



## 4° INCONTRO ITALO-FRANCESE SUL CARCINOMA MAMMARIO: problematiche attuali

Coordinatori del convegno:  
*Cynthia Aristei*  
*Bruno Cutuli*  
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Hotel Giotto  
Assisi  
22/23 novembre 2013

# Radioterapia dopo ricostruzione

**Dr.ssa Laura LOZZA**  
**Ss Radioterapia dei Tumori della  
Mammella**



FONDAZIONE IRCCS  
ISTITUTO NAZIONALE  
DEI TUMORI



# **RADIOTERAPIA POSTOPERATORIA**

**dopo**

## **MASTECTOMIA**

**e posizionamento di espansori/protesi per neoplasia mammaria o ricostruzione con tessuti autologhi (lembo di m. retto addominale o di gran dorsale)**

## **CHIRURGIA CONSERVATIVA**

**per neoplasia mammaria in pazienti precedentemente sottoposte a mastoplastica additiva**

# **CHIRURGIA CONSERVATIVA E RT IN PAZIENTI CON PROTESI ESTETICHE**



**Negli USA 150.000 donne/anno  
sono sottoposte a mastoplastica  
additiva con protesi**

**9% svilupperà una neoplasia  
mammaria**

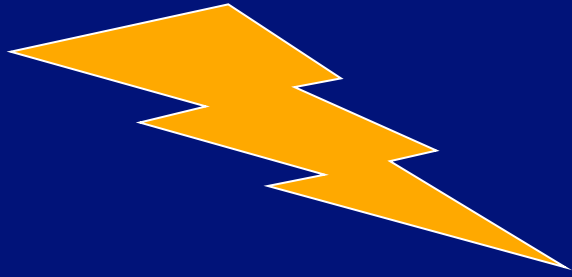
**L'opzione di chirurgia conservativa  
+ RT, se indicata, potrà essere  
applicata anche in questi casi**

***Senkus-Konefka, 2004***

# RADIOTERAPIA E RICOSTRUZIONE MAMMARIA: quali problemi ?

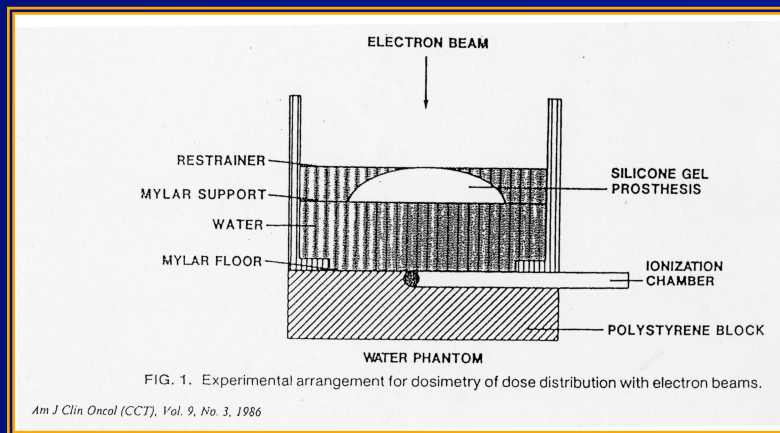


**Indicazioni, volumi e  
tecniche di trattamento  
non differiscono da  
quelli per la RT dopo  
chirurgia conservativa**

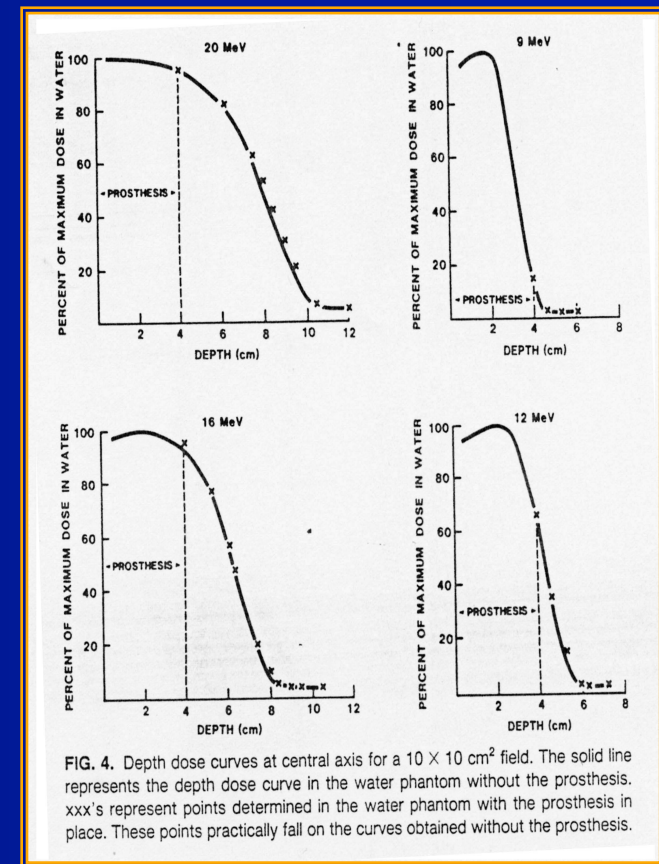


**“ LA PRESENZA DI UNA PROTESI  
COMPROMETTE LA DISTRIBUZIONE DELLA  
DOSE E, DI CONSEGUENZA, L' EFFICACIA  
DEL TRATTAMENTO RADIANTE ?”**

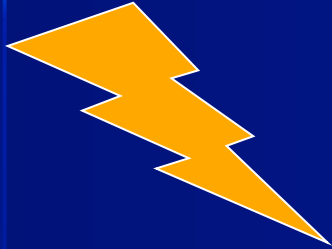
# IRRADIAZIONE SPERIMENTALE DI UNA PROTESI IN SILICONE



**Confronto tra la distribuzione di dose per elettroni da 9 – 20 MeV in presenza di protesi e in un fantoccio di acqua tessuto equivalente**



**“ LA PRESENZA DI UNA PROTESI COMPROMETTE LA DISTRIBUZIONE DELLA DOSE E, DI CONSEGUENZA, L' EFFICACIA DEL TRATTAMENTO RADIANTE ?”**



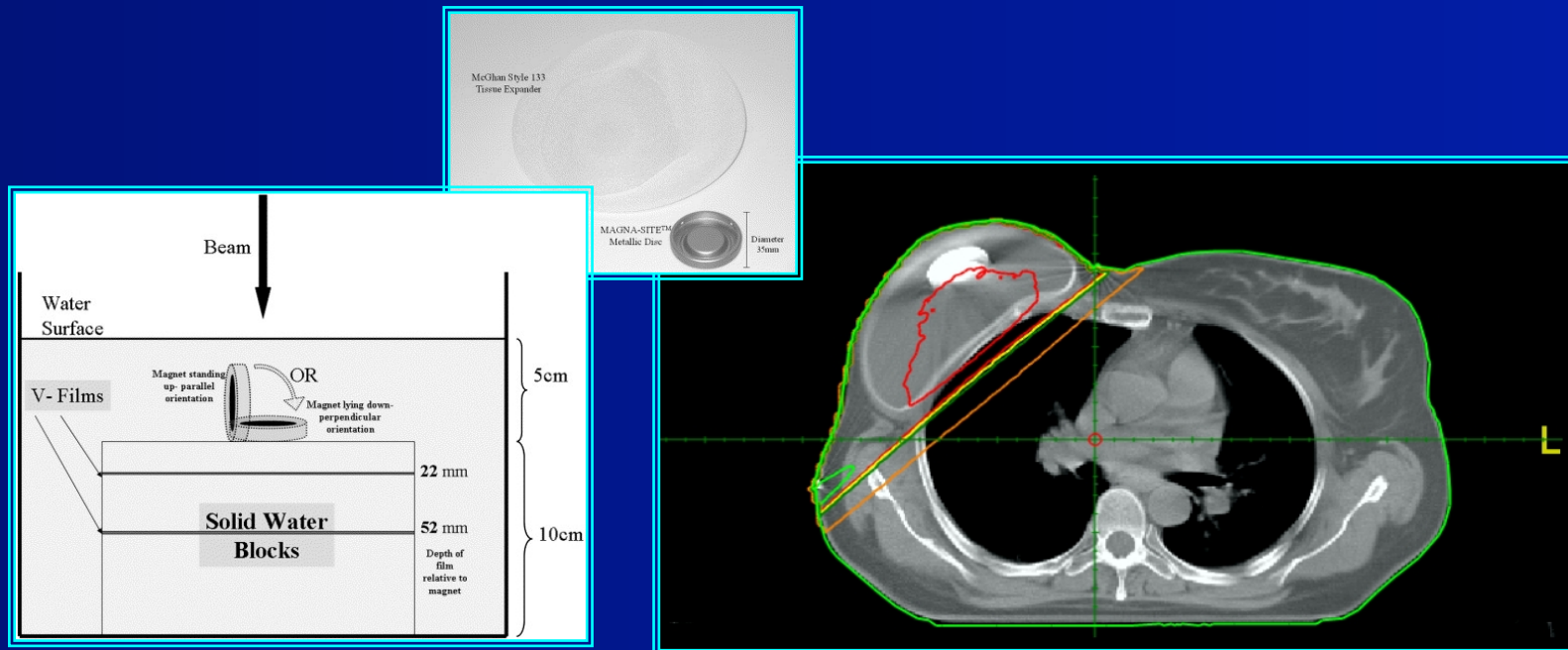
**“La trasmissione dei fotoni e degli elettroni nel silicone e nell'acqua è identica”  
(Piontek and Kase: Radiology, 1980 )**

**“Il gel di silicone si comporta come tessuto. I coefficienti di attenuazione lineare per il gel di silicone e per l'acqua sono sovrapponibili”  
( Shendbalkar et al: Plast Reconstr Surg, 1980 )**

**“ I RISULTATI INDICANO CHIARAMENTE CHE LA PRESENZA DI PROTESI NON MODIFICA SIGNIFICATIVAMENTE LE DOSE EROGATA AI TESSUTI CIRCOSTANTI”**

**Krishnan and Krishnan: Am J Clin Oncol, 1986**

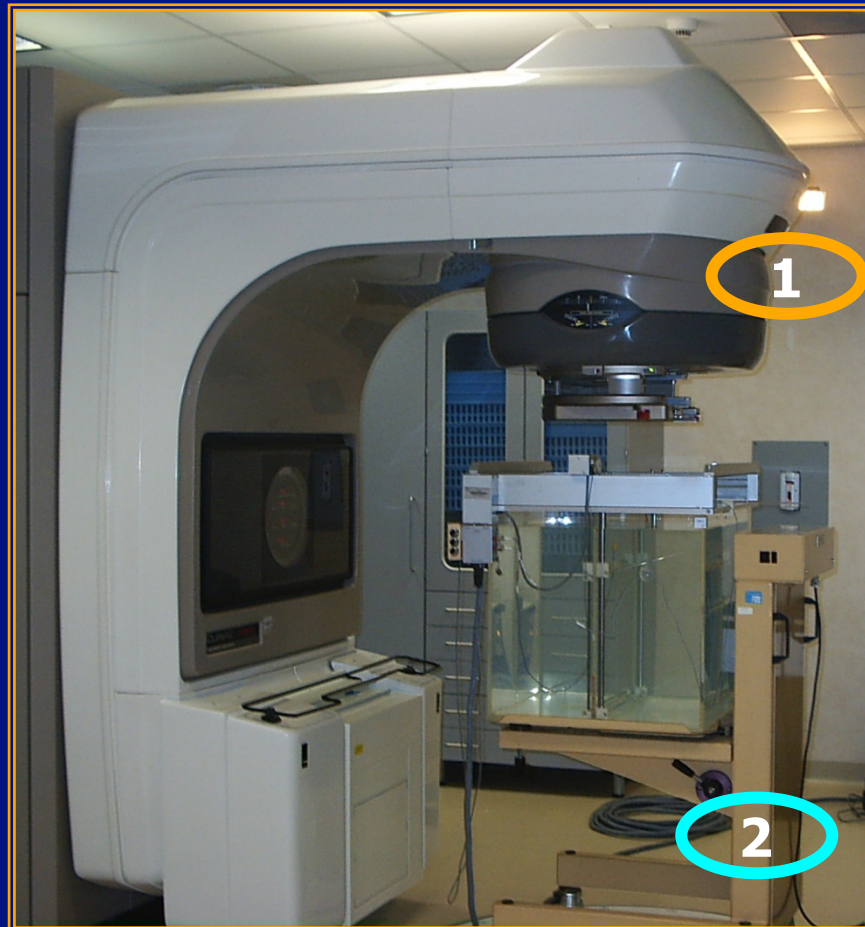
# “LE VALVOLE METALLICHE DEGLI EXPANDERS ALTERANO LA TRASMISSIONE DELLE RADIAZIONI ?”

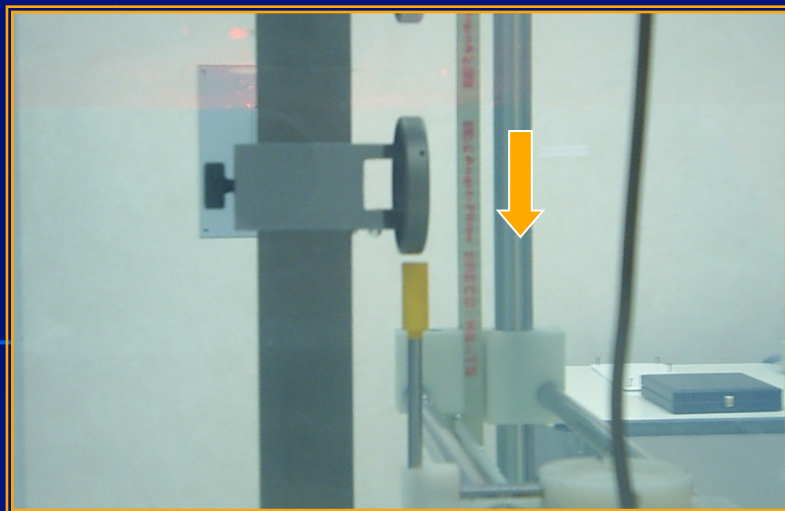


**Le valvole metalliche possono attenuare un fascio standard di fotoni da 6MV di circa il 22%**  
**Il volume di tessuto interessato dall' attenuazione è trascurabile**



**Sorgente di radiazione X 6MV: LINAC Varian DBX (1)**  
**Fantoccio ad acqua servocomandato Scanditronix RFA 300 con rivelatore a semiconduttore (2)**

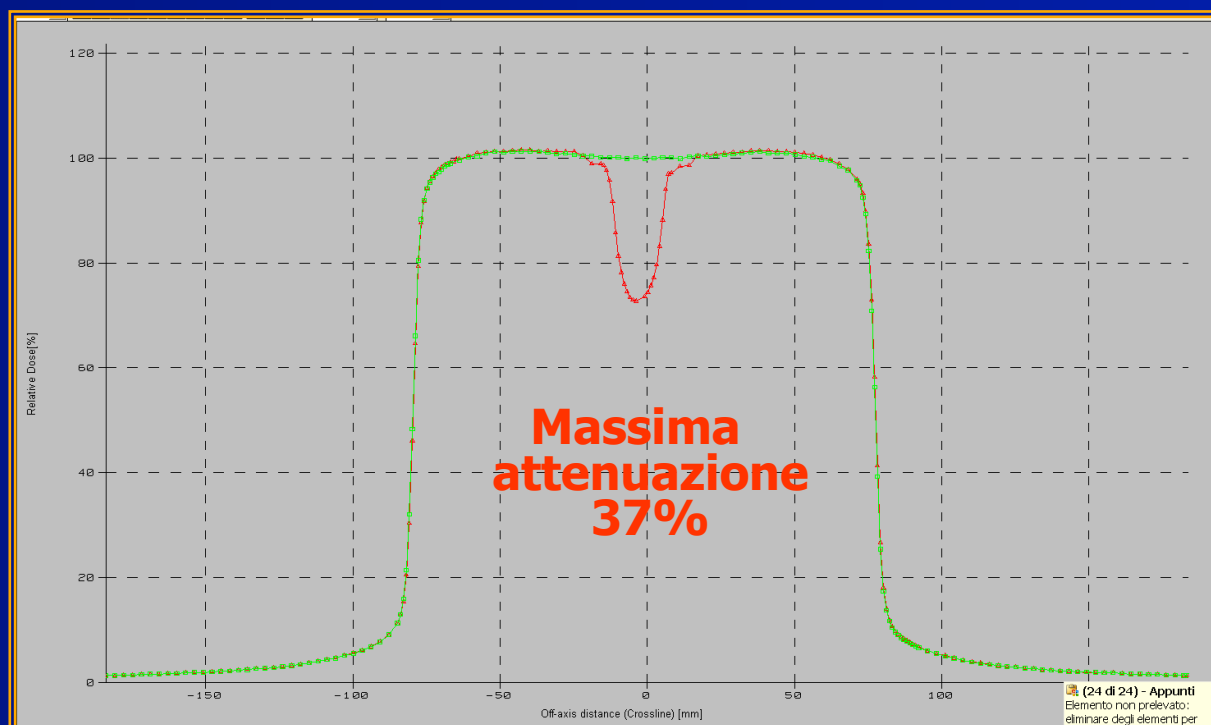


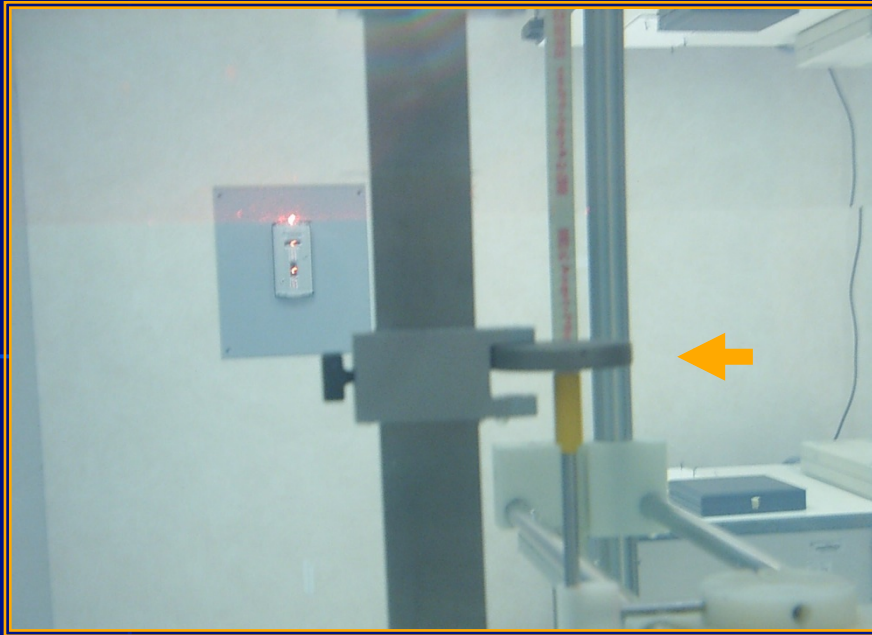


Il disco metallico del Magna-Site è immerso nel fantoccio ad acqua con l'asse maggiore del disco in posizione **parallela** alla direzione di propagazione del fascio di radiazione X6MV.

Il profilo della dose è stato rilevato a 5 cm di profondità d'acqua a contatto del disco metallico (linea rossa).

Le misure sono normalizzate (100%) alla profondità di 5cm in assenza del disco metallico (linea verde).



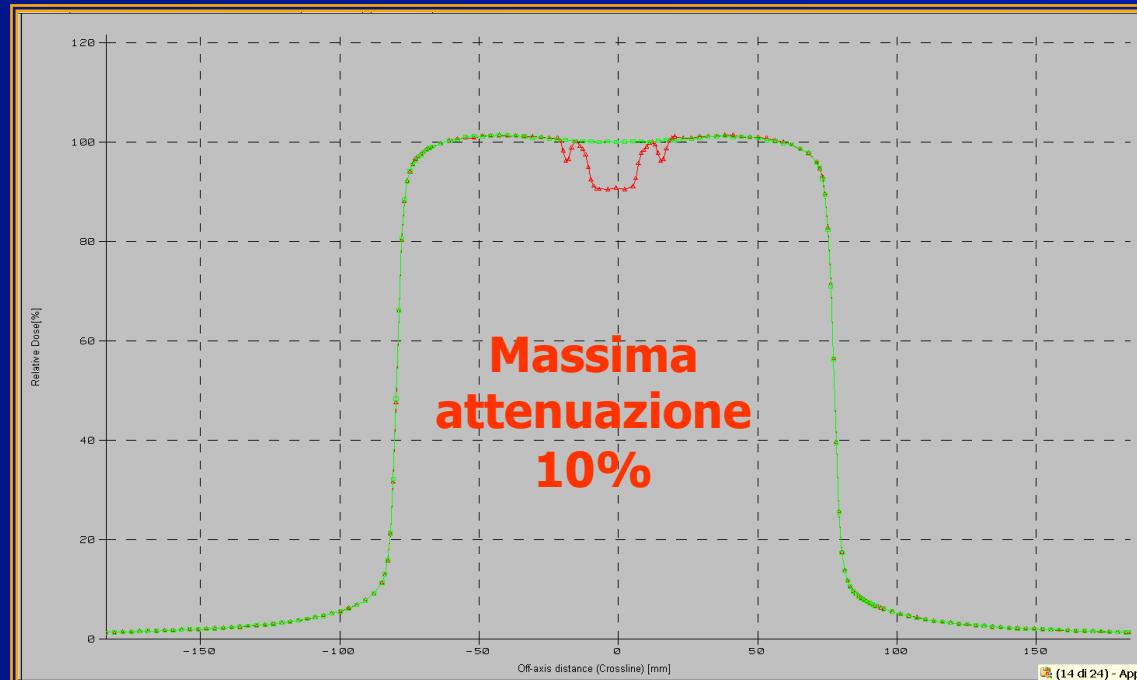


Il disco metallico del Magna-Site è immerso nel fantoccio ad acqua con l'asse maggiore del disco in posizione **perpendicolare** alla direzione di propagazione del fascio di radiazione X6MV.

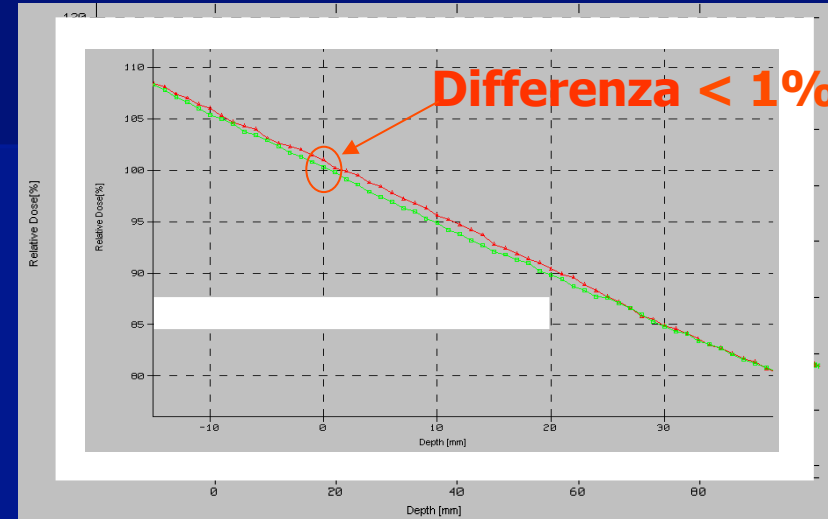
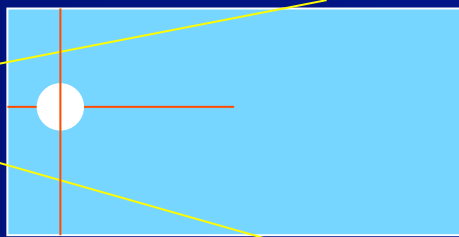
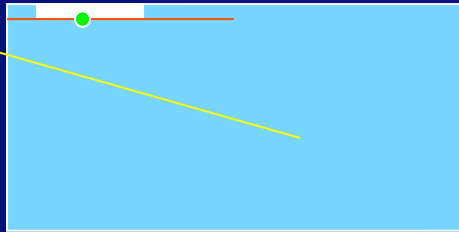
Il profilo della dose è stato rilevato a 5 cm di profondità d'acqua a contatto del disco metallico (linea rossa).



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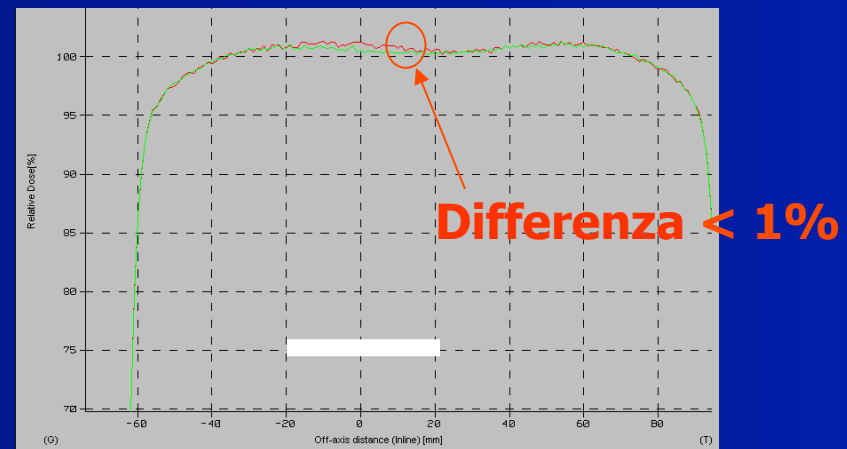


# Valutazione in condizioni di irraggiamento tangenziale



**Curva rossa con espansore**

**Curva verde senza espansore**



**DOSIMETRY AROUND METALLIC PORTS IN TISSUE EXPANDERS IN  
PATIENTS RECEIVING POSTMASTECTOMY RADIATION THERAPY: AN  
EX VIVO EVALUATION**

JANAKI MONI, MARIA GRAVES-DITMAN, PAUL CEDERNA, KENT GRIFFITH,  
EDITHA A. KRUEGER, BENEDICK A. FRAASS, and LORI J. PIERCE

**Int J Radiat Oncol Biol Phys 2004**

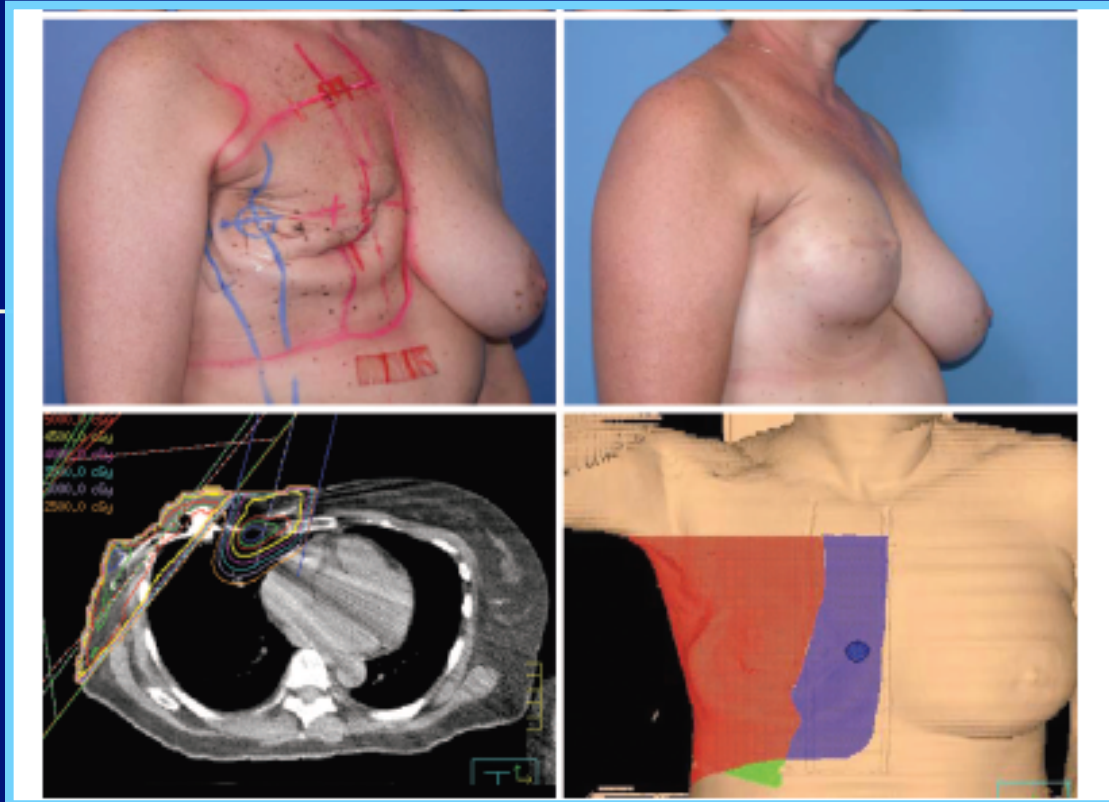
**...non si rileva che la valvola metallica  
dell'espansore contribuisca  
significativamente all'elevata incidenza di  
complicanze osservate in pazienti irradiate su  
espansori dopo mastectomia**

## **Impact of internal metallic ports in temporary tissue expanders on postmastectomy radiation dose distribution**

Chen SA et al, Int J Radiation Oncol Biol Phys, 2013

.... Internal magnetic metal ports **increase dose heterogeneity** and **reduce dose** to the CTV through attenuation of the beam  
(mean dose to CTV **87.7% vs 99.7%** )

**For optimal RT treatment heterogeneity corrections should be used**



*Kronowitz, 2009*

**Complete deflation of the expander before postmastectomy radiation therapy allows for treatment of the internal mammary lymph nodes without excessive injury to the heart and lungs and avoids nonuniform radiation dose distribution.**

# 3xTE

## three RT plans for Tissue Expanders



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A. Espansore vuoto dopo mastectomia  
Superficie cutanea  
PIATTA



B. Espansore a pieno riempimento dopo  
mastectomia  
Superficie cutanea MAX Espansione



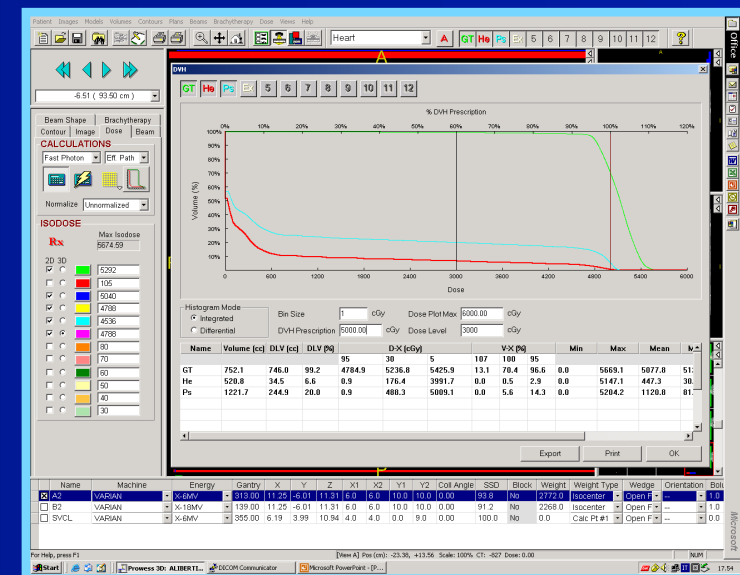
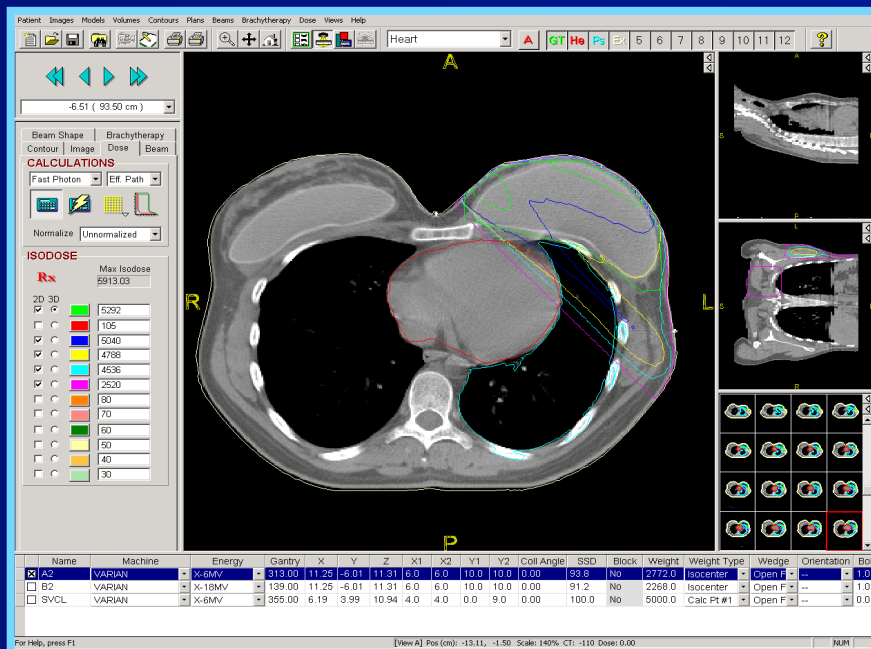
C. Espansore a pieno riempimento dopo  
mastectomia  
Superficie irregolare.

Razionale: verificare la distribuzione dosimetrica nelle tre condizioni .  
Le pazienti verranno irradiate secondo protocollo standard .



# RADIOTERAPIA E RICOSTRUZIONE MAMMARIA : TECNICA

Nelle pazienti con espansori o protesi il trattamento della parete toracica è talora complicato dal ripido cambiamento del profilo anatomico tra regione sopra/sottoclaveare e il volume a volte cospicuo della mammella ricostruita con possibile maggiore irradiazione degli organi critici e difficoltà nelle giunzioni.



## THE IMPACT OF IMMEDIATE BREAST RECONSTRUCTION ON THE TECHNICAL DELIVERY OF POSTMASTECTOMY RADIOTHERAPY

SABIN B. MOTWANI, M.D.,\* ERIC A. STROM, M.D.,\* NAOMI R. SCHECHTER, M.D.,<sup>†</sup>  
CHARLES E. BUTLER, M.D.,<sup>‡</sup> GORDON K. LEE, M.D.,<sup>§</sup> HOWARD N. LANGSTEIN, M.D.,<sup>‡</sup>  
STEVEN J. KRONOWITZ, M.D.,<sup>‡</sup> FUNDA MERIC-BERNSTAM, M.D.,<sup>||</sup> NUHAD K. IBRAHIM, M.D.,<sup>¶</sup>  
AND THOMAS A. BUCHHOLZ, M.D.\*

Int J Radiat Oncol Biol Phys 2006

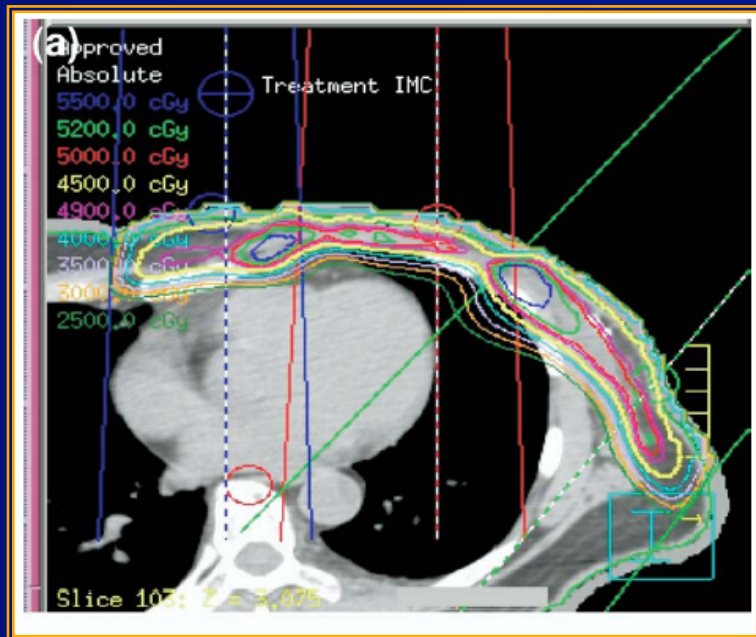
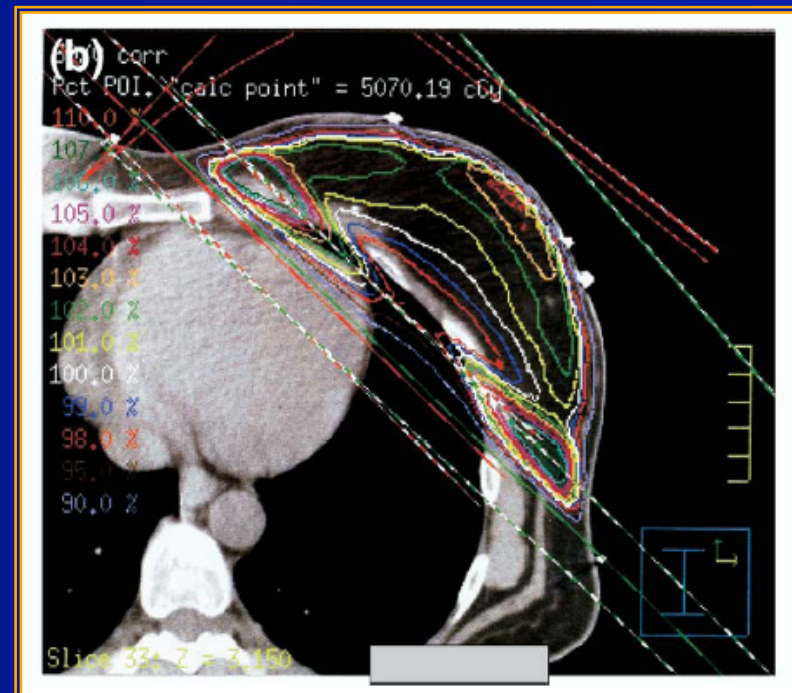


Fig. 1. (a) An “optimal” treatment plan received no point deductions in chest wall coverage, treatment of the ipsilateral internal mammary chain (IMC), minimization of lung volume, and avoidance of epicardial structures. (b) A treatment plan with “major” compromises received 2.5 point deductions. A full point was deducted for irradiating more than 1 cm of heart. One full point was deducted for irradiating more than 3 cm of lung volume. A 0.5-point deduction was given for partially treating the IMC. No deductions were made for chest wall coverage.

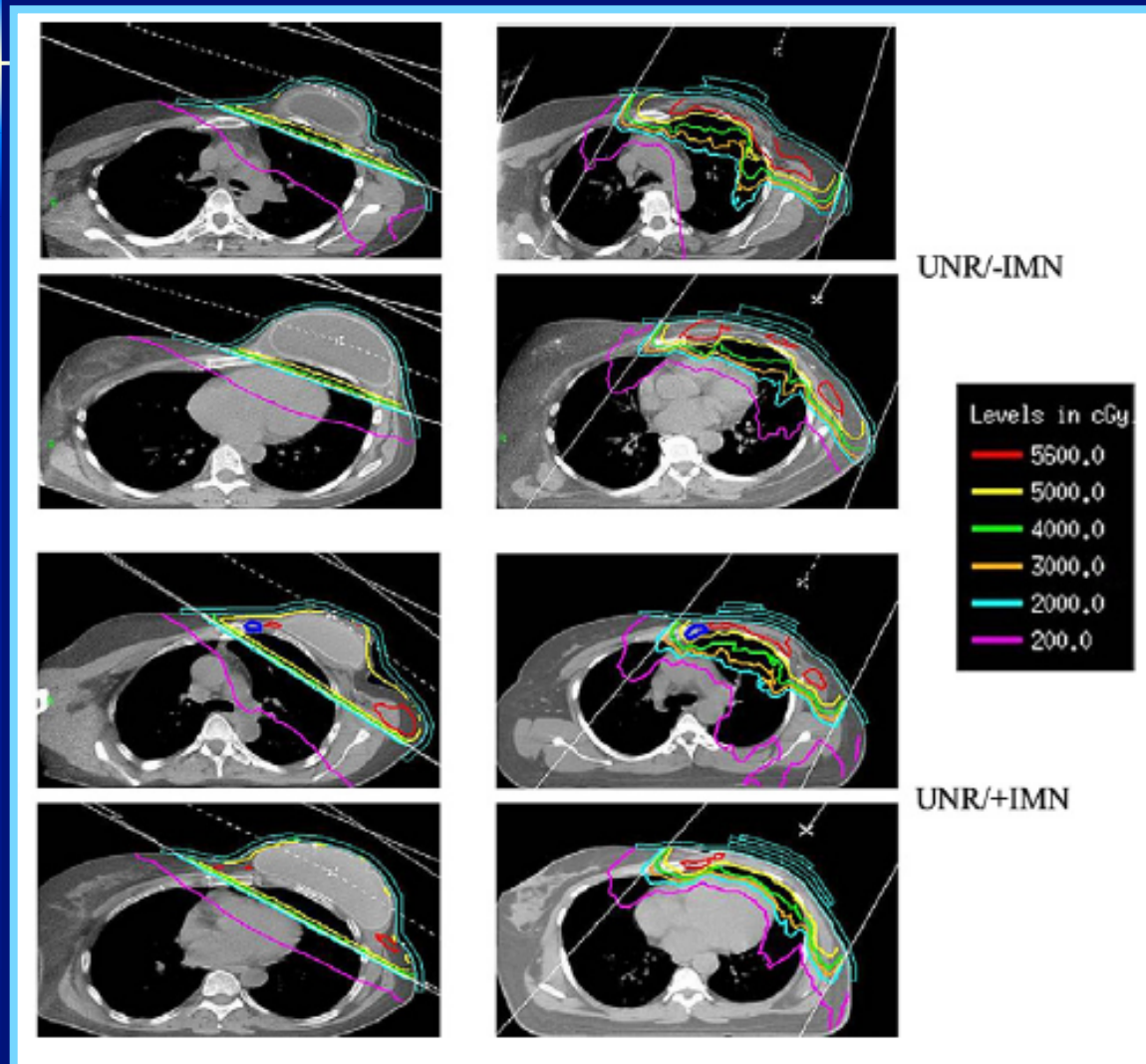


**In this study, RT (mainly to chest wall and IMC) was altered in 52% of the patients compared to 7% of matched controls**

# Quantifying the Impact of Immediate Reconstruction in Postmastectomy Radiation: A Large, Dose-Volume Histogram-Based Analysis

Ohri N et al

Int J Radiation Oncol Biol Phys, Vol. 84, No. 2, pp. e153–e159, 2012



196 pts with implants  
treated with  
tangential photons

and

51 pts without  
reconstruction with  
en-face electron  
fields with bolus

# Quantifying the Impact of Immediate Reconstruction in Postmastectomy Radiation: A Large, Dose-Volume Histogram-Based Analysis

Ohri N et al  
Int J Radiation Oncol Biol Phys, Vol. 84, No. 2, pp. e153–e159, 2012

**Table 2** Mean dosimetric values for lung and heart (N=247)

	Reconstructed	Unreconstructed	P value	Propensity-matched analysis
Ipsilateral lung ± SD	n=196	n=51		
V20 (%)	25.3 ± 8.4	41.4 ± 9.8	<.0001	<.0001
V40 (%)	18.7 ± 7.4	18.9 ± 6.9	.88	
Mean dose (Gy)	13.0 ± 3.9	18.0 ± 4.0	<.0001	<.0001
Dmax (Gy)	54.6 ± 6.0	60.9 ± 4.9	<.0001	<.0001
Heart ± SD*	n=107	n=32		
V25 (%)	3.9 ± 4.0	4.8 ± 4.6	.31	
Mean dose (Gy)	3.5 ± 2.1	2.9 ± 2.2	.17	
Dmax (Gy)	48.4 ± 8.2	46.2 ± 9.1	.20	
PTV ± SD				
D95 (%)	99.9 ± 1.9	NA	NA	
D05 (%)	107.5 ± 2.5	NA	NA	
Dmax (%)	114.6 ± 6.2	NA	NA	

Abbreviations: NA = not applicable; PTV = planning target volume; SD = standard deviation.

\* Calculated only for patients with left-sided disease.

Reconstruction is associated with **lower lung V20**, mean dose and maximum dose  
Heart dose are similar

**90% pts with reconstruction had excellent chest wall coverage D95 >98%**

# Quantifying the Impact of Immediate Reconstruction in Postmastectomy Radiation: A Large, Dose-Volume Histogram-Based Analysis

Ohri N et al

Int J Radiation Oncol Biol Phys, Vol. 84, No. 2, pp. e153–e159, 2012

**Table 3** Comparison of mean dosimetric values between groups with and without reconstruction subdivided by internal mammary node treatment (N=247)

	Reconstructed (n=196)		P value	Unreconstructed (n=51)		P value
	No IMNs	IMNs		No IMNs	IMNs	
Ipsilateral lung ± SD	n=173	n=23		n=25	n=26	
V20 (%)	23.8 ± 7.1	36.9 ± 8.5	<.0001	40.4 ± 12.3	42.3 ± 6.7	.504
V40 (%)	17.5 ± 6.7	27.5 ± 6.7	<.0001	18.7 ± 8.4	19.0 ± 5.3	.638
Mean dose (Gy)	12.3 ± 3.4	18.2 ± 3.7	<.0001	17.6 ± 4.2	18.3 ± 3.8	.351
Dmax (Gy)	54.0 ± 5.7	59.4 ± 6.1	<.0001	60.8 ± 4.5	61.0 ± 5.4	.888
Heart ± SD*	n=96	n=11		n=20	n=12	
V25 (%)	3.4 ± 3.3	8.5 ± 6.1	.011	4.5 ± 5.2	5.2 ± 3.3	.179
Mean dose (Gy)	3.3 ± 1.8	6.0 ± 2.9	.002	3.1 ± 2.5	2.8 ± 1.8	.953
Dmax (Gy)	47.8 ± 8.4	52.8 ± 4.2	.010	47.6 ± 9.7	43.4 ± 7.9	.115

Abbreviations: IMNs = internal mammary nodes; SD = standard deviation.

\* Calculated only for patients with left-sided disease.

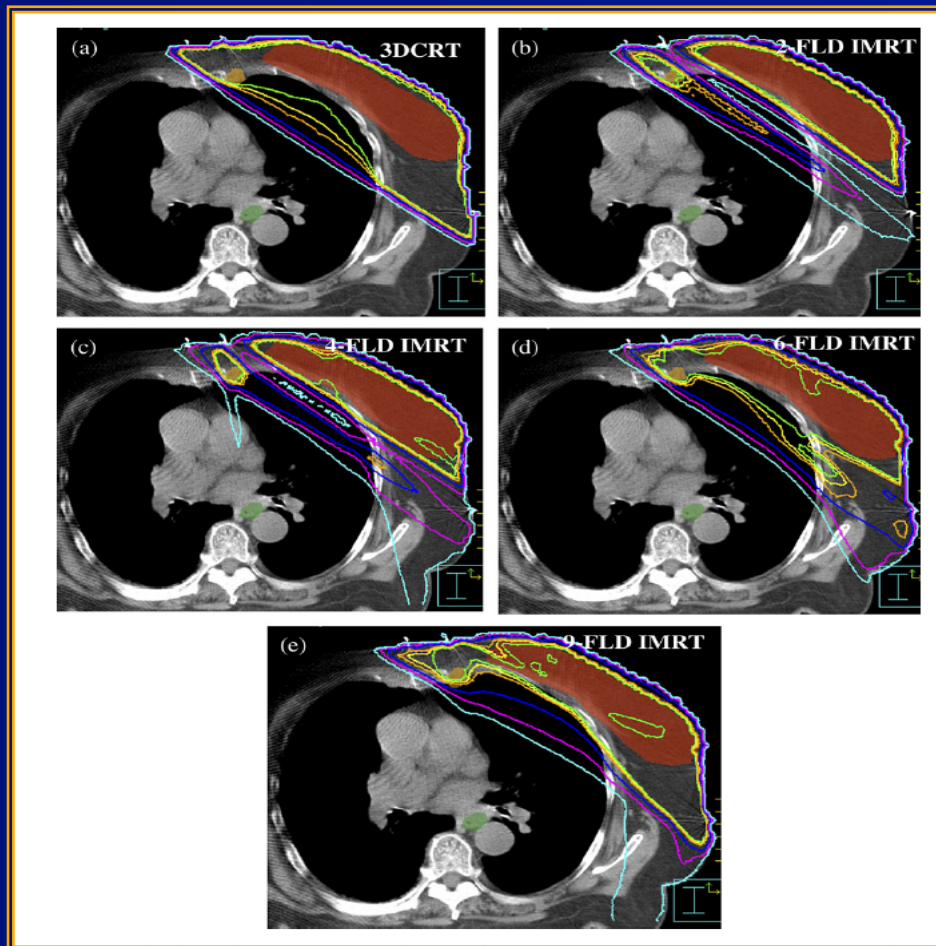
## IMN coverage

- is superior in pts with reconstruction (D95 >92%)
- significantly **increases lung and heart parameters** in pts with reconstr
- minimally affects pts without reconstruction

# OPTIMIZED DOSE COVERAGE OF REGIONAL LYMPH NODES IN BREAST CANCER: THE ROLE OF INTENSITY-MODULATED RADIOTHERAPY

NESRIN DOGAN, PH.D., LAURIE CUTTINO, M.D., RICK LLOYD, C.M.D.,  
EDWARD A. BUMP, C.M.D., AND DOUGLAS W. ARTHUR, M.D.

**Int J Radiat Oncol Biol Phys 2007**



**The use of IMRT improves breast and regional nodes coverage while decreasing doses to the lungs, heart and contralateral breast when compared with 3D-CRT**

# Postmastectomy intensity modulated radiation therapy following immediate expander-implant reconstruction

Lawrence Koutcher<sup>a,\*</sup>, Åse Ballangrud<sup>b</sup>, Peter G. Cordeiro<sup>c</sup>, Beryl McCormick<sup>a</sup>, Margie Hunt<sup>b</sup>, Kimberly J. Van Zee<sup>d</sup>, Clifford Hudis<sup>e</sup>, Kathryn Beal<sup>a</sup>

<sup>a</sup> Department  
of Medicine

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Received  
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Keyword:  
Postmas  
Immedia  
Lung V<sub>20</sub>  
Heart D<sub>n</sub>

## Conclusion

The delivery of PMRT following immediate expander-implant reconstruction resulted in excellent local control with acceptable doses to the heart and lungs. Although doses to critical normal structures are less in patients not undergoing IMN treatment, they are also acceptable in patients with IMN treatment. With previous studies showing excellent cosmetic and oncologic outcomes for patients treated in this manner, we feel that PMRT following immediate expander-implant reconstruction is a safe and reasonable option for patients.

# **RADIOTERAPIA POST –TRAM : E' FATTIBILE?**

Il reale impatto della RT dopo ricostruzione con lembo è di difficile definizione



- Esperienza limitata
- Dettagli tecnici della RT spesso non noti



## **RADIOTERAPIA POST –TRAM : E' FATTIBILE?**

**Un modello sperimentale animale ha dimostrato che i lembi miocutanei sono relativamente resistenti agli effetti collaterali più comuni della RT quando irradiati a dosi di 50 Gy /25 fr**

Lin et al, Plast Reconstr Surg, 2001

## **Radioterapia e ricostruzione con TRAM : sono compatibili ?**

- Tolleranza delle anastomosi microvascolari e vitalità del lembo
- Ritardo di guarigione
- Sclerosi delle pareti dei vasi
- Risultato cosmetico

# EFFETTI ACUTI E TARDIVI DELLA RT SUI LEMBI

- **Reazioni cutanee**

(eritema, desquamazione secca/umida, ulcerazione)

- **Liponecrosi**

- **Contrattura del lembo**

- **Perdita di volume**



*Fig. 2.* Free TRAM flap followed by RT demonstrating skin discoloration and volume asymmetry.



*Fig. 5.* Patient who had single pedicle TRAM reconstruction before and after RT to the right reconstructed breast. The right TRAM flap is contracted, firm, and distorted following RT.

## RT DOPO RICOSTRUZIONE CON TRAM

	<b>Pz valutabili</b>	<b>RT (Gy)</b>	<b>Effetti cutanei acuti (%)</b>	<b>Effetti tardivi sul lembo (%)</b>	<b>Fibrosi (%)</b>	<b>Liponecrosi (%)</b>
Williams, 1997 FU 53 m	19	50.3	20	15.8	10.5	15.8
Tran, 2000 FU 36 m	32	50		44-75	75	43.8
Hanks, 2000 FU 19 m	25	50.4	20-94	6		
Rodgers, 2001	30	50.4			56.7	23
Halyard, 2004 FU 26 m	15	60	40-80			13
Metha, 2004 FU 18 m	22	50.4	9-68			
Spear, 2005	72	50.4				23.7
Huang, 2006 FU 36 m	82	50	1-90	8.5-35		

# RT DOPO RICOSTRUZIONE IMMEDIATA CON TRAM

	<b>Pz valutabili</b>	<b>RT (Gy)</b>	<b>Cosmesi Buona/eccellente (%)</b>
<b>Zimmermann, 1998 FU 19 m</b>	21	54	90
<b>Chawla, 2002 FU 19 m</b>	30	50	69
<b>Halyard, 2004 FU 26 m</b>	15	60	87
<b>Huang, 2006 FU 36 m</b>	82	50	70

## **RADIOTERAPIA POST –TRAM : E' FATTIBILE?**

- La ricostruzione immediata con TRAM può essere considerata fattibile
- Gli effetti acuti della RT sul TRAM is sono generalmente ben tollerati

**“LA IRRADIAZIONE ALTERA LA PROTESI  
E, DI CONSEGUENZA, COMPROMETTE IL  
RISULTATO COSMETICO ?”**

**VALUTAZIONE DELLE MODIFICAZIONI FISICHE DI  
PROTESI IRRADIAATE A 50 Gy :**



**RIDOTTA MALLEABILITA’**

**OPACITA’**

**Klein and Kuske, Int J Radiat Oncol Biol Phys, 1993**



Corso di Laurea in Ingegneria Biomedica

Tesi di Laurea Magistrale

Anno Accademico 2010-2011



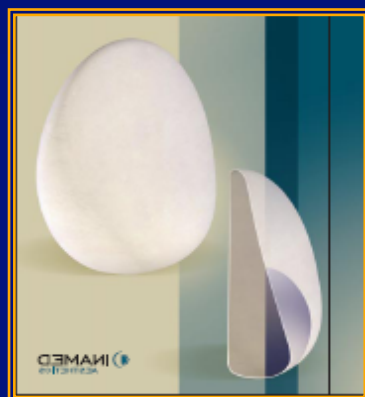
## VALUTAZIONE DEGLI EFFETTI DELLA RADIOTERAPIA SU PROTESI MAMMARIE IN SILICONE

Tesi di **Valentina Milesi**

Relatori: **Prof.ssa Silvia FARE'**

**Dott. Claudio G. STUCCHI**

Correlatore: **Ing. Serena BERTOLDI**





## Valutazione degli effetti della radioterapia su protesi mammarie in silicone

Gli effetti chimici indotti dalla radiazione X possono ripercuotersi sulle dimensioni di alcune grandezze caratteristiche delle protesi e che sono di interesse clinico:

• **variazioni morfologiche della protesi** → **IMAGING TAC**

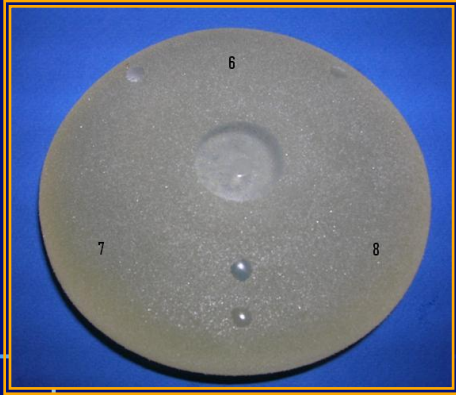
• **variazioni meccaniche del guscio** → **PROVE MECCANICHE A TRAZIONE**

• **variazioni reologiche del gel** → **PROVE REOLOGICHE**

Le variazioni sono state sottoposte ad un test di significatività di Student per valutare principalmente **l'influenza del trattamento RT** osservando anche eventuali

**differenze dell'effetto del trattamento RT**

La variazione viene classificata significativa se  $p < 0,05$



# **IRRADIAZIONE SPERIMENTALE DI PROTESI DI ULTIMA GENERAZIONE**

- **ANALISI DEI PARAMETRI MORFO-MECCANICI DI PROTESI NON IRRADIAE (Laboratorio di Biomateriali del Politecnico di Milano)**
- **TC E STUDIO DOSIMETRICO**
- **IRRADIAZIONE CON 60 CO A DOSE DI 50 Gy**
- **TC POST RT ( 60 gg)**
- **ANALISI DEI PARAMETRI MORFO-MECCANICI DELLE PROTESI IRRADIAE (Politecnico di Milano)**



**VALUTAZIONE DEI CAMBIAMENTI**

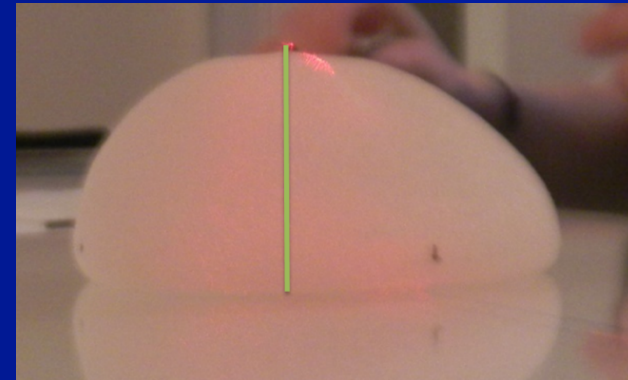
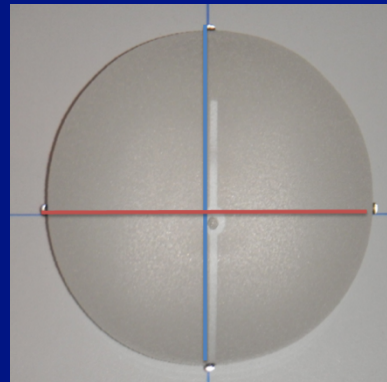


## LE PROTESI MAMMARIE UTILIZZATE

protesi mammarie con guscio testurizzato in elastomero di silicone e gel siliconico ad elevata coesività

parametri principali per identificazione protesi:

- ✓ volume
- ✓ larghezza
- ✓ altezza
- ✓ proiezione



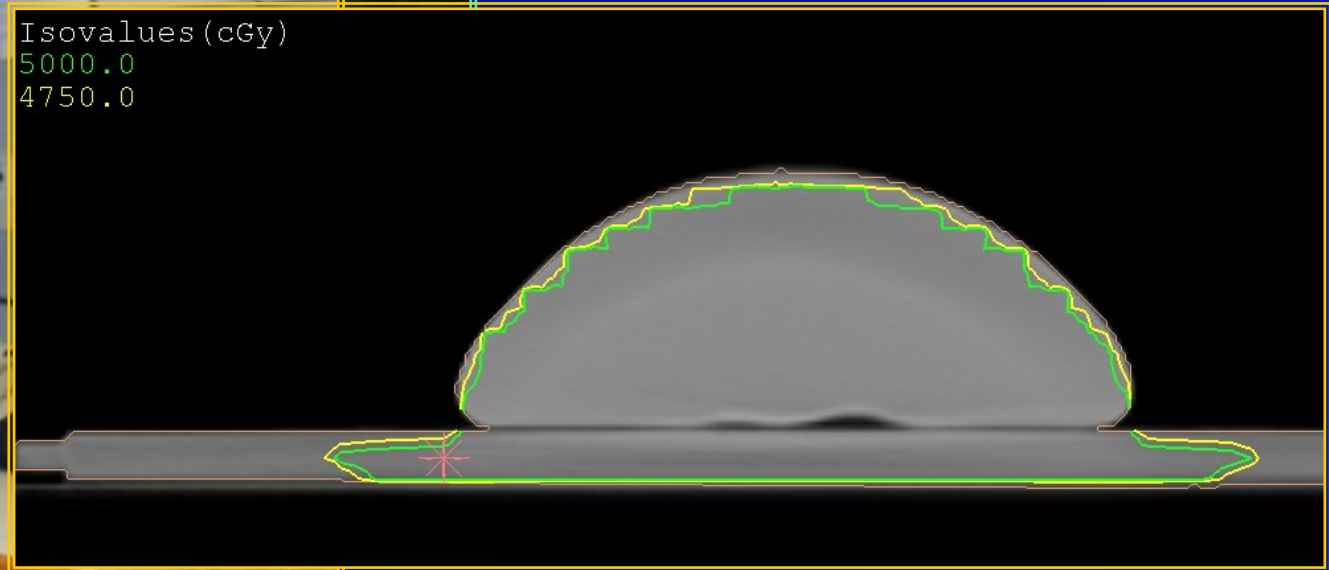
Analizzate protesi per i modelli:

- A (1, 2)
- B (1, 2)
- C (1, 2)
- D (1, 2)

## ACQUISIZIONE TC



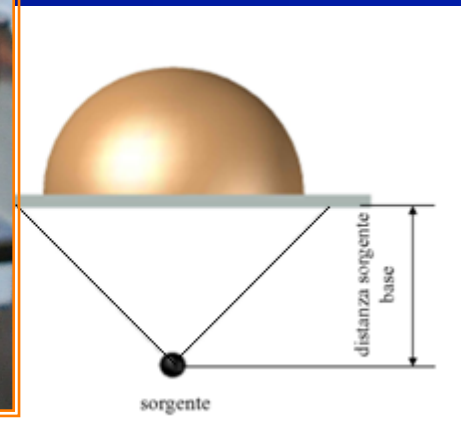
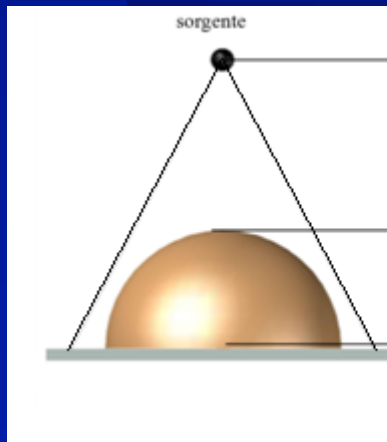
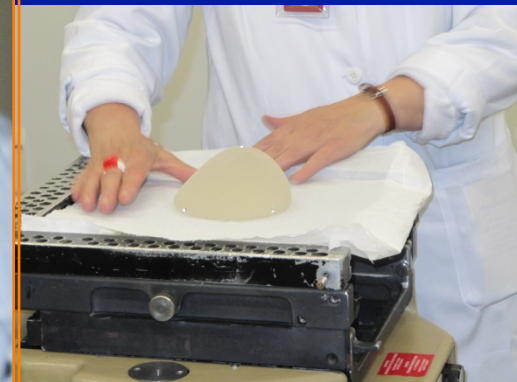
Isovalues (cGy)  
5000.0  
4750.0



PIANO DI TRATTAMENTO

25 Gy a 0° (proiezione PA)

0° (proiezione PA)



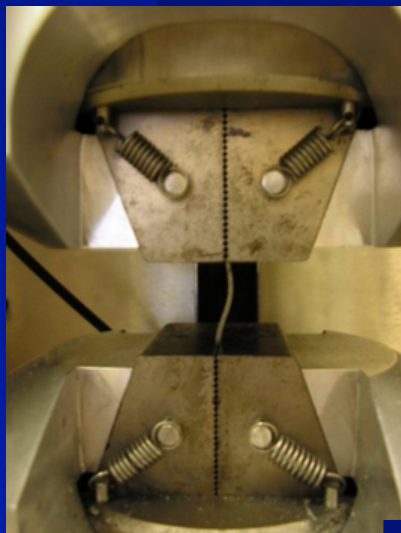
## PROTOCOLLO SPERIMENTALE

### Prove meccaniche

separazione dei due componenti



### Prove a trazione uniassiale a rottura

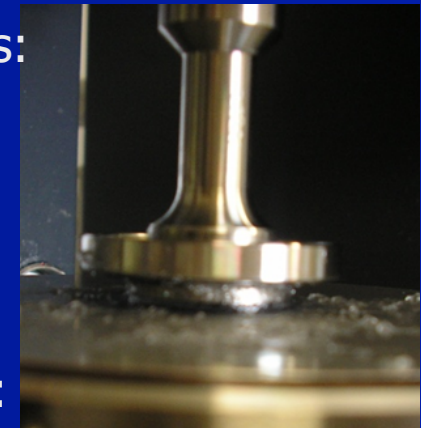


analisi di:





- modulo elastico
- moduli secanti
- sforzo e deformazione a rottura

### Prove reologiche

1. Transient shear stress:  
shear rate =  $10 \text{ s}^{-1}$ ,  
analisi di viscosità complessa e sforzo di taglio
2. Oscillation frequency:  
moto oscillatorio e frequenza =  $0:16 \text{ Hz}$ ,  
analisi di storage modulus e loss modulus
3. Flow ramp: shear rate =  $1:1000 \text{ s}^{-1}$   
analisi di viscosità complessa e sforzo di taglio



## CONCLUSIONI

	<u>TAC</u> $\Delta$ dimensioni e volume	<u>Prove a trazione</u> $\Delta$ irrigidimento del guscio	<u>Prove reologiche</u> $\Delta$ irrigidimento del gel
A1			
A2			
B1			
B2			
C1			
C2			
D1			
D2			



# **RADIOTERAPIA E RICOSTRUZIONE MAMMARIA**

**E' dimostrato che la RT influisce sulla  
insorgenza di complicanze e sul  
risultato estetico a seconda della  
procedura ricostruttiva**



## RT E IMPIANTI PROTESICI INCIDENZA DELLE COMPLICAZIONI

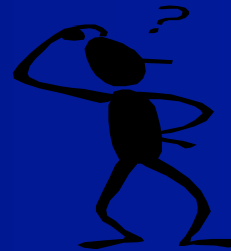
	RT	NO RT
Dickson, 1987	70 %	9%
Evans, 1994	43%	12%
Kraemer, 1996	43%	17%
Spear, 2000	47.5%	10%
Krueger, 2001	68%	31%
Tallet, 2003 *	29%	0
Cordeiro, 2006*	50.7%	10.3%
Aschermann, 2006	40.7%	16.7%
Withfield, 2009*	19.5%	0
Spear, 2012 *	60.7%	1.4%

\*contrattura Baker III/IV

**L'incidenza di complicanze è superiore quando effettuata RT, ma estremamente variabile da centro a centro**

# RT E FORMAZIONE DELLA CAPSULA

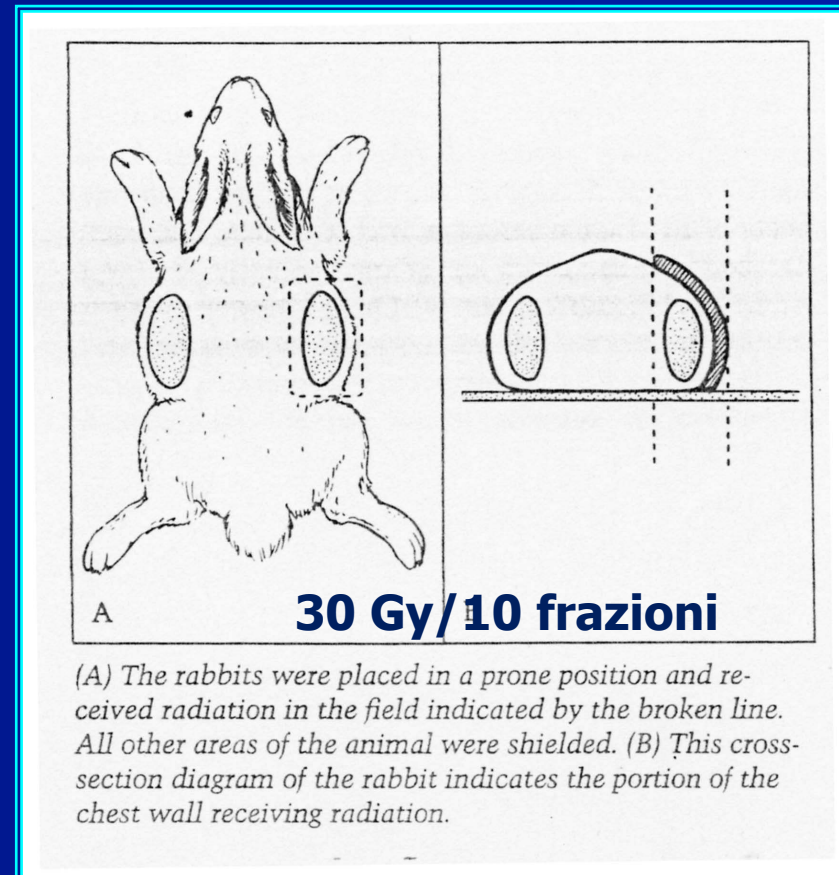
- **“La RT postoperatoria non determina formazione della capsula”** (Caffee et al; Ann Plast Surg, 1988)
- **“La RT dopo espansione non causa alterazioni dermiche e reazione capsulare in tessuti cutanei espansi di animali da esperimento”** (Goodman et al; Plast Reconstr Surg, 2002)



- **“L’espansione di tessuti precedentemente irradiati mostra una riduzione di spessore del derma se confrontata con tessuti non irradiati”** (Kao et al; Ann Plast Surg, 1997)

# RT postoperatoria e contrattura capsulare

La fisiopatologia della formazione radioindotta della capsula non è ancora stata definita



H.H Caffee et al, 1988

# INCIDENZA DELLE COMPLICAZIONI E RISULTATO COSMETICO



**Contrattura....%**

**Dolore.....%**

**Infezioni..... %**

**Rottura dell'impianto...%**

**Deiscenza della ferita...%**

**Esposizione dell'impianto...  
%**

**Migrazione dell'impianto...  
%**

**Rimozione dell'impianto....  
%**

**Soddisfazione delle pz....%**

# RT E PROTESI RISULTATI INSODDISFACENTI

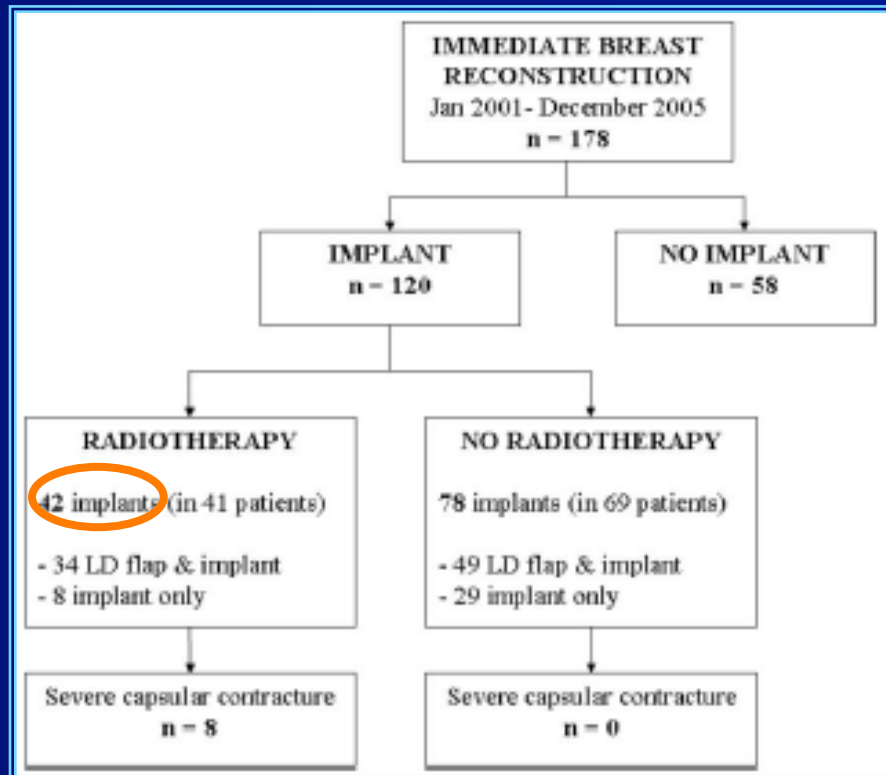


	pz valutabili	RT (Gy)	Poor	Note
<b>Halpern, 1990 (1971 – 1981)</b>	11	45 - 71	<b>8/11</b>	9 prim, 2 rec 8 subcut: poor
<b>Handel, 1991 (1981 – 1988)</b>	15	64 - 75	<b>10/15</b>	15 prim 13 retroghiand.
<b>Ringberg, 1999 (1980 – 1994)</b>	14	n.s.	<b>10/14</b>	RT su impianti non raccomandata
<b>Spear, 2000 (1990-1997)</b>	40	50-110	<b>19/40</b>	Chirurgia necessaria

# Incidence of severe capsular contracture following implant-based immediate breast reconstruction with or without postoperative chest wall radiotherapy using 40 Gray in 15 fractions

Gillian A. Whitfield<sup>a</sup>, Gail Horan<sup>a</sup>, Michael S. Irwin<sup>b,c</sup>, Charles M. Malata<sup>b,c</sup>, Gordon C. Wishart<sup>c</sup>, Charles B. Wilson<sup>a,c\*</sup>

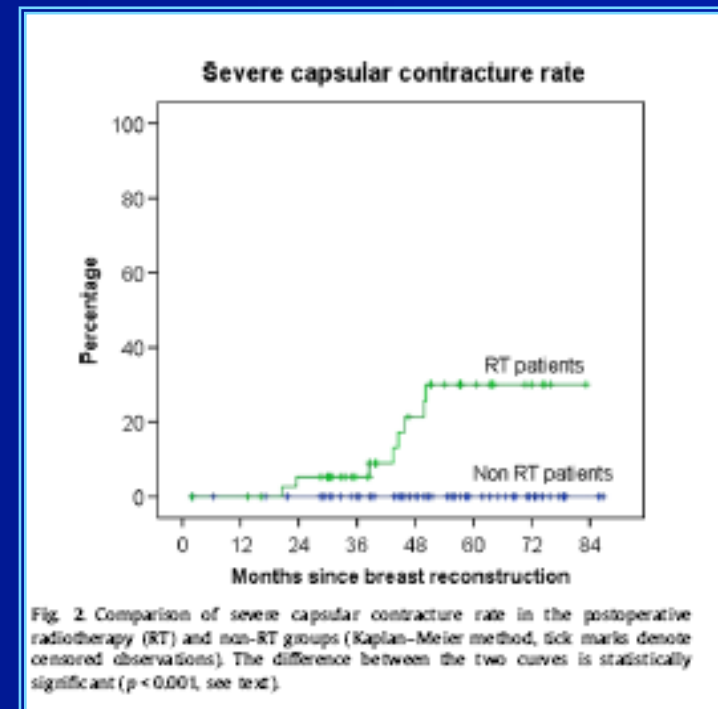
Radiotherapy and Oncology 90 (2009) 141–147



**19.5 %**

Risultati sovrapponibili a 50 Gy  
con frazionamento convenzionale

**30% a 5 anni**  
Capsulotomie, rimozione impianto



# RT E PROTESI RISULTATI SODDIFACENTI



	pz valutabili	RT (Gy)	Excellent/good	Note
Jacobson, 1986 (1970 – 1984)	7/10	46 - 60	<b>5/7</b>	5 prim, 5 rec 1 subcut: poor
Ryu, 1990 (1984 – 1989)	9/14	44 - 62	<b>6/9</b>	4 prim, 10 rec 3 subcut: poor
Chu, 1992 (1984 – 1991)	39	50 - 62	<b>34/39</b>	12 prim, 27 rec
Guenther, (1983 – 1993)	20	64 – 71	<b>17/20</b>	20 prim 3 subcut: poor
Victor, 1998 (1977 – 1995)	21	57 - 66	<b>15/21</b>	21 prim, 5 subcut

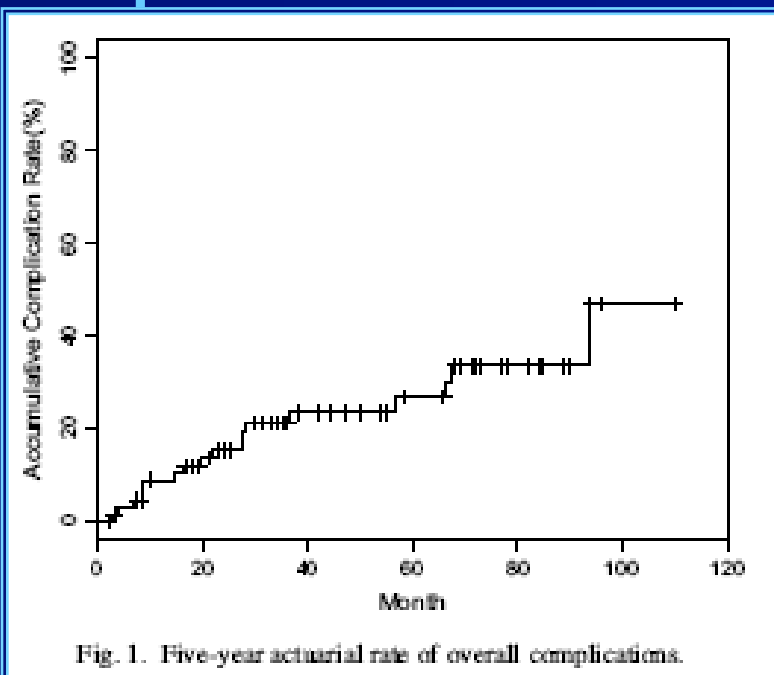
# POSTMASTECTOMY CHEST WALL RADIATION TO A TEMPORARY TISSUE EXPANDER OR PERMANENT BREAST IMPLANT—IS THERE A DIFFERENCE IN COMPLICATION RATES?

PENNY R. ANDERSON, M.D.,\* GARY FREEDMAN, M.D.,\* NICOS NICOLAOU, M.D.,\*  
 NAVESH SHARMA, D.O., PH.D.,\* TIANYU LI, PH.D.,† NEAL TOPHAM, M.D.,‡ AND MONICA MORROW, M.D.‡

Int. J. Radiation Oncology Biol. Phys., Vol. 74, No. 1, pp. 81–85, 2009

74 pz, MR : RT su espansore in 62, RT su protesi definitiva in 12  
 RT: 50 Gy frazionamento convenzionale

**Complicanze: 27 % a 5 anni**



	<b>Expander</b>	<b>Protesi</b>	
	%	%	
Compl maggiori *	4.8	0	ns
Compl minori	18	33	
Cosmesi Excell/good	90	80	

\* rimozione dell'impianto



# Outcome of different timings of Radiotherapy in implant-based breast reconstructions

Nava M et al, Plast Reconstr Surg , 2011

109 pts :RT on Permanent Implant ; 50 pts RT on Tissue Expander;  
 98 ctr pts : no RT  
 2003 – 2007

	Shape (%)			Symmetry (%)			Baker capsular contracture (%)			Patient's opinion of final result (%)			Total failure rates (%)		
	P	TE	ctr	P	TE	ctr	P	TE	ctr	P	TE	ctr	P	TE	ctr
good	<b>59</b>	31	74	<b>29</b>	15	46	1	7	3	<b>52</b>	46	68	<b>93</b>	60	98
medium	33	62	23	53	69	45	29	33	72	36	46	30			
bad	7	7	2	17	15	9	57	<b>63</b>	24	11	8	2	7	<b>40</b>	2

**higher total failure rate and incidence of Baker IV when RT on TE**

# RT SU EXPANDER O SU PROTESI ?

	RT on expander	RT on prostheses
<b>Number of procedures (2003-2007)</b>	<b>78</b>	<b>99</b>
<b>capsular contracture baker 3</b>	<b>33 %</b>	<b>34 %</b>
<b>capsular contracture baker 4</b>	<b>9 %</b>	<b>3 %</b>
<b>infection</b>	<b>18 %</b>	<b>2 %</b>
<b>scar diastasis</b>	<b>17 %</b>	<b>1 %</b>
<b>exposure - extrusion</b>	<b>7 %</b>	<b>1 %</b>
<b>displacement</b>	<b>3 %</b>	<b>0 %</b>
<b>implant damage-deflation</b>	<b>3 %</b>	<b>0 %</b>
<b><i>INCIDENCE OF COMPLICATIONS</i></b>	<b><i>70 %</i></b>	<b><i>37 %</i></b>
<b>implant removal</b>	<b>54 %</b>	<b>3 %</b>



# ALGORITMO PER IRRADIAZIONE DOPO RICOSTRUZIONE IMMEDIATA

(Cordeiro et al: Plast Reconstr Surg, 2004)

MASTECTOMIA E POSIZIONAMENTO DI ESPANSORE



INIZIO DELL' ESPANSIONE  
( 10 – 14 gg postop)



ESPANSIONE DURANTE CHEMIOTERAPIA



SOSTITUZIONE ESPANSORE CON PROTESI DEFINITIVA  
(4 settimane dopo la chemioterapia)



**RADIOTERAPIA 50 Gy/25 fr**

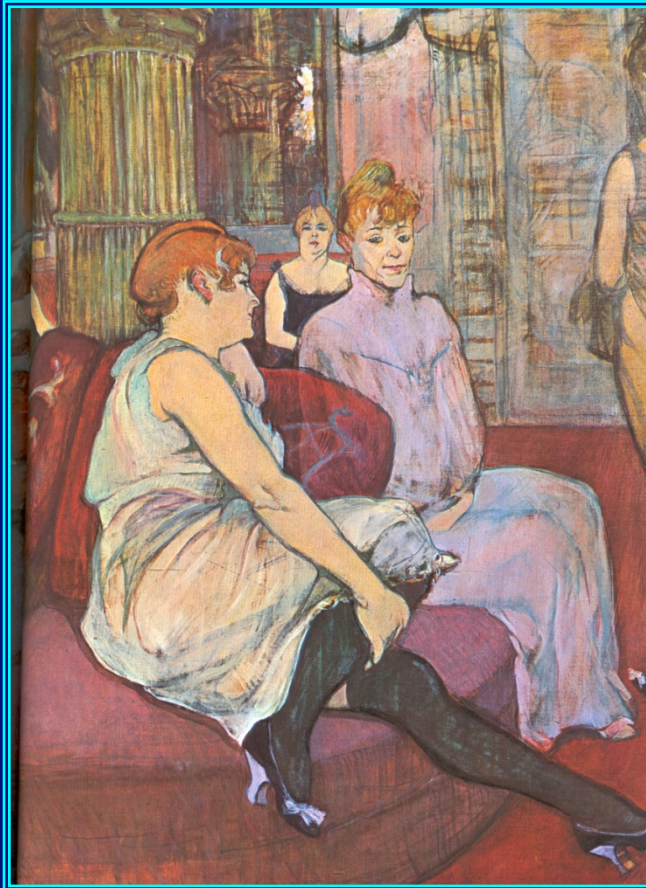
(10 – 15 gg dopo posizionamento protesi – a guarigione della  
ferita chirurgica)

**Irradiation after immediate tissue expander/implant breast reconstruction: outcomes, complications, aesthetic results and satisfaction among 156 patients  
(Cordeiro et al: Plast Reconstr Surg, 2004)**

**68 pts (aa 1995-2001) irradiated at the end of reconstruction**

- ...the negative effects of irradiation can perhaps be minimized with delivery of RT after the completion of implant reconstruction.
- ...2/3 of irradiated patients were satisfied with their results and almost  $\frac{3}{4}$  would chose the same method of reconstruction
- ...this study supports the hypothesis that successful outcomes are possible for this patient group

# RISULTATI



**CONTRATTURA CAPSULARE 68%**

**RISULTATO ESTETICO BUONO 80%**

**SODDISFAZIONE DELLE PZ 67%**

**SCELTA STESSA METODICA 72%**

**Cordeiro et al: Plast Reconstr Surg, 2004**

# **Mastectomy with immediate expander-implant reconstruction, adjuvant chemotherapy and radiation for stage II-III breast cancer: treatment intervals and clinical outcomes**

**(Wright JL, Cordeiro P et al, 2007)**

**May 1996 - March 2004: 104 pts, median FU 64 months**

## **Median interval from**

- |                                |         |
|--------------------------------|---------|
| ■ surgery to CT                | 5 weeks |
| ■ completion of CT to exchange | 4 weeks |
| ■ exchange to RT               | 4 weeks |
| ■ completion of CT to RT       | 8 weeks |

## **5 year rate of**

- |                                    |      |
|------------------------------------|------|
| ■ Locoregional disease control     | 100% |
| ■ Distant metastasis-free survival | 90%  |
| ■ Overall survival                 | 96%  |

**Unilateral postoperative chest wall radiotherapy in bilateral tissue expander/implant reconstruction patients: a prospective outcomes analysis.**  
(McCarthy et al: *Plast Reconstr Surg*, 116; 2005)

12 pts underwent bilateral expander/implant reconstruction and unilateral postexchange radiotherapy (10 pts evaluable)

At a mean follow-up of 23.5 months

EXCELLENT/VERY GOOD RESULTS	80%
SIMMETRY	80%
NO DIFFERENCE BETWEEN THE TWO BREASTS	40%
PTS SATISFACTION	70%
SAME RECONSTRUCTION AGAIN	80%

**INT study \_ SOSTITUIRE CON DATI LAVORO PUBBL**  
**Irradiation after immediate tissue expander/  
implant breast reconstruction**

**Start of protocol**

**21/01/2003**

**Pts enrolled**

**108 pts**

**Capsular contracture Baker 3 -4**

**37.6 %**

**Good to excellent aesthetic results**

**60 %**

**Pts satisfaction**

**89%**

**Local control**

**100 %**



## **Increasing the Time to Expander-Implant Exchange after Postmastectomy Radiation**

### **Therapy Reduces Expander-Implant Failure**

*( Peled A, Plast. Reconstr. Surg., 2012.)*

**The sequence and timing of tissue expansion and implant exchange with regard to PMRT may impact complication rates.**

**The authors' protocol is to complete tissue expansion before radiation, irradiate the fully inflated expander, and then perform expander-implant exchange.**

**Starting in 2009, the authors refined their protocol by increasing the time interval between completion of RT and expander implant exchange from **3 months to 6 months** as a strategy to reduce surgical complications.**

**55.7 % of pts had expander-implant exchange within 6 months of completing radiation therapy and the rest had at least a 6-month interval.**

**Overall expander implant failure was 15.9 percent; failure was significantly higher in the cohort with less than 6 months' time before exchange (22.4 % vs 7.7 %, *p* 0.036).**

# FATTORI CONDIZIONANTI IL RISULTATO ESTETICO



**CARATTERISTICHE DELLE PZ**

**TIPO DI RICOSTRUZIONE  
(TRAM VS IMPIANTI)**

**COMPLICANZE CHIRURGICHE**

**TECNICA DI RT, DOSE, FRAZIONAMENTO**

**TIMING**

**CT/OT**



# **EFFETTI COLLATERALI DELLA RADIOTERAPIA**

## **AMPLIFICATI IN PAZIENTI CON**

- **DIABETE MELLITO**
- **OBESITA'**
- **VASCULOPATIE**
- **IPERTENSIONE**
- **COLLAGENOPATIE**
- **IPERSENSIBILITA' GENETICHE INDIVIDUALI**
- **CHEMIOTERAPIA CONCOMITANTE**

- **ABITUDINI DI VITA**
- **ETA' \***

**\* Aristei C et al, Strahlenther Onkol, 2012**

## **FACTORS CONDITIONING COSMETIC RESULTS: patient's characteristics**

Smoking is an independent risk factor for postoperative complications following tissue expander/implant breast reconstruction.

Smokers are 3 times more likely to experience a complication

A dose-response relationship exists between the number of cigarette packs smoked per day and overall complications.

**Goodwin S et al, Ann Plast Surg: 55: 16- 20, 2005**

# FATTORI CONDIZIONANTI IL RISULTATO : RT

- Dose totale
- Frazionamento giornaliero
- Utilizzo di bolus
- Utilizzo di filtri a cuneo
- Hot spots

## CLINICAL OUTCOMES OF POSTMASTECTOMY RADIATION THERAPY AFTER IMMEDIATE BREAST RECONSTRUCTION

JIGNA DESAI JHAVERI, M.D.,\* STEPHEN C. RUSH, M.D.,\* KAREN KOSTROFF, M.D.,† DWIGHT DERISI, M.D.,‡  
LEONARD A. FARBER, M.D.,\* VIRGINIA E. MAURER, M.D.,§ AND JAY L. BOSWORTH, M.D.\*

**Int J Radiat Oncol Biol Phys 2008**

**92 pts: 69 TE/I, 23 ATR. FU 38 months  
PMRT**

Table 4. Rates of poor functional results (Grade 2–4) and severe complications (Grade 3–4) as a function of immediate reconstruction (IR) type

Complication	TE/I		ATR		p
	n	%	n	%	
Grade 2–4	38	55.1	2	8.7	<0.001
Grade 3–4	23	33	0	0	0.001

*Abbreviations:* ATR = autologous tissue reconstruction; TE/I = tissue expander and implant reconstruction.

Unico fattore significativo predittivo di risultati meno favorevoli è il **tipo di ricostruzione**

# La cosmesi dal punto di vista delle pazienti e dei medici

“Pz sottoposte a ricostruzione con TRAM e con protesi mostrano gradi di soddisfazione generale sovrapponibili”

**Alderman, 2006**

“... le pazienti sono meno soddisfatte dalla ricostruzione con protesi. E' necessaria una **migliore informazione** sulle opzioni ricostruttive”

**Saulis, 2007**

“La soddisfazione delle pz relativamente al risultato cosmetico e' **superiore** a quella dei medici e non è solo dipendente dagli effetti della radioterapia.”

**Hoeller, 2003**



**POCHI STRUMENTI PER LA RILEVAZIONE OGGETTIVA DEI RISULTATI  
NECESSITA' DI COUNSELING E MIGLIORI INFORMAZIONI**

# RICOSTRUZIONE IN PZ IRRADIAE SULLA PARETE TORACICA

**Gli effetti della RT sulla cute e sui tessuti sottocutanei aumentano il rischio di complicanze postoperatorie quando la ricostruzione preveda impianti protesici (dolore, infezioni, esposizione, estrusione, espianto della protesi)**

**In poche pz selezionate con modeste alterazioni tissutali postattiniche può essere presa in considerazione una ricostruzione in due tempi (expander e protesi). Lembi miocutanei possono provvedere ad un volume addizionale di tessuto ben vascolarizzato che faciliti il processo di espansione**

**La ricostruzione con lembi di tessuto autologo è la tecnica che consente miglior risultato cosmetico con minor incidenza di complicazioni**



*Fig. 1. Expansion of previously irradiated left chest. Note skin changes on irradiated chest wall with asymmetry following the expansion process on the left.*



# RICOSTRUZIONE IN PARETE TORACICA PRECEDENTEMENTE IRRADIATA

TABLE 4. Postoperative Complication Rates and Radiation Timing

	Study Patients (n = 21); %	Prior to Mastectomy/Reconstruction (n = 7); %	During Expansion (n = 9); %	Post Expander/Implant Exchange (n = 5); %
Hematoma	5	5	0	0
Seroma	5	5	0	0
Infection	15	10	0	5
Delayed healing	5	5	0	0
Implant exposure	10	5	5	0
Tissue expander rupture	5	5	0	0
Surgical revision	33	28	5	0

(Percec, 2008)

# **Radiation Therapy and Breast Reconstruction: A Critical Review of the Literature**

*(Kronowitz SJ, Plast. Reconstr. Surg. 2009)*

**Even with the latest prosthetic materials and modern RT techniques, the complication rate for implant-based breast reconstruction in patients undergoing PMRT is greater than 40 percent, and the extrusion rate is 15 percent.**

**Modified sequencing of two-stage implant reconstruction, such that the expander is exchanged for the permanent implant before PMRT, results in higher rates of capsular contracture and is not generally feasible after neoadjuvant chemotherapy.**

**Current evidence suggests that PMRT also adversely affects autologous tissue reconstruction. Even with modern RT techniques, immediate implant-based or autologous tissue breast reconstruction can distort the chest wall and limit the ability to treat the targeted tissues without excessive exposure of the heart and lungs.**

**In patients for whom PMRT appears likely but may not be required, “delayed-immediate reconstruction,” in which tissue expanders are placed at mastectomy, avoids the difficulties associated with RT delivery after immediate reconstruction and preserves the opportunity for the aesthetic benefits of skin-sparing mastectomy.**

**Conclusions:** In patients who will receive or have already received PMRT the optimal approach is delayed autologous tissue reconstruction after postmastectomy radiation therapy. If PMRT appears likely but may not be required, delayed-immediate reconstruction may be considered.

**Clinical treatment of radiotherapy tissue damage by lipoaspirate transplant: a healing process mediated by adipose-derived adult stem cells ( G. Rigotti, 2007)**

**20 pts with RT side effects G3-G4: FU 31 months**

**Systematic improvement or remission of symptoms after lipoaspirate transplantation**

**There is evidence that stem cells contribute to the restoration of tissue vascularization and organ function**



Fig. 5. (Above, left) Grade 4 patient (2): ulcerative phase with osteoradionecrosis of the ribs. (Above, right) First result after one treatment with adipose-derived adult stem cells showing good granulation tissue. (Below, left) Result after skin grafting with three residual lobes and osteoradionecrosis. (Below, right) Note the healing of the residual ulcer and osteoradionecrosis after three consecutive adipose-derived adult stem cell injections.



6. One case following stem cell therapy after a severe outcome of quadrantectomy irradiation. Stiffness and scarring were resolved enormously. This follow-up is 1 year after the last treatment.



7. Severe irradiation performed after expander insertion with dramatic capsular contracture (above, left) with a high risk of rupture laterally (above, right) and lateral capsular contraction (below, left) and lateral capsular contraction (below, right).



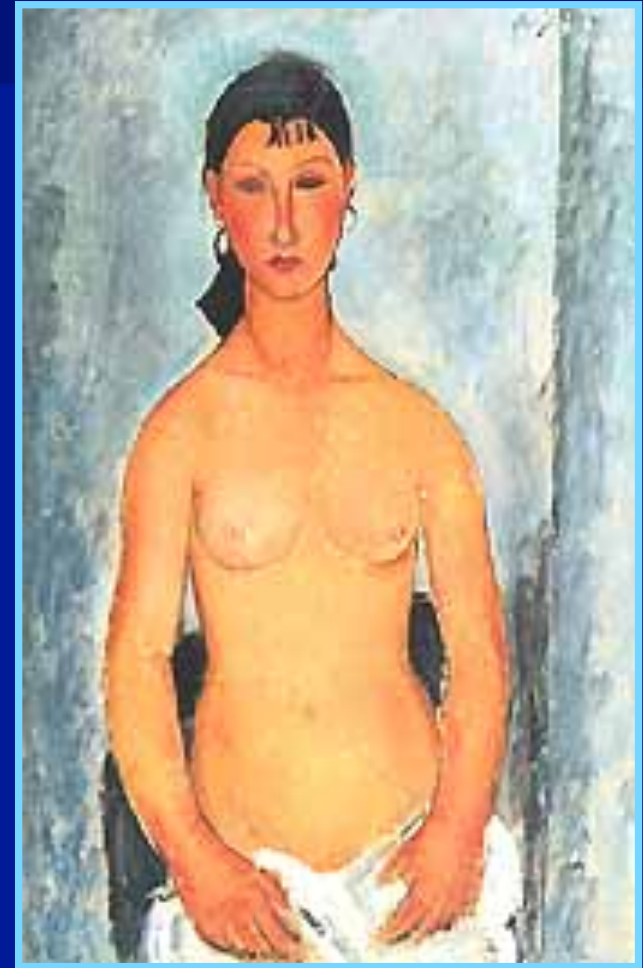
8. An implant covered only by undamaged periprosthetic capsule and skin with initial microscrosis (above). Liposuction was used between the two layers four times. Notice the newly formed adipose tissue exactly in the treated area that allowed nipple reconstruction with local flaps and reduction of the capsular contracture (below). No additional surgery was performed.

**There is a paucity of high quality conclusive data regarding the correct sequencing of breast reconstruction and RT.**

**Immediate breast reconstruction with PMRT may be undertaken though morbidity is higher**

**The timing and effect of RT on breast reconstruction must be discussed to ensure informed opinion and consent of the patient.**

**The patients' expectations, preferences, motivations and their level of understanding should be explored to enhance postoperative satisfaction and quality of life.**



**Decisions concerning the sequencing of breast reconstruction and postmastectomy RT should be made by a closely coordinated multidisciplinary team whose focus is on avoidance of recurrence, improvement of curability, and maximization of long-term quality of life of the patients**

*(Buchholz TA, 2002)*

