2.2. Genitourinary side effects

2.2.1. Urethral sloughing

Comparing the studies the study done in India may have more validity of data than the other studies because of their larger study sample size.

Table 14. Prevalence of Urethral sloughing

References	Treatment modality	Study sample	Prevalence
(40)	Cryotherapy	92	3.2%
(8)		76	3.9%
(46)		37	10%

2.2.2. Urinary incontinence

The U.S. National institute of health had conducted studies with sample size of 1156 patients may have a higher validity.

Table 15. Prevalence of Urinary incontinence

References	Treatment modality	Study sample	Prevalence
(40)	Cryotherapy	122	4.3%
(8)		76	1.3%
(46)		37	72%
(24)		575	7.5%
(39)	Surgery	1156	9.6%
		901	15.4%
		901	14%-16%
(39)	Conventional radiotherapy	435	3.5%
		286	4%
(27)	Brachytherapy	271	4%-6%
(40)	HIFU	315	13%

2.2.3. Testicular abscess

Testicular abscess was only observed with cryotherapy in a study conducted by Donnellya, J, B 2002.

Table 16. Prevalence of Testicular abscess

References	Treatment modality	Study sample	Prevalence
(8)	Cryotherapy	76	1.3%

2.2.4. Impotence

According to the one of the studies done with a total number of 1156 patients 80% of impotence was observed and the other study published 79.6% of patients as having affected for a total of 901 patients. The more valid prevalence of impotence may be from the former study which had 1156 patients.

Table 17. Prevalence of Impotence

References	Treatment modality	Study sample	Prevalence
(46)	Cryotherapy	37	59%
(24)		575	93%
(39)	Surgery	1156	80%
		901	79.6%
(39)	Conventional radiotherapy	435	62%
		286	62.5%
(2)	Brachytherapy	667	50%

2.2.5. Erectile dysfunction

Among all the published journal articles the most valid data was provided by U.S. National institute of health (79.3%) compared to other studies due its larger population (901) than the others.

Table 18. Prevalence of Erectile dysfunction

References	Treatment modality	Study sample	Prevalence
(27)	Surgery	602	44%
(39)		901	79.3%
		901	59.4%
(39)	Conventional radiotherapy	286	25.3%
(52)	3DCRT	137	2%
(27)	Brachytherapy	271	13%
(52)		145	53%
(27)	IMRT	202	22%
(40)	HIFU	315	22%

2.2.6. Acute Grade 1 urinary symptoms

The most valid data may have on the surgery because of the large study sample.

Table 19. Prevalence of Acute grade 1 Urinary symptoms

References	Treatment modality	Study sample	Prevalence
(27)	Surgery	602	7%
	Brachytherapy	271	18%
	IMRT	202	11%

2.2.7. Urinary strictures

Among both treatment modalities, the most valid data was on surgery because of the sample size is larger than the study under conventional radiotherapy.

Table 20. Prevalence of Urinary strictures

References	Treatment modality	Study sample	Prevalence
(39)	Surgery	1156	17.4%
	Conventional radiotherapy	435	7.2%

2.2.8. Dysuria

These side effects were mentioned as separately observed side effects in the article. In this observation also had more accurate data for 3DCRT treatment results because of the large study sample size (146 patients).

Table 21. Prevalence of moderate Dysuria

References	Treatment modality	Study sample	Prevalence
(37)	3DCRT	146	5%
	Conventional radiotherapy	131	6%

Table 21.1. Prevalence of Dysuria

References	Treatment modality	Study sample	Prevalence
(37)	3DCRT	146	18%
	Conventional radiotherapy	131	9%

2.2.9. Moderate urinary frequency

On this data most accurate information was provided for 3DCRT as its sample size (146 patients) is larger.

Table 22. Prevalence of moderate urinary frequency

References	Treatment modality	Study sample	Prevalence
(37)	Conventional radiotherapy	131	18%
	3DCRT	146	24%

2.2.10. Nocturia

Comparing both studies the most valid data provided by 3CDRT treatment side effect because of relatively large sample size to conventional radiotherapy study.

Table 23. Prevalence of Nocturia

References	Treatment modality	Study sample	Prevalence
(37)	Conventional radiotherapy	131	21%
	3DCRT	146	8%-19%

2.2.11. Acute grade 2 urinary toxicity

The most valid data (4%) was published by Katz, A J, in 2010 due to large sample size (304 patients) than the other studies.

Table 24. Prevalence of Acute grade 2 urinary toxicity

References	Treatment modality	Study sample	Prevalence
(49)	3DCRT	61	4%-13%
(52)		137	8%
(52)	Brachytherapy	145	31%
(19)	Stereotactic radiotherapy	304	4%
(19)	Stereotactic radiotherapy	253	4.7%

2.2.12. Late grade 2 urinary toxicity

The most valid data may have been the one published by Zelefsky, M J, in August 2002 as their study sample size (772 patients) is larger than the other study.

Table 25. Prevalence of Late grade 2 urinary toxicity

References	Treatment modality	Study sample	Prevalence
(52)	3DCRT	137	2%
(51)	IMRT	772	9%

2.2.13. Grade 3 urinary toxicity

More valid data were published by the Zelefsky MJ, in August 2002 study compared to other researches.

Table 26. Prevalence of Grade 3 urinary toxicity

References	Treatment modality	Study sample	Prevalence
(52)	3DCRT	137	6%
	Brachytherapy	145	12%
(49)	IMRT	571	3%
(51)		772	0.5%

2.2.14. Urinary retention

Comparing both studies more valid data may be produced by Zelefsky, MJ, in August 2002 in study as their sample size (772 patients) being larger than study on brachytherapy.

Table 27. Prevalence of Urinary retention

References	Treatment modality	Study sample	Prevalence
(23)	Brachytherapy	67	33%
(51)	IMRT	772	0.12%

2.2.15. Urethral symptoms

The urethral symptom identified only for a single article for Brachytherapy and it was published by UK research study (2).

Table 28. Prevalence of Urethral symptoms

References	Treatment modality	Study sample	Prevalence
(2)	Brachytherapy	667	2.5%

2.2.16. Grade 3 GU toxicity

In a research conducted in Switzerland by Ghadjar, P in 2008 had observed grade 3 GU toxicity with IMRT.

Table 29. Prevalence of Grade 3 GU toxicity

References	Treatment modality	Study sample	Prevalence
(12)	IMRT	39	3%

2.2.17. Late grade 2 GU toxicity

More accurate data was obtained by Martin, M, J, in 2009, because they had taken a larger sample size (222 patients) than the other study.

Table 30. Prevalence of Late grade 2 GU toxicity

References	Treatment modality	Study sample	Prevalence
(12)	IMRT	37	15%
(28)	IGRT	222	12.1%

2.2.18. Urethral toxicity/ strictures

In USA Zelefsky, M, J, in October 2006 had conducted a study on IMRT and observed urethral toxicity/ strictures.

Table 31. Prevalence of urethral toxicity/ strictures

References	Treatment modality	Study sample	Prevalence
(49)	IMRT	561	1.6%

2.2.19. Acute grade 2 Urinary symptoms

In USA Zelefsky, MJ, in August 2002 had conducted a study on IMRT.

Table 32. Prevalence of Acute grade 2 Urinary symptoms

References	Treatment modality	Study sample	Prevalence
(51)	IMRT	772	28%

2.2.20. Urinary tract infection

Ranjan P, in 2008 conducted and observed Urinary tract infection for HIFU, 5% of the patients had this side effect in a study of 315 patients.

Table 33. Prevalence of Urinary tract infection

References	Treatment modality	Study sample	Prevalence
(40)	HIFU	315	5%

2.2.21. Bladder toxicity

For proton therapy Schulte R, W, in 2000 conducted a research and they observed Bladder toxicity of 5.4% of patients among the study sample of 870 patients.

Table 34. Prevalence of Bladder toxicity

References	Treatment modality	Study sample	Prevalence
(41)	Proton therapy	870	5.4%

2.3. Other side effects

2.3.1. Perineal pain

Perineal pain was only observed with cryotherapy in a study conducted by Theodorescu, Krupski, 2008, with a 37 patient sample 44% of affected patients.

Table 35. Prevalence of Perineal pain

References	Treatment modality	Study sample	Prevalence
(46)	Cryotherapy	37	44%

2.3.2. Cardiopulmonary complications

The patient sample size of 1156 is evaluated with a large number of patients than the other, hence it is provided more valid data.

Table 36. Prevalence of Cardiopulmonary complications

References	Treatment modality	Study sample	Prevalence
(39)	Surgery	1156	5.5%
	Conventional radiotherapy	435	1.9%

2.3.3. Implanted radiotherapy sources migrated to lungs

There was only one research publication found related to seeds or implanted radiotherapy sources migrated to lungs that was observed on brachytherapy.

Table 37. Prevalence of Implanted radiotherapy sources migrated to lungs

References	Treatment modality	Study sample	Prevalence
(15)	Brachytherapy	272	10%-15%

3. Outcomes for each change in technology.

3.1. Cryotherapy

More valid data was published by Longa J, P. in 2001 compared to other studies because they had taken a large number of patients to study. The five year survival ranged from 36% to 92% for low risk disease and for intermediate patients it was in the range of 61% to 89% for cryotherapy treatments.

Table 38. Five year outcomes of low risk and intermediate risk prostate cancer patients from Cryotherapy

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(40)	Not mentioned	60%-92%	61%-89%
(8)	72	89%	
(3)	93	61%-92%	
(3)	178		68%
(24)	244	36%-61%	

3.2. Watchful waiting

Under watchful waiting there was only one article publication found and the five year survival for low risk localized prostate cancer patients.

Table 39. Five year outcomes of low risk and intermediate risk prostate cancer patients from Watchful waiting

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(46)	378	86%	

3.3.Surgery

The prevalence of five year survival for low risk range from 76% to 98% and for intermediate risk patients range from 37% to 77%. More accurate data may be published by the study conducted by Pisansky in 2006 due to the large patient sample in the study.

Table 40. Five year outcomes of low risk and intermediate risk prostate cancer patients from Surgery

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(40)	Not mentioned	76%-98%	37%-77%
(38)	2991	81%	
(30)	151	94%	
(21)	1034		76%

3.4.Conventional radiotherapy

The survival data for low risk disease had ranged from 35% to 93% and for intermediate risk patients it ranged from 26% to 69.8%. According to the study of published articles more valid data may have been identified by Pisansky in 2006, because it had the larger sample size (2291 patients) than the other studies.

Table 41. Five year outcomes of low risk and intermediate risk prostate cancer patients from Conventional Radiotherapy

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(40)	Not mentioned	81%-86%	26%-60%
(38)	2991	51%-81%	
(4)	794	35%	
(34)	301	75%	43%-62%
(2)	667	81.4%	69.8%
(30)	152	93%	
(21)	785	51%-81%	
(37)	94	65%	
	20		40%

3.5. Three Dimensional Conformal Radiotherapy

The study data on five year survival ranged low risk patient from 85% to 96% and the intermediate risk patient survival ranged from 58% to 88% in the published articles. More valid data have been identified by Zelefsky et al, in 2001.

Table 42. Five year outcomes of low risk and intermediate risk prostate cancer patients from Three Dimensional Conformal Radiotherapy

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(49)	1100	85%	58%
(52)	137	88%	
(37)	111	96%	
	26		88%
(35)	116	88%	

3.6.Brachytherapy

According to the published data the survival data for low risk patients has ranged from 78% to 95% and for intermediate risk disease ranged from 60% to 100%. But among the published data the more valid data may be published by Pisansky in 2006 as there was a larger sample size than in the other studies.

Table 43. Five year outcomes of low risk and intermediate risk prostate cancer patients from Brachytherapy

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(40)	Not mentioned	78%-89%	66%-82%
(33)	Not mentioned	95%	
			88%-100%
(10)	33	79%	
	34		71%
(38)	2991	83%	
(2)	Not mentioned	85%-90%	60%-70%
(21)	950		75%
(52)	145	82%	

3.7.Intensity Modulated Radiotherapy

In the published data the low risk survival prevalence range from 92% to 100% and intermediate risk patient survival has ranged from 85% to 96%. And according to the published data more valid data was published by Zelefsky, MJ, in August 2002 as they has taken a larger sample size than the other studies in the world.

Table 44. Five year outcomes of low risk and intermediate risk prostate cancer patients from Intensity Modulated Radiotherapy

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(32)	478	98%	85%
(49)	561	100%	96%
(51)	772	92%	86%
(35)	116	94%	

3.8. Image Guided Radiotherapy

According to the publication more valid data were produced for intermediate risk patient statistics, because they had selected a large number of patients to study.

Table 45. Five year outcomes of low risk and intermediate risk prostate cancer patients from Image Guided Radiotherapy

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(28)	59	88.4%	
	163		76.5%

3.9. High Intensity Focused Ultrasound

In the analyzed data the more valid statistics were published by Toyoaki, U, in 2006 as they had taken a larger sample size (181) to study than the other studies. These observed outcomes of five year survival range from 75% to 94% for low risk disease and 67% to 78% for intermediate risk patients.

Table 46. Five year outcomes of low risk and intermediate risk prostate cancer patients from High Intensity Focused Ultrasound

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(40)	132	88%	67%
(40)	132	75%	78%
(47)	181	94%	75%

3.10. Proton therapy

The observed statistics ranged from 82% to 90% for low risk disease patients. And according to the analysed statistics more valid data may have been produced by Slater J D, in 2004 on low risk localized prostate cancer patients due to their study sample size (1255) which was larger compared to other studies.

Table 47. Five year outcomes of low risk and intermediate risk prostate cancer patients from Proton therapy

References	Study sample	Five year survival rate	
		Low risk	Intermediate risk
(42)	1255	90%	
(43)	319		97%
(41)	911	82%	

Conclusions

- The research results showed that the technological innovations were between 1920 and 2010.
- Side effects were varying for localized prostate cancer treatments in each change in technology and there was no common side effect to all treatment method on the published data studied.
- IMRT was associated with minimal percentile side effects.
- Proton therapy and HIFU has associated with the minimum number of side effects.
- From the published data IMRT appears to be a favorable treatment method for localized prostate cancers.
- According to analyzed data for low risk prostate cancer, the maximum five year survival was identified with IMRT hence it is the best treatment method for low risk diseased patients.
- The least percentage was observed with conventional radiotherapy, hence it is not a favorable treatment for localized prostate cancer patients.

Acknowledgement

I owe a great many thanks to a great many people who helped and supported me during the writing of this project report. My deepest thanks to Dr. P. Badra Hewavithana, former Head of the Department Radiography/Radiotherapy, and Mr. Joycelyn Cottrell, Therapy radiographer, Australia.

I would like to thank all the members in Department of Radiography/Radiotherapy at the faculty of allied health sciences.

Declaration

I do hereby declare that the work reported in this project thesis was exclusively carried out by me under the supervision of Dr. P. Badra Hewavithana and Mr. Joycelyn Cottrell. It describes the results of my own independent research except where due reference has been made in the text. No part of this project thesis has been submitted earlier or concurrently for the same or any other degree.

Accepted: 20th September 2011