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Autologous Breast Reconstruction with Transverse Rectus Abdominis Musculocutaneous (TRAM) or Deep Inferior Epigastric Perforator (DIEP) Flaps: An Analysis of the 100 Most Cited Articles

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Post-mastectomy autologous reconstruction with abdominal tissue has evolved over the past 4 decades and is a common reconstructive modality today. To gain more insight into this evolution, we performed an analysis of the 100 most commonly cited articles focusing on autologous breast reconstruction with transverse rectus abdominis musculocutaneous (TRAM) or deep inferior epigastric perforator (DIEP) flaps.


A review of the ISI Web of Knowledge database was performed. Only peer-reviewed articles in English were included for analysis. Articles were ranked by their total citations as well as citation density (citations divided by years since publication). The 100 most cited articles were analyzed by their bibliographic parameters.

The 100 most cited articles were published in 12 journals. The highest ranked plastic surgery journal published almost 2/3 of the articles. All articles were published within 23 years and marked the "rising age" of autologous breast reconstruction with TRAM and DIEP flaps. The focus of clinical research changed over this time period and ranged from innovations in surgical technique to analysis of clinical outcomes, comparative analyses with other reconstructive modalities, timing of reconstruction, and preoperative diagnostic workup, as well as cost-effectiveness analyses.

This literature review illustrates the dramatic change that has occurred subsequent to introduction of abdominal flaps for breast reconstruction. While the use of abdominal flaps has become widely accepted for breast reconstruction, many questions remain unanswered, thus highlighting the need for ongoing clinical investigation.

MeSH Keywords: **Epigastric Arteries • Free Tissue Flaps • Mammoplasty • Myocutaneous Flap • Perforator Flap • Rectus Abdominis**

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Background

Breast cancer remains the leading cancer entity in women and is the second most common cancer worldwide [1–4]. The American Cancer Society estimates there were >260 000 new cases of invasive breast cancer in 2018 in the United States alone [5]. Despite significant therapeutic advances, mastectomy remains a cornerstone of breast cancer treatment [6]. Additionally, increased breast cancer awareness, as well as the use of genetic testing, has resulted in an increase in the number of women seeking prophylactic mastectomy [7,8]. The negative impact of mastectomy on physical and psychological well-being is beyond dispute, and numerous studies have demonstrated the benefit of post-mastectomy reconstruction [9–11]. In particular, the high long-term patient satisfaction associated with autologous reconstruction is noteworthy [10].

For decades, the pedicled latissimus dorsi flap described by Tansini (1906) and rediscovered by Olivari (1976) was a common approach for autologous breast reconstruction [12–14]. The abdomen as a tissue source was first described by Holmstroem, who reported his experience with the free transverse rectus abdominis musculocutaneous (TRAM) flap in 1979 [15]. Interestingly, it was not until Hartrampf et al. described the pedicled TRAM flap in 1982 that the abdomen became the preferred donor site for autologous breast reconstruction [16]. The ability to harvest the abdominal soft tissues in a muscle-preserving fashion, as initially reported by Koshima and Sueda, ushered in the era of perforator flap-based breast reconstruction that was championed and popularized by Allen et al. and Blondeel et al. [17–19]. Progressive experience with this reconstructive modality has resulted in the autologous breast reconstruction now widely performed, even in the elderly population, as well as extremes of body weight [20, 21].

In light of the prevalence of autologous breast reconstruction, we felt it prudent to reflect on the landmark articles that have shaped contemporary breast reconstruction.

Material and Methods

Assuming a correlation between the importance of an article and its number of citations, we sought to identify the 100 most cited peer-reviewed articles on autologous breast reconstruction with TRAM or DIEP flaps. We queried the ISI Web of Knowledge database (v.5.21.1, Thomson Reuters, New York, USA) with the period of interest ranging from January 1979 to December 2015. The following keywords were utilized: “breast reconstruction TRAM flap” OR “breast reconstruction transverse rectus abdominis muscle flap” OR “breast reconstruction DIEP flap” OR “breast reconstruction deep inferior epigastric perforator flap”. The search was performed in July 2016 and was limited to articles in English.

Following a preliminary review of titles and abstracts by 2 independent reviewers, articles meeting inclusion criteria underwent a full-text review. Discrepancies were resolved by consensus. Included articles were then ranked based on the number of citations.

A ranking of the 100 most cited articles was generated. If 2 articles had an identical citation count, the articles were ranked by their citation density (citations per year since publication). Additional parameters retrieved included the title, journal, publication year, number of authors and country of origin (of the first author), total number of citations as well as the citation density (citations per year since publication). Papers were additionally categorized according to the type of study (multi-center vs. single-center, prospective vs. retrospective, review, case report, experimental study) and clinical focus. Graphs were generated using Excel (Microsoft Corp., 2016).

Results

The initial search retrieved a total of 1984 articles, of which 1910 were in English. Table 1 demonstrates the 100 most cited articles on autologous breast reconstruction with TRAM and/or DIEP flaps. These were published in 12 different journals. However, substantial heterogeneity was noted, as 68 of the 100 articles were published in *Plastic and Reconstructive Surgery*, followed by 8 articles in *Annals of Plastic Surgery*. The remaining 24 articles were distributed across the 10 journals (Figure 1).

The most frequently cited (512 total citations) paper was published in 1994 by Allen and Treece, describing the surgical technique of DIEP flaps [17]. The oldest paper was published in 1989 with 200 total citations and compared conventional to free TRAM flap for immediate breast reconstruction [22]. The most recent paper in our ranking was published in 2012 with 56 citations and described lower abdominal flap breast reconstruction with simultaneous lymph node transfer for management of post-mastectomy lymphedema [23] (Figure 2). The largest number of articles (10 articles) in our ranking was published in the year 2000 [24–33] (Figure 2). Moreover, these articles were increasingly cited until cumulative citations reached a peak of 1107 citations per year by 2010 (99 out of 100 articles) (Figure 3).

To account for the fact that more recently published articles had less time to be cited, we calculated the citation density (citations divided by years since publication) in addition to the absolute number of citations (Table 1). Interestingly, the effect of the contribution by Allen and Treece is evidenced by the fact that their article remains at the top of the list, even after incorporation of the citation density data. Their article

Table 1. The 100 most cited articles regarding to autologous breast reconstruction with TRAM or DIEP flaps.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD	Further article information
1	1	Deep inferior epigastric perforator flap for breast reconstruction	Allen RJ et al.	Ann Plas Surg (1.536)	1994	512	24.38	15 DIEP, diverse amount of perforators
2	4	A prospective study of microvascular free-flap surgery and outcome	Khouri RK et al.	Plast Reconstr Surg (3.621)	1998	329	19.35	493 free flaps including 118 TRAM (rest other free flaps), prospective, 23 centers during 6 month period, 60 variables recorded
3	7	One hundred free DIEP flap breast reconstructions: A personal experience	Blondeel PN	Brit J Plast Surg (1.95)	1999	282	17.63	100 DIEP in 87 patients, single center
4	2	A 10-year retrospective review of 758 DIEP flaps for breast reconstruction	Gill PS et al.	Plast Reconstr Surg (3.621)	2004	245	22.27	758 DIEP, retrospective 10 years
5	6	Breast reconstruction with the free TRAM or DIEP flap: Patient selection, choice of flap, and outcome	Nahabedian MY et al.	Plast Reconstr Surg (3.621)	2002	239	18.38	143 free TRAM and 20 DIEP, retrospective, single surgeon
6	8	Complications in postmastectomy breast reconstruction: Two-year results of the Michigan breast reconstruction outcome study	Alderman AK et al.	Plast Reconstr Surg (3.621)	2002	219	16.85	Expander/implant vs. pedicled TRAM vs. free TRAM in 326 patients, "Michigan Breast reconstruction outcome study", prospective cohort, 12 centers/23 surgeons, evaluation 2 years after operation, multiple variables recorded, immediate vs. delayed breast reconstruction
7	49	Conventional TRAM flap versus free microsurgical TRAM flap for immediate breast reconstruction	Grotting JC et al.	Plast Reconstr Surg (3.621)	1989	200	7.69	135 breast reconstructions, 44 pedicled TRAM, 10 free TRAM, immediate vs. delayed reconstruction
8	31	Choice of flap and incidence of free flap success	Kroll SS et al.	Plast Reconstr Surg (3.621)	1996	197	10.37	854 free flaps including 315 free TRAM, single center
9	16	Determinants of patient satisfaction in postmastectomy breast reconstruction	Alderman AK et al.	Plast Reconstr Surg (3.621)	2000	186	12.40	expander/implant vs. pedicled TRAM vs. free TRAM, 212 included patient questionnaires, "Michigan Breast reconstruction outcome study", prospective cohort, 12 centers/23 surgeons, evaluation 1 years after operation, immediate vs. delayed breast reconstruction
10	26	Doppler flowmetry in the planning of perforator flaps	Blondeel PN et al.	Brit J Plast Surg (1.95)	1998	186	10.94	color Duplex scanning in 50 DIEP flap patients, evaluated for sensitivity and positive predictive value, also 2 further flaps types
11	13	Comparison of immediate and delayed free TRAM flap breast reconstruction in patients receiving postmastectomy radiation therapy	Tran NV et al.	Plast Reconstr Surg (3.621)	2001	184	13.14	102 free TRAM, retrospective, single center, TRAM before radiation vs. radiation before TRAM

Table 1 continued. The 100 most cited articles regarding to autologous breast reconstruction with TRAM or DIEP flaps.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD	Further article information
12	18	Fat necrosis in free transverse rectus abdominis myocutaneous and deep inferior epigastric perforator flaps	Kroll SS	Plast Reconstr Surg (3.621)	2000	181	12.07	310 free TRAM and DIEP, single surgeon
13	3	Multidetector-row computed tomography in the planning of abdominal perforator flaps	Masia J et al.	J Plast Reconstr Aes (2.158)	2006	179	19.89	66 patients with DIEP, evaluation of CT angiography prior to operation, single center
14	20	Prospective analysis of psychosocial outcomes in breast reconstruction: One-year postoperative results from the Michigan Breast Reconstruction Outcome Study	Wilkins EG et al.	Plast Reconstr Surg (3.621)	2000	174	11.60	56 expander/implant vs. 128 pedicled TRAM vs. 66 free TRAM, "Michigan Breast reconstruction outcome study", prospective cohort, 12 centers/23 surgeons, evaluation 1 years after operation, immediate vs. delayed breast reconstruction
15	21	Effect of smoking on complications in patients undergoing free TRAM flap breast reconstruction	Chang DW et al.	Plast Reconstr Surg (3.621)	2000	174	11.60	936 free TRAM in 718 patients, non-smoker vs. former smoker (stopped at least 4 weeks before surgery) vs. smoker, single center, retrospective
16	24	Venous congestion and blood flow in free transverse rectus abdominis myocutaneous and deep inferior epigastric perforator flaps	Blondeel PN et al.	Plast Reconstr Surg (3.621)	2000	167	11.13	271 free TRAM and 240 DIEP, two centers, retrospective
17	55	A comparison of outcomes using three different methods of breast reconstruction	Kroll SS et al.	Plast Reconstr Surg (3.621)	1992	166	7.22	161 free TRAM vs. 39 Latissimus dorsi flap vs. 87 expansion/implants, single surgeon, outcome: symmetry/shape/ptosis/scarring
18	50	Refinements in free flap breast reconstruction: the free bilateral deep inferior epigastric perforator flap anastomosed to the internal mammary artery	Blondeel PN et al.	Brit J Plast Surg (1.95)	1994	161	7.67	case report of anastomosed bilateral DIEP
19	41	The donor site morbidity of free DIEP flaps and free TRAM flaps for breast reconstruction.	Blondeel N et al.	Brit J Plast Surg (1.95)	1997	157	8.72	18 patients with unilateral DIEP vs. 20 free TRAM vs. 20 non-operated controls, abdominal wall stability, follow-up 1 year, single surgeon
20	33	Effect of obesity on flap and donor-site complications in free transverse rectus abdominis myocutaneous flap breast reconstruction	Chang DW et al.	Plast Reconstr Surg (3.621)	2000	154	10.27	936 free TRAM in 718 patients, normal weight vs. overweight vs. obese, single center, retrospective
21	38	Deep inferior epigastric perforator flap in breast reconstruction: Experience with the first 50 flaps	Hamdi M et al.	Plast Reconstr Surg (3.621)	1999	146	9.13	50 DIEP in 42 patients, immediate vs. delayed, abdominal wall stability follow-up of 20 patients, single center
22	53	Abdominal wall strength, bulging, and hernia after TRAM flap breast reconstruction	Kroll SS et al.	Plast Reconstr Surg (3.621)	1995	145	7.25	168 free TRAM vs. 100 pedicled TRAM, single-pedicled vs. double-pedicled, mesh vs. no mesh, at least 6 months follow-up, single center

Table 1 continued. The 100 most cited articles regarding to autologous breast reconstruction with TRAM or DIEP flaps.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD	Further article information
23	36	A retrospective comparison of abdominal muscle strength following breast reconstruction with a free TRAM or DIEP flap	Futter CM et al.	Brit J Plast Surg (1.95)	2000	143	9.53	27 free TRAM vs. 23 DIEP vs. 32 non-operated controls, assessment of abdominal and back extensor muscle strength isokinetic dynamometer and questionnaires
24	56	Reconstruction and the radiated breast: Is there a role for implants?	Evans GRD et al.	Plast Reconstr Surg (3.621)	1995	142	7.10	inter alia 4 implants beneath TRAM vs. 16 TRAM vs. <i>Lattissimus dorsi</i> flaps vs. prosthesis only, single center
25	57	TRAM flap anatomy correlated with a 10-year clinical experience with 556 patients	Watterson PA et al.	Plast Reconstr Surg (3.621)	1995	140	7.00	556 TRAM, unipedicled vs. bipedicled, single center, risk factors and complications
26	11	Breast reconstruction with the DIEP flap or the muscle-sparing (MS-2) free TRAM flap: Is there a difference?	Nahabedian MY et al.	Plast Reconstr Surg (3.621)	2005	137	13.70	89 free TRAM and 88 DIEP, unilateral vs. bilateral, evaluation of risk factors and complications
27	58	The free transverse rectus abdominis musculocutaneous flap for breast reconstruction: One center's experience with 211 consecutive cases	Schusterman MA et al.	Ann Plas Surg (1.536)	1994	137	6.52	211 free TRAM in 163 patients, complications
28	72	Complications of TRAM flap breast reconstruction in obese patients	Kroll SS et al.	Plast Reconstr Surg (3.621)	1989	134	5.15	82 unilateral TRAM, patients grouped by BMI, evaluation of aesthetic outcome and complication rate, single center
29	29	Perforator flaps: Evolution, classification, and applications	Geddes CR et al.	Ann Plas Surg (1.536)	2003	126	10.50	review of perforator flaps including TRAM and DIEP
30	70	Immediate TRAM flap breast reconstruction: 128 consecutive cases	Elliott LF et al.	Plast Reconstr Surg (3.621)	1993	123	5.59	128 TRAM (86 pedicled, 40 free, 2 "supercharged" TRAM), immediate reconstruction, bilateral and unilateral
31	73	Abdominal wall function after rectus abdominis transfer	Lejour M et al.	Plast Reconstr Surg (3.621)	1991	123	5.13	57 TRAM, delayed, up-to 2 years follow-up, evaluation by clinical examination, questionnaire, physiotherapist, computer tomography
32	27	Delayed-immediate breast reconstruction	Kronowitz SJ et al.	Plast Reconstr Surg (3.621)	2004	119	10.82	16 patients, 6 free TRAM vs. other techniques, single center
33	14	Preoperative planning of deep inferior epigastric artery perforator flap reconstruction with multislice-CT angiography: Imaging findings and initial experience	Alonso-Burgos A et al.	J Plast Reconstr Aes (2.158)	2006	117	13.00	6 DIEP, evaluation of pre-operative computer tomography angiography, single center
34	74	Comparison of strategies for preventing abdominal-wall weakness after TRAM flap breast reconstruction	Kroll SS et al.	Plast Reconstr Surg (3.621)	1992	117	5.09	130 pedicled TRAM, single center, mean follow-up 18 months
35	51	Postoperative adjuvant irradiation: Effects on transverse rectus abdominis muscle flap breast reconstruction	Tran NV et al.	Plast Reconstr Surg (3.621)	2000	115	7.67	32 free TRAM vs. 9 pedicled TRAM, average of 50.99 Gy within 6 months after breast reconstruction

Table 1 continued. The 100 most cited articles regarding to autologous breast reconstruction with TRAM or DIEP flaps.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD	Further article information
36	77	Immediate breast reconstruction: why the free TRAM over the conventional TRAM flap?	Schusterman MA et al.	Plast Reconstr Surg (3.621)	1992	114	4.96	20 free TRAM vs. 48 pedicled TRAM, single center
37	43	Radiation effects on breast reconstruction with the deep inferior epigastric perforator flap	Rogers NE et al.	Plast Reconstr Surg (3.621)	2002	112	8.62	30 DIEP with radiation after surgery vs. 30 non-radiated DIEP, single center, analysis of structural and aesthetic outcome
38	44	Contour abnormalities of the abdomen after breast reconstruction with abdominal flaps: The role of muscle preservation	Nahabedian MY et al.	Plast Reconstr Surg (3.621)	2002	112	8.62	108 free TRAM vs. 37 pedicled TRAM vs. 10 DIEP, single center
39	17	DIEP and pedicled TRAM flaps: A comparison of outcomes	Garvey PB et al.	Plast Reconstr Surg (3.621)	2006	111	12.33	94 pedicled TRAM vs. 96 DIEP, single center, comparison of multiple parameters
40	19	Perfusion zones of the DIEP flap revisited: A clinical study	Holm C et al.	Plast Reconstr Surg (3.621)	2006	108	12.00	15 DIEP, single center, laser-induced fluorescence of indocyanine green
41	67	The effects of radiation treatment after TRAM flap breast reconstruction	Williams JK et al.	Plast Reconstr Surg (3.621)	1997	103	5.72	608 pedicled TRAM (19 radiation after reconstruction vs. 108 prior radiation vs. 572 non-radiated), single center, retrospective
42	10	Breast reconstruction after surgery for breast cancer	Cordeiro PG	New Engl J Med (79.258)	2008	102	14.57	Review of breast reconstruction techniques
43	79	Breast reconstruction with myocutaneous flaps in previously irradiated patients	Kroll SS et al.	Plast Reconstr Surg (3.621)	1994	100	4.76	66 TRAM (after radiation) vs. 16 Latissimus dorsi (after radiation) vs. 158 TRAM (non-radiated) vs. 44 Latissimus dorsi (non-radiated), single center
44	84	Experience with 50 free TRAM flap breast reconstructions	Arnez ZM et al.	Plast Reconstr Surg (3.621)	1991	100	4.17	50 free TRAM, patient's data analyzed, risk factors and complications
45	65	Fat necrosis in free and pedicled TRAM flaps	Kroll SS et al.	Plast Reconstr Surg (3.621)	1998	99	5.82	49 free TRAM vs. 67 pedicled TRAM, single center, examination clinically and mammographically
46	80	Assessment of the abdominal wall after pedicled TRAM flap surgery: 5- to 7-year follow-up of 150 consecutive patients	Mizgala CL et al.	Plast Reconstr Surg (3.621)	1994	99	4.71	135 patients (98.5%) returned questionnaire 5–7.5 years postoperatively, 132 patients with clinical examination (68 single pedicled, 63 double rectus harvest, 4 single pedicled with contralateral microvascular augmentation)
47	68	A comparison of resource costs of immediate and delayed breast reconstruction	Khoo A et al.	Plast Reconstr Surg (3.621)	1998	97	5.71	194 TRAM vs. 82 implant reconstructions, immediate vs. delayed, single center
48	12	Preoperative imaging for DIEA perforator flaps: A comparative study of computed tomographic angiography and Doppler ultrasound	Rozen WM et al.	Plast Reconstr Surg (3.621)	2008	94	13.43	8 DIEP patients, preoperative computer tomography angiography and Doppler ultrasound, single center

Table 1 continued. The 100 most cited articles regarding to autologous breast reconstruction with TRAM or DIEP flaps.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD	Further article information
49	30	Complications after microvascular breast reconstruction: Experience with 1195 flaps	Mehrara BJ et al.	Plast Reconstr Surg (3.621)	2006	94	10.44	1195 breast reconstructions in 952 patients (978 TRAM and 217 other flaps), single center (11-year period), retrospective, risk factors and complications
50	37	The effect of radiation on pedicled TRAM flap breast reconstruction: Outcomes and implications	Spear SL et al.	Plast Reconstr Surg (3.621)	2005	93	9.30	171 pedicled TRAM in 150 patients (91 TRAM only, 42 radiation pre-TRAM, 38 radiation post-TRAM), risk factors and complications, single center
51	34	Comparison of donor-site complications and functional outcomes in free muscle-sparing TRAM flap and free DIEP flap breast reconstruction	Bajaj AK et al.	Plast Reconstr Surg (3.621)	2006	91	10.11	124 free TRAM vs. 35 DIEP, unilateral vs. bilateral, single center, 99 patients with questionnaire
52	48	Breast reconstruction with superficial inferior epigastric artery flaps: A prospective comparison with TRAM and DIEP flaps	Chevray PM	Plast Reconstr Surg (3.621)	2004	89	8.09	12 SIEA (superficial inferior epigastric artery flap) vs. 21 TRAM vs. 7 DIEP, single center, prospective
53	63	A prospective and randomized study, SVEA, comparing effects of three methods for delayed breast reconstruction on quality of life, patient- defined problem areas of life, and cosmetic result	Brandberg Y et al.	Plast Reconstr Surg (3.621)	2000	88	5.87	29 pedicled TRAM vs. 30 Latissimus dorsi vs. 16 lateral thoracodorsal flap, randomized, "SVEA" study
54	76	A comparison of morbidity from bilateral, unipedicled and unilateral, unipedicled TRAM flap breast reconstructions	Paige KT et al.	Plast Reconstr Surg (3.621)	1998	86	5.06	257 pedicled TRAM (only unipedicled), single center, retrospective
55	87	Prospective evaluation of immediate reconstruction after mastectomy	Eberlein TJ et al.	Ann Surg (9.203)	1993	86	3.91	101 TRAM vs. 71 implants vs. 23 tissue expander vs. 21 Latissimus dorsi, only immediate reconstruction, single center
56	60	Postoperative morphine requirements of free TRAM and DIEP flaps	Kroll SS et al.	Plast Reconstr Surg (3.621)	2001	84	6.00	132 free TRAM vs. 26 DIEP, single center, retrospective
57	85	A comparison of factors affecting aesthetic outcomes of TRAM flap breast reconstructions	Kroll SS et al.	Plast Reconstr Surg (3.621)	1995	83	4.15	68 free TRAM vs. 169 pedicled TRAM, single center, unilateral vs. bilateral, immediate vs. delayed
58	64	Complications of postmastectomy breast reconstructions in smokers, ex-smokers, and nonsmokers	Padubidri AN et al.	Plast Reconstr Surg (3.621)	2001	82	5.86	263 TRAM vs. 4 Latissimus dorsi vs. 11 implants vs. 466 tissue expanders, 155 smokers vs. 76 ex-smokers vs. 517 non-smokers, single center, retrospective
59	40	Breast reconstruction with the deep inferior epigastric perforator flap: History and an update on current technique	Granzow JW et al.	J Plast Reconstr Aes (2.158)	2006	80	8.89	Review of abdominal wall anatomy and DIEP technique

Table 1 continued. The 100 most cited articles regarding to autologous breast reconstruction with TRAM or DIEP flaps.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD	Further article information
60	9	Patient Satisfaction in postmastectomy breast reconstruction: A comparative evaluation of DIEP, TRAM, latissimus flap, and implant techniques	Yueh JH et al.	Plast Reconstr Surg (3.621)	2010	79	15.80	439 patients completed questionnaire, 117 DIEP vs. 119 pedicled TRAM vs. 87 tissue expander vs. 116 Latissimus dorsi (+/- implants), single center
61	23	Prospective analysis of long-term psychosocial outcomes in breast reconstruction: Two-year postoperative results from the Michigan Breast Reconstruction Outcomes Study	Atisha D et al.	Ann Surg (9.203)	2008	79	11.29	40 free TRAM vs. 91 pedicled TRAM vs. 42 expander/implant, immediate vs. delayed, "Michigan Breast Reconstruction Outcome Study", multi-center, prospective
62	86	Comparison of resource costs between implant-based and TRAM flap breast reconstruction	Kroll SS et al.	Plast Reconstr Surg (3.621)	1996	78	4.11	154 TRAM vs. 86 implants, only full reconstruction (including nipple), single center, retrospective
63	25	Does the preoperative imaging of perforators with CT angiography improve operative outcomes in breast reconstruction?	Rozen WM et al.	Microsurg (2.071)	2008	77	11.00	88 patients with abdominal free flaps, 40 preoperative CTA vs. 48 without, comparing operation data, complications and surgeons stress levels during operation, single center
64	15	Patient-Reported aesthetic satisfaction with breast reconstruction during the long-term survivorship period	Hu ES et al.	Plast Reconstr Surg (3.621)	2009	75	12.50	109 TRAM vs. 110 expander/implants, follow-up to >8 years post-reconstruction, single center, questionnaire
65	66	Radiotherapy and breast reconstruction: Complications and cosmesis with tram versus tissue expander/implant	Chawla AK et al.	Int J Radiat Oncol (3.333)	2002	75	5.77	30 TRAM vs. 18 expander/implant, radiation prior or following reconstruction, single center, evaluation of complications and cosmetic outcome
66	89	Late results of breast reconstruction with free TRAM flaps: A prospective multicentric study	Banic A et al.	Plast Reconstr Surg (3.621)	1995	75	3.75	123 free TRAM, unilateral vs. bilateral, evaluation of risk factors and complications, multi-center, prospective
67	99	Double-pedicled TRAM flap for unilateral breast reconstruction	Wagner DS et al.	Plast Reconstr Surg (3.621)	1991	74	3.08	500 pedicled TRAM, only unilateral, unipedicled vs. bipedicled, single center
68	59	An outcome analysis comparing the thoracodorsal and internal mammary vessels as recipient sites for microvascular breast reconstruction: A prospective study of 100 patients	Moran SL et al.	Plast Reconstr Surg (3.621)	2003	73	6.08	60 free TRAM, randomized recipient vessel, prospective, evaluation of risk factors and aesthetic outcome
69	32	Arterial and venous anatomies of the deep inferior epigastric perforator and superficial inferior epigastric artery flaps	Schaverien M et al.	Plast Reconstr Surg (3.621)	2008	72	10.29	10 cadavers and 2 abdominoplastic specimens, experimental setting, computer tomography studies
70	91	TRAM flap vascular delay for high-risk breast reconstruction	Codner MA et al.	Plast Reconstr Surg (3.621)	1995	72	3.60	30 bi-pedicled TRAM in 23 high-risk patients, vascular delay by ligation 2 weeks prior to flap elevation

Table 1 continued. The 100 most cited articles regarding to autologous breast reconstruction with TRAM or DIEP flaps.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD	Further article information
71	97	Breast reconstruction in women treated with radiation therapy for breast cancer: cosmesis, complications, and tumor control	Schuster RH et al.	Plast Reconstr Surg (3.621)	1992	72	3.13	8 TRAM vs. 11 Latissimus dorsi plus implants vs. 1 gluteal artery flap vs. 39 expander/implant, every patient with mastectomy and radiation, single center
72	75	Clinical determinants of patient satisfaction with breast reconstruction	Andrade WN et al.	Plast Reconstr Surg (3.621)	2001	71	5.07	185 TRAM vs. 26 implant, groups: satisfied vs. unsatisfied, questionnaire and retrospective chart review, single center
73	90	Skin-sparing mastectomy with immediate breast reconstruction: The M D Anderson Cancer Center experience	Singletary SE	Ann Surg Oncol (3.857)	1996	70	3.68	single center review
74	94	Color-flow duplex scanning in the preoperative assessment of TRAM flap perforators: a report of 32 consecutive patients	Rand RP et al.	Plast Reconstr Surg (3.621)	1994	70	3.33	32 free TRAM patients, preoperative color-flow duplex scanning, single center
75	96	The deep inferior epigastric artery free skin flap: Anatomic study and clinical application	Itoh Y et al.	Plast Reconstr Surg (3.621)	1993	70	3.18	17 cadavers, DIEP anatomic study and clinical applications
76	82	Cost-based comparison between perforator flaps and TRAM flaps for breast reconstruction	Kaplan JL et al.	Plast Reconstr Surg (3.621)	2000	69	4.60	59 DIEP vs. 5 gluteal artery flaps vs. 154 TRAM, comparison of costs, single center, retrospective
77	52	Risk factors and complications in free TRAM flap breast reconstruction	Selber JC et al.	Ann Plas Surg (1.536)	2006	68	7.56	500 free TRAM, risk factors and complications, single center, retrospective
78	69	Recurrence following treatment of ductal carcinoma <i>in situ</i> with skin-sparing mastectomy and immediate breast reconstruction	Spiegel AJ et al.	Plast Reconstr Surg (3.621)	2003	68	5.67	138 TRAM vs. 75 implant, 8 Latissimus dorsi (with or without implant), retrospective, single center
79	78	Prospective evaluation of late cosmetic results following breast reconstruction: II. TRAM flap reconstruction	Clough KB et al.	Plast Reconstr Surg (3.621)	2001	68	4.86	171 TRAM, follow-up 8 years, complications and cosmetic outcome, prospective, single center
80	92	TRAM flap breast reconstruction after radiation treatment	Williams JK et al.	Ann Surg (9.203)	1995	68	3.40	108 pedicled TRAM with radiation prior vs. 572 non-radiated patients with TRAM, unilateral vs. bilateral, unipedicled vs. bipedicled, single center, retrospective
81	71	Skin-sparing mastectomy with conservation of the nipple-areola complex and autologous reconstruction is an oncologically safe procedure	Gerber B et al.	Ann Surg (9.203)	2003	67	5.58	55 TRAM in total and 67 Latissimus dorsi vs. 32 implants, local recurrence rates, single center, retrospective
82	83	Rational selection of flaps from the abdomen in breast reconstruction to reduce donor site morbidity	Arnez ZM et al.	Brit J Plast Surg (1.95)	1999	67	4.19	5 SIEA vs. 13 DIEP vs. 2 TRAM, complications, single center

Table 1 continued. The 100 most cited articles regarding to autologous breast reconstruction with TRAM or DIEP flaps.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD	Further article information
83	93	Postmastectomy reconstruction: comparative analysis of the psychosocial, functional, and cosmetic effects of transverse rectus abdominis musculocutaneous flap versus breast implant reconstruction	Cederna PS et al.	Ann Plas Surg (1.536)	1995	67	3.35	8 TRAM patients vs. 14 implant patients, mastectomy and immediate or delayed reconstruction, questionnaire, single center
84	47	Microvascular complications of DIEP flaps	Tran NV et al.	Plast Reconstr Surg (3.621)	2007	65	8.13	100 DIEP in 74 patients, evaluation of microvascular complications, prospective, single center
85	61	Factors associated with anastomotic failure after microvascular reconstruction of the breast	Nahabedian MY et al.	Plast Reconstr Surg (3.621)	2004	65	5.91	176 free TRAM vs. 58 DIEP vs. 6 SGAP, analysis of complications, single center
86	81	An outcome study of breast reconstruction: Presurgical identification of risk factors for complications	Lin KY et al.	Ann Surg Oncol (3.857)	2001	65	4.64	14 free TRAM vs. 70 pedicled TRAM vs. 39 expander/implants, analysis of complications and risk factors, single center, retrospective
87	88	Donor-site morbidity after pedicled or free TRAM flap surgery: A prospective and objective study	Edsander-Nord A et al.	Plast Reconstr Surg (3.621)	1998	65	3.82	19 free TRAM vs. 23 pedicled TRAM, questionnaire and evaluation of abdominal wall strength, prospective, single center
88	98	Free TRAM. Results and abdominal wall function	Feller AM	Clin Plast Surg (1.68)	1994	65	3.10	151 free TRAM
89	100	The sensational transverse rectus abdominis musculocutaneous (TRAM) flap: Return of sensibility after TRAM breast reconstruction	Slezak S et al.	Ann Plas Surg (1.536)	1992	65	2.83	10 pedicled TRAM vs. 10 healthy volunteers, evaluation of sensibility, single center
90	28	Abdominal wall following free TRAM or DIEP flap reconstruction: a meta-analysis and critical review	Man LX et al.	Plast Reconstr Surg (3.621)	2009	64	10.67	Review of six studies (DIEP vs. free TRAM), outcome analysis
91	95	Internal mammary vessels: Anatomical and clinical considerations	Hefel L et al.	Brit J Plast Surg (1.95)	1995	64	3.20	Investigating the anatomy of the internal mammary (thoracic) artery (IMA) and comitant vein(s) (IMV) relevant to their use in microsurgery, 86 cadavers dissected and Doppler ultrasound of 34 healthy female volunteers, single center
92	39	True incidence of all complications following immediate and delayed breast reconstruction	Sullivan SR et al.	Plast Reconstr Surg (3.621)	2008	63	9.00	124 DIEP vs. 33 free TRAM vs. 22 pedicled <i>Latissimus dorsi</i> vs. 142 expander/implant, immediate vs. delayed, single center, retrospective
93	42	The value of the multidetector row computed tomography for the preoperative planning of deep inferiorepigastic artery perforator flap: Our experience in 162 cases	Masia J et al.	Ann Plas Surg (1.536)	2008	61	8.71	162 DIEP patients, preoperative computer tomography, single center, prospective

Table 1 continued. The 100 most cited articles regarding to autologous breast reconstruction with TRAM or DIEP flaps.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD	Further article information
94	45	Abdominal wall CT angiography: A detailed account of a newly established preoperative imaging technique	Phillips TJ et al.	Radiology (7.469)	2008	60	8.57	Description of preoperative computer tomography angiography for planning free TRAM/DIEP
95	35	Preoperative CT angiography reduces surgery time in perforator flap reconstruction	Smit JM et al.	J Plast Reconstr Aes (2.158)	2009	59	9.83	138 DIEP, preoperative computer tomography angiography vs. Doppler ultrasound, single center, retrospective
96	46	Risk factors for abdominal donor-site morbidity in free flap breast reconstruction	Vyas RM et al.	Plast Reconstr Surg (3.621)	2008	59	8.43	219 free TRAM vs. 128 DIEP, analysis of abdominal donor-site morbidity, single center
97	62	Skin-sparing mastectomy and immediate reconstruction is an acceptable treatment option for patients with high-risk breast carcinoma	Downes KJ et al.	Cancer (6.537)	2005	59	5.90	38 TRAM vs. 3 <i>Latissimus dorsi</i> vs. 4 expander/implants, skin-sparing mastectomy and immediate reconstruction, single center, retrospective
98	22	Intraoperative perfusion mapping with laser-assisted indocyanine green imaging can predict and prevent complications in immediate breast reconstruction	Komorowska-Timek E et al.	Plast Reconstr Surg (3.621)	2010	58	11.60	6 DIEP/SIEA vs. 2 <i>Latissimus dorsi</i> vs. 16 expander/implants, immediate reconstruction after mastectomy, single center
99	54	A critical review of perioperative complications in 175 free deep inferior epigastric perforator flap breast reconstructions	Hofer SOP et al.	Ann Plas Surg (1.536)	2007	58	7.25	159 DIEP vs. 16 TRAM, analysis of complications, single center
100	5	Microvascular breast reconstruction and lymph node transfer for postmastectomy lymphedema patients	Saaristo AM et al.	Ann Surg (9.203)	2012	56	18.67	9 modified lower abdominal reconstruction flap containing lymph nodes and lymphatic vessels surrounding the superficial circumflex vessel pedicle, single center

In the ISI Web of Knowledge data base the 100 most cited articles for autologous breast reconstruction with TRAM or DIEP flaps were searched. By analyzing the abstracts inclusion and exclusion was made. All articles are in English language and published in a peer-reviewed journal. Articles were ranked based on the total citations (RTC) and the citation density (citations per year since publication; RCD). RTC – rank total citations; RCD – rank citation density; PY – publication year; TC – total citations; CD – citation density; IF – impact factor (most recent IF are listed for each journal). Ann Surg – Annals of Surgery; Ann Plas Surg – Annals of Plastic Surgery; Ann Surg Oncol – Annals of Surgical Oncology; Brit J Plast Surg – British Journal of Plastic Surgery; Clin Plast Surg – Clinics in Plastic Surgery; Int J Radiat Oncol – International Journal of Radiation Oncology Biology Physics; J Plast Reconstr Aes – Journal of Plastic Reconstructive and Aesthetic Surgery; Microsurg – Microsurgery; New Engl J Med – New England Journal of Medicine; Plast Reconstr Surg – Plastic And Reconstructive Surgery.

has been cited 24 times per year since its publication in 1994. In contrast, the mean citation density of all articles was 8.53 citations per year since publication, with the lowest value being 2.83 citations per year [34] (Table 2).

Analysis of the geographic origin of the respective articles revealed that the vast majority (71 of the 100 articles) were published by groups in North America (Figure 4). Authors from Europe published 23 articles, followed by Australia (3 articles), Canada (2 articles), and Japan (1 article).

We also analyzed the number of authors per article (Figure 5). Most articles were published by more than 2 authors, with the largest number of authors being 11 in an article published in 1994 [35]. Only 6 articles were published by a single author and 11 articles by 2 authors (Figure 5). A slight increase in the number of authors was noted as demonstrated by the mean number of authors being 4.81 from 1989 to 2000 versus 4.98 from 2001 to 2012.

Stephen S. Kroll was the first author of 11 articles in our ranking (Table 1). Furthermore, 36 articles were published by the

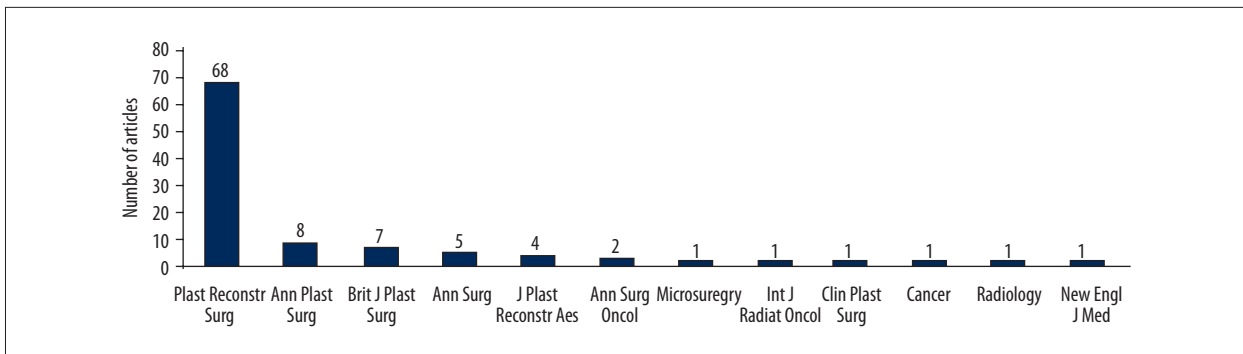


Figure 1. The majority of the 100 most cited articles were published in journals within the field of plastic surgery. (*) Until December 2005 *British Journal of Plastic Surgery*, since January 2006 *Journal of Plastic and Reconstructive Surgery*.

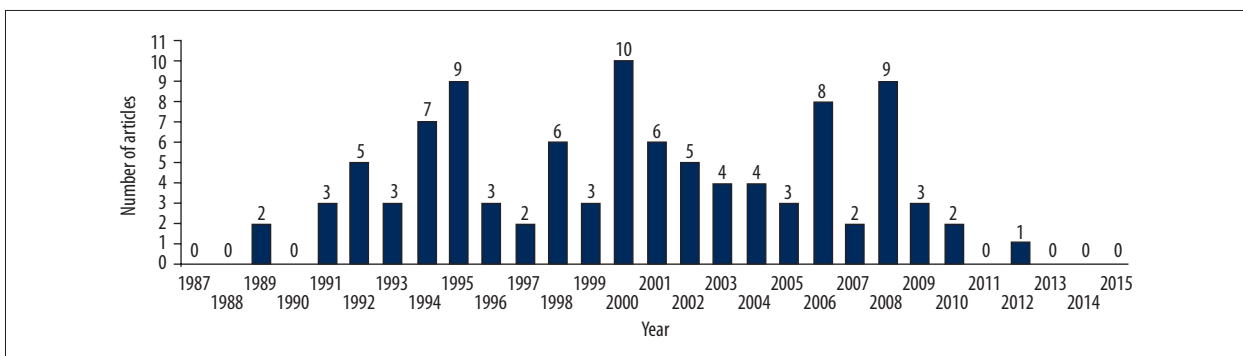


Figure 2. All 100 articles in our most cited ranking were published between 1989 and 2012. The maximum number of 10 articles per year was published in 2000.

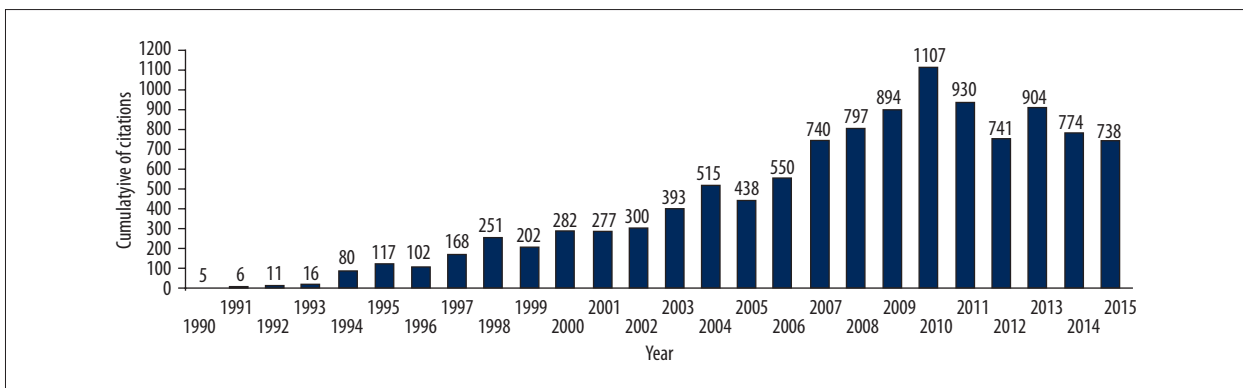


Figure 3. Cumulative citations of all 100 most cited articles were counted for each year. In 1990, 5 articles from our ranking were cited. Since then, there was an increasing trend of cumulative citations per year for all articles published until the respective year. Since the maximum of 1107 citations in 2010, there was a slight decreasing trend in the cumulative citation number.

same leading author 2 or more times. The majority of studies were retrospective (71 articles). The remaining studies included 20 prospective studies, 1 case report, 3 experimental studies, and 5 reviews. The articles could be furthermore divided into 89 single-center and 7 multicenter studies.

Studies most commonly focused on indications for TRAM/DIEP flaps, postoperative complications, preoperative diagnostics, and perioperative risk factors. Sixty-two articles reported on

peri-/postoperative complications and associated risk factors. Twenty-six articles particularly investigated the issue of donor site morbidity. While earlier studies evaluated advantages of DIEP flaps compared to free TRAM flaps [36] or free TRAM flaps compared to conventional TRAM flaps [37,38] with respect to effect on abdominal wall function, more recent studies focused on muscle-sparing TRAM and DIEP flaps [39,40]. These results suggest that contrary to free and conventional TRAM flaps, which lead to a higher rate of abdominal bulging or hernia, muscle-sparing

Table 2. The 25 most cited articles regarding autologous breast reconstruction with TRAM or DIEP flaps ranked by citation density.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD
1	1	Deep inferior epigastric perforator flap for breast reconstruction	Allen RJ et al.	Ann Plas Surg (1.536)	1994	512	24.38
4	2	A 10-year retrospective review of 758 DIEP flaps for breast reconstruction	Gill PS et al.	Plast Reconstr Surg (3.621)	2004	245	22.27
13	3	Multidetector-row computed tomography in the planning of abdominal perforator flaps	Masia J et al.	J Plast Reconstr Aes (2.158)	2006	179	19.89
2	4	A prospective study of microvascular free-flap surgery and outcome	Khoury RK et al.	Plast Reconstr Surg (3.621)	1998	329	19.35
100	5	Microvascular breast reconstruction and lymph node transfer for postmastectomy lymphedema patients	Saaristo AM et al.	Ann Surg (9.203)	2012	56	18.67
5	6	Breast reconstruction with the free TRAM or DIEP flap: Patient selection, choice of flap, and outcome	Nahabedian MY et al.	Plast Reconstr Surg (3.621)	2002	239	18.38
3	7	One hundred free DIEP flap breast reconstructions: A personal experience	Blondeel PN	Brit J Plast Surg (1.95)	1999	282	17.63
6	8	Complications in postmastectomy breast reconstruction: Two-year results of the Michigan breast reconstruction outcome study	Alderman AK et al.	Plast Reconstr Surg (3.621)	2002	219	16.85
60	9	Patient satisfaction in postmastectomy breast reconstruction: A comparative evaluation of DIEP, TRAM, latissimus flap, and implant techniques	Yueh JH et al.	Plast Reconstr Surg (3.621)	2010	79	15.80
42	10	Breast reconstruction after surgery for breast cancer	Cordeiro PG	New Engl J Med (79.258)	2008	102	14.57
26	11	Breast reconstruction with the DIEP flap or the muscle-sparing (MS-2) free TRAM flap: Is there a difference?	Nahabedian MY et al.	Plast Reconstr Surg (3.621)	2005	137	13.70
48	12	Preoperative imaging for DIEA perforator flaps: A comparative study of computed tomographic angiography and Doppler ultrasound	Rozen WM et al.	Plast Reconstr Surg (3.621)	2008	94	13.43
11	13	Comparison of immediate and delayed free TRAM flap breast reconstruction in patients receiving postmastectomy radiation therapy	Tran NV et al.	Plast Reconstr Surg (3.621)	2001	184	13.14
33	14	Preoperative planning of deep inferior epigastric artery perforator flap reconstruction with multislice-CT angiography: Imaging findings and initial experience	Alonso-Burgos A et al.	J Plast Reconstr Aes (2.158)	2006	117	13.00
64	15	Patient-reported aesthetic satisfaction with breast reconstruction during the long-term survivorship period	Hu ES et al.	Plast Reconstr Surg (3.621)	2009	75	12.50
9	16	Determinants of patient satisfaction in postmastectomy breast reconstruction	Alderman AK et al.	Plast Reconstr Surg (3.621)	2000	186	12.40
39	17	DIEP and pedicled TRAM flaps: A comparison of outcomes	Garvey PB et al.	Plast Reconstr Surg (3.621)	2006	111	12.33
12	18	Fat necrosis in free transverse rectus abdominis myocutaneous and deep inferior epigastric perforator flaps	Kroll SS	Plast Reconstr Surg (3.621)	2000	181	12.07
40	19	Perfusion zones of the DIEP flap revisited: A clinical study	Holm C et al.	Plast Reconstr Surg (3.621)	2006	108	12.00
14	20	Prospective analysis of psychosocial outcomes in breast reconstruction: One-year postoperative results from the Michigan Breast Reconstruction Outcome Study	Wilkins EG et al.	Plast Reconstr Surg (3.621)	2000	174	11.60
15	21	Effect of smoking on complications in patients undergoing free TRAM flap breast reconstruction	Chang DW et al.	Plast Reconstr Surg (3.621)	2000	174	11.60
98	22	Intraoperative perfusion mapping with laser-assisted indocyanine green imaging can predict and prevent complications in immediate breast reconstruction	Komorowska-Timek E et al.	Plast Reconstr Surg (3.621)	2010	58	11.60

Table 2 continued. The 25 most cited articles regarding autologous breast reconstruction with TRAM or DIEP flaps ranked by citation density.

RTC	RCD	Article	Authors	Journal (IF)	PY	TC	CD
61	23	Prospective analysis of long-term psychosocial outcomes in breast reconstruction: Two-year postoperative results from the Michigan Breast Reconstruction Outcomes Study	Atisha D et al.	Ann Surg (9.203)	2008	79	11.29
16	24	Venous congestion and blood flow in free transverse rectus abdominis myocutaneous and deep inferior epigastric perforator flaps	Blondeel PN et al.	Plast Reconstr Surg (3.621)	2000	167	11.13
63	25	Does the preoperative imaging of perforators with CT angiography improve operative outcomes in breast reconstruction?	Rozen WM et al.	Microsurg (2.071)	2008	77	11.00

RCD – rank citation density (citations per year since publication); RTC – rank total citations; PY – publication year; TC – total citations; CD – citation density; IF – impact factor (most recent IF are listed for each journal).

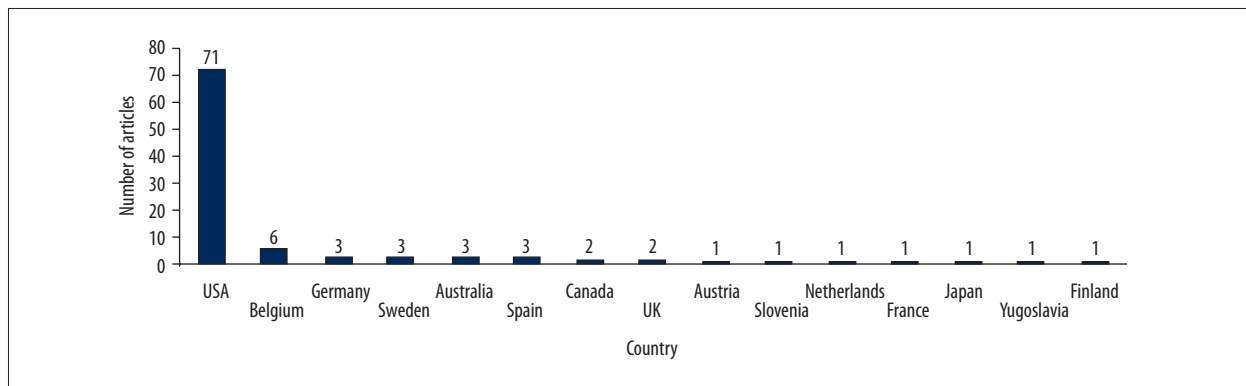


Figure 4. All ranked articles were analyzed for authors and official institutions they were published by as labeled in the ISI Web of Knowledge. All 100 articles in our ranking are shown. USA – United States of America; UK – United Kingdom.

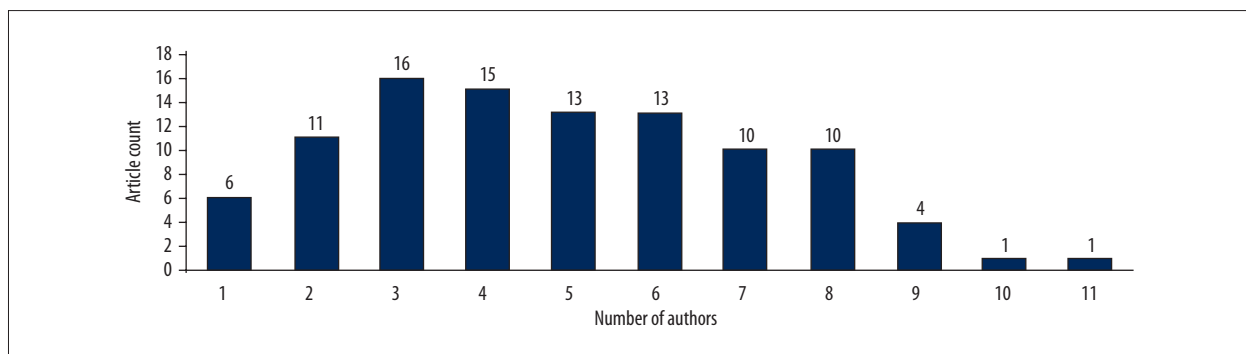


Figure 5. We recorded all authors from the ISI Web of Knowledge database for every article in our ranking of the most cited articles for autologous breast reconstruction. Six articles were published by 1 author. In contrast, 1 article had a maximum of 11 authors.

TRAM, and DIEP flaps are equivalent in terms of abdominal wall morbidity.

The most prevalent risk factors leading to complications such as flap necrosis, reoperation, or abdominal issues were radiation (16 articles), obesity (10 articles), and smoking (7 articles). DIEP and TRAM flaps were directly compared to each other in 10 articles, while they were compared to other autologous or

alloplastic breast reconstruction techniques in 25 articles. Twenty articles included description of surgical technique, anatomical or experimental studies, or reported on flap success. Another important topic was immediate breast reconstruction (16 articles), which was associated with higher complications rates [41,42], lower resource costs [43], and superior aesthetic and psychosocial outcome compared to delayed procedures [37,44]. More recent studies emphasize the effect of breast reconstruction on

quality of life and patient satisfaction (9 articles), imaging tools (10 articles), cosmetic outcome (2 articles), resource costs (3 articles), and recipient vessels (2 articles). Current imaging tools include preoperative CT angiography for identification of perforators (7 articles) and laser-assisted indocyanine green imaging for intraoperative perfusion mapping (1 article) (Table 1).

Discussion

Breast cancer is the leading cancer entity in female patients and has been the second most common cancer for decades [45,46]. The high incidence and prevalence of this disease entity is paralleled by an increasing awareness of reconstructive options after mastectomy. The increasing demand is further reflected by an increasing number of breast reconstructions being performed annually [47].

Although tremendous advances have also been made in the field of implant-based breast reconstruction, the focus of our analysis was on autologous breast reconstruction with abdominal tissue, specifically TRAM and DIEP flaps. Among the most commonly cited articles, study objectives included clinical outcomes data (specifically postoperative complication rates) [28–30,36,39,42], comparative analyses with other reconstructive techniques [10, 24, 42, 44, 48], and description of surgical techniques, including experimental and anatomical studies [17,18,23,29,35,49] (Table 1).

Due to recent microsurgical advances, breast reconstruction techniques have developed from a flap safety-based approach using pedicled or free TRAM flaps to more perforator-based flaps and super-microsurgery due to co-factors like donor-site morbidity [50] and lymphedema [23]. Furthermore, novel imaging technologies such as intraoperative perfusion mapping have increased the safety profile of the procedure and have allowed for more predictable results to be achieved [51]. While experimental (e.g., tissue-engineered) options for breast reconstruction have been theorized, they are not yet available for clinical application [52].

In the early period of autologous breast reconstruction with abdominal tissue, authors from the United States, Belgium, Sweden, and Japan were at the forefront of developing these surgical techniques [15,17,18,53]. While the pedicled TRAM flap as described by Hartrampf 1982 has been frequently cited and described as the origin of modern autologous breast reconstruction, it is important to acknowledge that the free TRAM flap was described earlier by Holmstrom, in 1979 [15,16].

It is interesting that the first articles in our ranking were published in 1989, 10 years after the initial TRAM techniques were described. This may be because scientific progress cannot always be described in terms of breakthroughs or landmark

publications alone, since a finding may at times not immediately be recognized as a breakthrough until decades later. Regardless, the description of a perforator-based abdominal flap harvest in 1989 certainly was a “starting-signal” for the propagation of the abdominal donor site as a reliable source for autologous breast reconstruction. Since then, surgeons from the United States have dominated the literature on autologous breast reconstruction with TRAM and DIEP flaps, as evidenced by the fact that 2/3 of the most cited articles have been published by authors/institutions from the United States (Figures 4, 5).

During our analysis of the literature, the impressive evolution of progressively less morbid techniques of abdominal flap harvest became evident. The transition from pedicled TRAM flap harvest to muscle-sparing techniques and finally perforator-based approaches has not only resulted in a progressive decrease in abdominal wall morbidity, but also highlights the innovative nature of our specialty.

All articles in our ranking were published within the 23-year period from 1989 to 2012, with a peak of total citations being noted in 2010 (Figures 2, 3). Our results show that a substantial lag period can exist between publication of a novel technique and widespread clinical adoption. Naturally, when it comes to reporting long-term data on pedicled TRAM flaps outcomes, a number of articles appeared decades after free flaps have been published and after free flaps have become a prevalent technique in the interim. Because of the latency of long-term reports, our review included all 3 prevailing techniques in our ranking. Hence, long-term analyses of pedicled and free TRAM flaps coincide with the period of comparative analyses of free TRAM vs. DIEP flaps.

Limitations of our study are related to the design, which includes a single electronic database. However, we believe that the database chosen is comprehensive and, hence, do not believe that highly cited articles eluded us. Of course, the quality of the included studies determines the quality of any literature review. However, since we did not perform a quantitative analysis, but rather provide a descriptive report of highly cited studies, this concern is not particularly relevant.

We believe that this study provides a general overview of the most cited articles on autologous breast reconstruction with TRAM and DIEP flaps and highlights the various areas of study.

Conclusions

This literature review illustrates not only the dramatic change that has occurred subsequent to introduction of abdominal flaps for breast reconstruction, but also the lag period from publication to widespread clinical adoption of a particular

surgical technique/approach. While the use of abdominal flaps has become widely accepted for breast reconstruction, many

questions remain unanswered, thus highlighting the need for ongoing clinical investigation.

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