

Morphological Study of Sacral Hiatus in Human Sacrum in Udaipur District.

Dr. Lekhni Vyas¹, Dr. Ghanshyam Gupta², Dr. Seema Prakash³,

Dr. Parveen Ojha⁴, Dr. Manali Arora⁵ (corresponding author)

¹(Anatomy, R.N.T Medical College/ Rajasthan University of Health Sciences, India)

²(Anatomy, J.N.U Institute of Medical Sciences and Research Center/ Jaipur National University, India)

³(Anatomy, R.N.T Medical College/ Rajasthan University of Health Sciences, India)

⁴(Anatomy, R.N.T Medical College/ Rajasthan University of Health Sciences, India)

⁵(Anatomy, Dr. S.N. Medical College/ Rajasthan University of Health Sciences, India)

Abstract:

Background: Sacral hiatus is an important landmark used during caudal epidural anesthesia or block (CEB).

Aim and objectives: Present study was planned to study the various shapes and location of apex and base of sacral hiatus with respect to sacral vertebrae.

Material and methods: Descriptive type of observational study was conducted on 80 dry human sacra in the department of Anatomy, R.N.T. Medical College, Udaipur. Morphological features such as shape of sacral hiatus, level of apex and base of sacral hiatus with respect to sacral vertebrae were observed.

Results: It was found that out of total studied sacra 53.75%, 27.50%, 11.25%, 5%, and 2.5% were having Inverted V, Inverted U, Dumbbell, Irregular and Spina Bifida shaped of sacral hiatus respectively. When level of apex and base of sacral hiatus with respect to sacral vertebrae were studied, apex was mostly present at the level of 4th sacral vertebra (47.44%) whereas most common (92.31%) location of base of sacral hiatus was at the level of 5th sacral vertebrae.

Conclusion: Sacral hiatus is an important landmark used for the successful caudal epidural anesthesia. Thus the exact localization of the sacral hiatus would help in easy placement of needle into the hiatus.

Date of Submission: 28-05-2023

Date of Acceptance: 08-06-2023

I. Introduction

The sacral hiatus shows variations during its development. Non fusion of laminae of fourth or the upper vertebrae results in an elongated sacral hiatus. Non fusion of all the sacral vertebrae, results in sacral spina bifida. This give rise to decreased surface area for the attachment of extensor muscle at the back, which may be a cause of backache^{1,2,3}

The sacral hiatus is the site for caudal epidural anaesthesia. The reliability and success rate of caudal epidural anaesthesia depends upon anatomical variations of sacral hiatus⁴. Caudal analgesia is used during surgical procedures in urology, proctology, general surgery, obstetrics and gynecology (painless delivery) and orthopaedics (diagnosis and treatment of lumbar spinal disorders). It is also used for three dimensional colour visualization of lumbosacral epidural space⁵. The success & reliability of caudal epidural anaesthesia depends upon anatomical variations of sacral hiatus. In clinical studies, success rate of caudal epidural anaesthesia has been reported to be about 70% to 80%⁶.

Caudal epidural injections are ideally performed with fluoroscopic guidance as the gold standard for accurate needle placement to decrease the risk of a subarachnoid puncture, decrease intrathecal or intravascular injection, and facilitate accurate delivery of drug but it is not always available. So in this case the knowledge of anatomical variations in sacral hiatus such as shape and level of apex may increase the success rate of caudal epidural block⁷.

So the present study was conducted to record the morphological parameters of sacral hiatus viz. shape and level of apex and base with respect to sacral vertebrae of sacral hiatus in order to study the anatomical variations which will be useful for caudal epidural anaesthesia and improve the reliability of the same.

II. Material and Methods

Descriptive type of Observational study was conducted in the Department of Anatomy R.N.T. Medical College, Udaipur (Rajasthan).

Study Type: Descriptive type of observational study

Study Design: Cross-sectional study

Study Location: Department of Anatomy R.N.T. Medical College, Udaipur (Rajasthan).

Sample size: 80 dry human sacra (convenient sampling method) of unknown sex were collected from Department of Anatomy, R.N.T. Medical College, Udaipur.

Inclusion Criteria:

Human sacra with complete sacral hiatus were taken for the present study.

Exclusion criteria:

Damaged, mutilated sacra were excluded.

For some morphological parameters viz. level of apex and base of sacral hiatus, the sacra with dorsal wall agenesis were also excluded.

Sample Collection Duration: from October 2019 to October 2020.

Plan of action: Fully ossified and undamaged 80 adult dry human sacra of unknown sex were collected from bone bank of department of anatomy R.N.T. medical college Udaipur after getting approval from Ethical Committee and institutional research board of R.N.T. Medical College. (letter no. RNT/Stat./IEC/2019/125 dated 21.10.2019). Then they were categorized into male (47) and female (33) sacra. After that Morphological features viz. shape of sacral hiatus, level of apex and base of sacral hiatus with respect to sacral vertebrae were observed.

Statistical analysis:

Data were recorded in a predesigned study proforma and were entered in Microsoft excel spreadsheet to prepare master chart. It was further subjected to statistical analysis. Chi Square Test was used and 'p' value <0.05 was taken as significant. Medcalc 16.4 version software was used for all statistical calculations.

III. Result

Table-1: Sex wise distribution of studied human sacra with respect to shape of sacral hiatus

Shape of sacral hiatus	Male		Female		Total	
	No.	%	No.	%	No.	%
Dumbbell	5	10.64	4	12.12	9	11.25
Inverted U	14	29.79	8	24.24	22	27.50
Inverted V	26	55.32	17	51.52	43	53.75
Irregular	1	2.13	3	9.09	4	5.00
Spina Bifida	1	2.13	1	3.03	2	2.50
Total	47	100.00	33	100.00	80	100.00

Chi-square = 2.250 with 4 degrees of freedom; P = 0.690

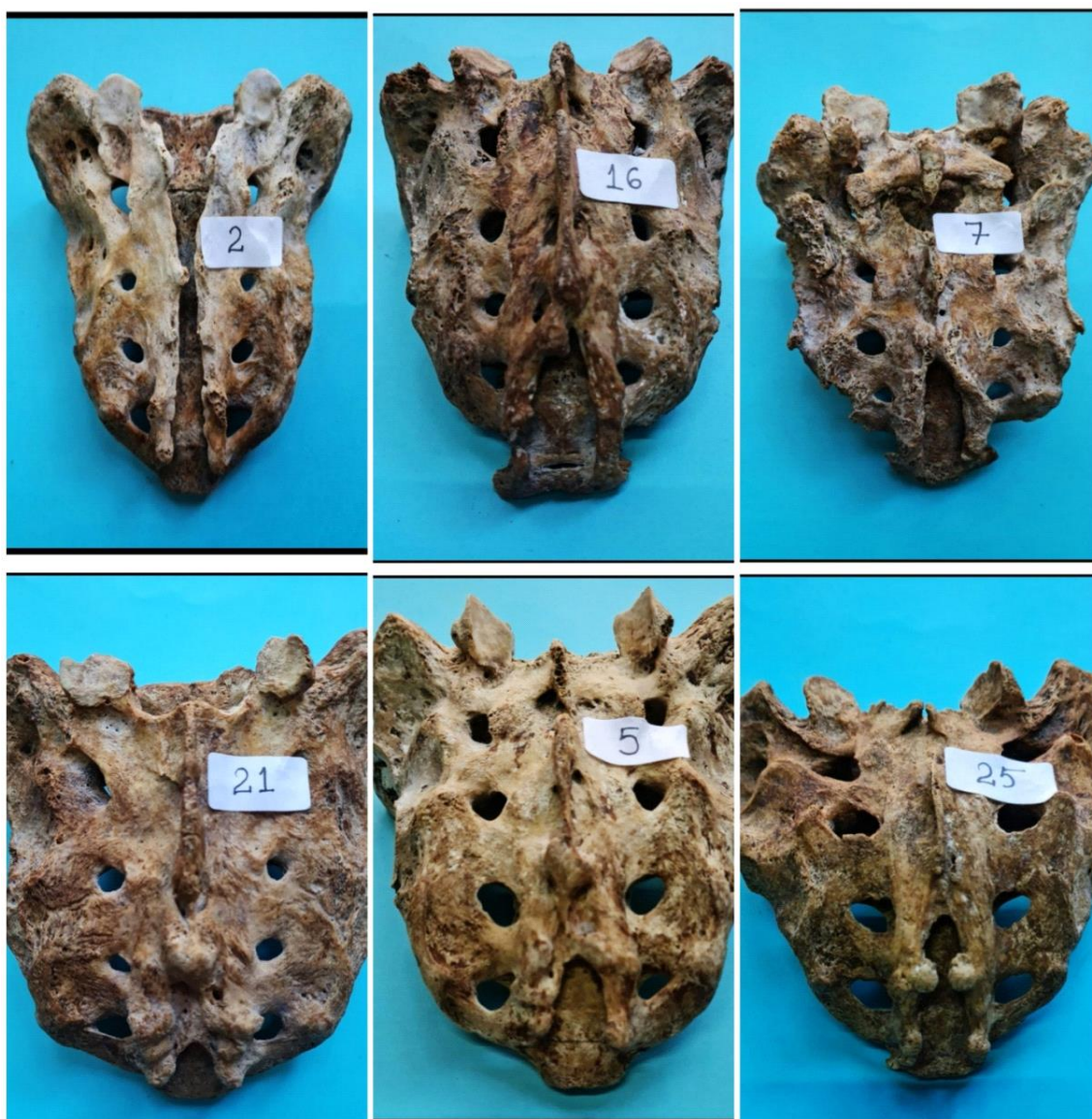
Table no.1 reveals that when sex wise distribution of human sacrum with respect to shape of sacral hiatus was done it was found that Inverted V shape of sacral hiatus was the most common shape to be found in male (55.32%), female (51.52%) and total (53.75%) studied sacra. When chi-square test was applied this difference was not found statistically significant. (p=0.690)

Table-2: Sex wise distribution of studied human sacra with respect to level of apex of sacral hiatus present

Level of apex	Male		Female		Total	
	No.	%	No.	%	No.	%
S2	0	0.00	2	6.25	2	2.56
S3	10	21.74	17	53.13	27	34.62
S4	26	56.52	11	34.38	37	47.44
S5	10	21.74	2	6.25	12	15.39
Total	46	100.00	32	100.00	78	100.00

Chi-square = 13.140 with 3 degrees of freedom; P = 0.005

Table no. 2 shows that when sex wise distribution of sacrum according to presence of level of apex of sacral hiatus was done it was mostly present at the level of 4th sacral vertebra in male (56.52%) and total (47.44%) sacra studied whereas in 53.13% female sacra it was present at the level of 3rd sacral vertebra. This difference was found statistically significant (p=0.005) when statistically compared.



Photograph-1: showing various shapes of sacral hiatus :Dorsal sacral agenesis or Spina bifida(2) Irregular shaped (16) Inverted ‘V’ shaped sacral hiatus with sacralization of L5(7) Inverted ‘V’ shaped (21) Inverted ‘U’ shaped (5) Dumbbell shaped (25)

IV. Discussion

Table-3: Comparison of various shapes of sacral hiatus

Author's Name	Year	Sex	N	Inverted 'U' (%)	Inverted 'V' (%)	Dumb bell (%)	Irregular (%)	Bifid (%)
Nagar SK et al. ⁸	2004		270	41.50	27.00	13.30	14.10	1.50
Aggarwal A et al. ⁹	2009		114	40.30	31.57	-	15.70	4.30
Njihia B N et al. ¹⁰	2011		88	16.70	32.00	31.00	19.00	-
Pal DR et al. ¹¹	2012		160	40.00	27.60	12.50	20.00	-
Clarista M Q et al. ¹²	2013		104	46.20	24.00	6.70	9.60	2.90
Ramamurthi K S et al. ¹³	2013		116	31.00	25.80	5.00	20.60	-
Seema et al. ¹⁴	2013		149	42.95	27.51	13.41	24.00	-
Sinha MB et al. ¹⁵	2014		68	35.93	17.18	7.81	15.62	7.81
Kamal Ahmm et al. ³	2014		172	38.00	35.10	5.30	15.20	0.60
A Y Nasr et al. ¹⁶	2014		150	31.33	38.66	12.00	15.33	2.66
Ukoha U U et al. ¹⁷	2014		83	48.20	34.90	4.80	4.80	4.80
Mishra M et al. ¹⁸	2014		93	50.53	26.90	5.40	11.80	-
Malarvani T et al. ²	2015		100	35.00	32.00	3.00	14.00	2.00

Rajapur Parashuram et al. ⁷	2015		200	50.00	27.50	2.00	15.50	2.00
Chauhan R et al. ¹⁹	2015	M	46	13.00	13.00	-	19.00	1.00
		F	14	5.00	3.00	-	5.00	1.00
Akhtar MD J et al. ²⁰	2016		124	44.36	35.48	4.84	8.87	4.03
Bharathi A et al. ²¹	2016		60	40.00	45.00	1.70	1.70	1.70
Pandey M et al. ²²	2016	M	100	48.00	32.00	2.00	10.00	8.00
		F		64.00	26.00	4.00	6.00	0.00
Punase VK et al. ²³	2016		66	33.33	33.33	-	24.24	3.03
Saha D et al. ²⁴	2016		117	70.09	14.53	0.85	12.82	1.71
Singh P et al. ²⁵	2016		67	22.39	22.39	17.91	19.40	8.96
Pundge SJ et al. ²⁶	2017		103	38.50	34.00	5.00	10.00	3.00
Singh A et al. ²⁷	2017			42.95	27.51	-	9.67	-
Singh H et al. ²⁸	2017		31	41.93	29.03	12.90	13.66	3.22
William FM et al. ²⁹	2017		75	30.66	42.00	10.66	6.00	10.66
Sasikumar R et al. ³⁰	2018		80	66.33	11.30	3.8	11.3	1.3
Ramswaroop PB et al. ³¹	2019		100	39.00	26.00	11.00	5.00	17.00
Mustafa MS et al. ³²	2019	M	22	36.3	22.7	9.1	18.2	0
		F	24	16.67	25.00	33.33	25.00	0
		Total	46	26.00	24.00	22.00	22.00	0
Present study	2020	M	46	29.79	55.32	10.64	2.13	2.13
		F	32	24.24%	51.52	12.12	9.09	3.03
		Total	78	27.50%	55.32	11.25	5.00	2.50

Table no. 3 shows that in the present study Inverted V shape was the commonest shape of sacral hiatus among male, female and total studied sacra. This finding of present study was more or less comparable to study of Bharathi A et al. (2016)²¹ whereas some other author found Inverted U as the commonest shape of sacral hiatus. This variation in the shape of sacral hiatus may be attributed to difference in geographical location, racial variation and variation in sampled population.

Table-4: Comparison of various levels of apex of sacral hiatus with respect to vertebrae

Author's name	Study year	Sex	N	Level of apex of Sacral hiatus			
				S2	S3	S4	S5
Nagar SK et al. ⁸	2004		270	3.40%	37.30%	55.90%	3.40%
Pal DR et al. ¹¹	2012		160	-	45%	50%	5%
Rammurti KS et al. ¹³	2013		116	7.7%	41.3%	50.8%	-
Seema et al. ¹⁴	2013		149	4.03%	35.57%	56.37%	4.03%
Chhabra N et al. ³³	2014		32	6.67%	33.33%	60%	-
Sinha MB et al. ¹⁵	2014		68	-	25%	70.86%	6.45%
Nadeem G et al. ³⁴	2014		100	2%	62%	34%	2%
Ukokha UU et al. ¹⁷	2014		83	2.40%	20.50%	69.90%	4.80%
Akhtar MD J ²⁰	2015		124	2.42%	20.97%	71.77%	4.84%
Sasikumar R et al. ³⁰	2018		80	1.30%	21.30%	76.00%	1.30%
Pulluru UR et al. ³⁵	2020		150	5.3%	44%	46.6%	4.3%
Present study	2020	M	46	0.00	21.28	55.32	21.28
		F	32	6.06	51.52	33.33	6.06
		Total	78	2.50	33.75	46.25	15.00

Table no. 4 reveals that out of total studied sacra, most common level (46.25%) of apex of sacral hiatus was present at the level of 4th sacral vertebra this finding of present study was commensurate with the studies of Pulluru UR et al. (2020)³⁵ Nagar SK et al. (2004)⁸, Pal DR et al. (2012)¹¹, Rammurti KS et al. (2013)¹³ and Seema et al. (2013)¹⁴ while in the study of Nadeem G et al. (2014)³⁴ most common level of apex of sacral hiatus was found at the level of S3 vertebra. This variation in the level of apex of sacral hiatus may be attributed to difference in geographical location, racial variation and variation in sampled population.

V. Conclusion

Sacral hiatus is an important landmark used for the successful caudal epidural anesthesia. Thus the exact localization of the sacral hiatus would help in easy placement of needle into the hiatus so one should be always attentive to anatomical variations of sacral hiatus while performing the caudal epidural block to avoid the failure and the risk of dural puncture.

References

- [1]. Standing S, Gatzoulis MA, Collins P, Healy JC. Gray's Anatomy: The Anatomical Basis of Clinical Practice, 41th Ed. Edinburgh, Elsevier Churchill Livingstone, London, 2016:726-730,739.
- [2]. Malarvani T, Ganesh E, Nirmala P. Study Of Sacral Hiatus In Dry Human Sacra In Nepal, Parsa Region. Int J Anat Res (ISSN 2321- 4287) 2015; 3(1):848-55.

- [3]. Kamal Ahmm, Ara S, Ashrafuzzaman M, Khatun K, Islam MS. Morphometry of sacral hiatus and its clinical relevance in caudal epidural block. *J Dhaka Med Coll.* April 2014; 23(1):31-36.
- [4]. Brailsford JF. Deformities of lumbosacral region of spine. *British Journal of Surgery* 1929; 16: 562 – 570.
- [5]. Sekiguchi M, Yabuki S, Saton K, Kikuchi S. An anatomical study of the sacral hiatus: A basis for successful caudal epidural block. *Clin J Pain* 2004; 20(1): 51-4.
- [6]. Susie Jeyalyn David. Morphometric measurements of sacral hiatus in south indian dry human sacra for safe caudal epidural block. *Int J Anat Res* Sep 2019; 7(3.3):6911-6917.
- [7]. Rajapur Parashuram. Morphometrical study of sacral hiatus in dry human sacra. *International journal of research in medical sciences* July 2015; 3 (7): 1726-1733.
- [8]. Nagar SK. A study of sacral hiatus in dry human sacra. *J Anatomical Soc India.* 2004; 53(2):18-21.
- [9]. Aggarwal A. Morphometry of sacral hiatus and its clinical relevance in caudal epidural block; *Surg Radiol Anat.* Dec 2009; 31(10): 793-800.
- [10]. Njihia B.N, Awori K.O, Gikenye G. Morphology of the sacral hiatus in an African population – Implications for caudal epidural injections. *The annals of African surgery.* January 2011; 7: 20-23.
- [11]. Pal D R, Md. Rahman A, Fatema K. Morphometric study of sacral hiatus: A basis for successful caudal epidural block. *Bangladesh journal of anatomy.* January 2012; 10 (1): 5-10.
- [12]. Clarista M.Q and Gautham K. Morphometrical study of sacral hiatus in dry human sacra in West Indian population. *CIB Tech journal of surgery.* May – August 2013; 2 (2): 56-63.
- [13]. Ramamurthi KS. Anil Kumar Reddy Y. Anatomical study of sacral hiatus for successful caudal epidural block. *International journal of medical research and health sciences.* July – September 2013; 2 (3): 496-500.
- [14]. Seema, Singh M. & Mahajan A. An anatomical study of variations of sacral hiatus in sacra of north Indian origin and its clinical significance. *Int. J. Morphol.* 2013; 31(1):110-113.
- [15]. Sinha MB, Rathore M, Sinha H. A study of variation of sacral hiatus in dry bone in central Indian origin. *International journal of healthcare and biomedical research.* July 2014; 2 (4): 46-52.
- [16]. Nasr AY, Youssef H Ali, Naser A E. The sacral hiatus: An anatomic study on both cadaveric and dry bones. *Translational clinical biology.* 2014; 2 (4): 4-12.
- [17]. Ukoha UU, Okafor JI, Anyabolu AE, Ndukwe GU, Eteudo AN, Okwudibia N J. Morphometric study of the sacral hiatus in Nigerian dry human sacral bones. *Int J Med Res Health Sci. (Jan –Mar)* 2014; 3(1):115-19.
- [18]. Mishra M, Singh AK, Jha S, Satyavathi P, Sah N. Sacral hiatus study in dry human sacra. *Janaki medical college journal of medical sciences.* March 2014; 2 (1): 17-22.
- [19]. Chauhan R, Nagar M. Anatomical profile and morphometric evaluation of human sacral hiatus in north Indians. *Journal of surgical academia.* Jan 2015; 5 (2): 8-12
- [20]. Akhtar MD J, Fatima N, Ritu, Kumar A, Kumar V. A morphometric study of sacral hiatus and its importance in caudal epidural anaesthesia. *International journal of anatomy, Radiology and Surgery* Jan 2016; 5 (1): 6-11.
- [21]. Bharathi, V. Janaki, Veenatai.J. Morphometric variations in sacral hiatus in Telangana region. *International journal of anatomy and research.* 2016; 4 (2): 2175-78.
- [22]. Pandey M. A morphometric study of variations in sacral hiatus of dry human bones. *International journal of anatomy and research.* 2016; 4 (3): 2804-08.
- [23]. Punase V K. Morphometric study of sacral hiatus for caudal epidural block (Ceb) in adult human dry sacrum in central india. *ParipeX- Indian journal of research.* March 2016; 5 (3): 224-227.
- [24]. Saha D, Bhattacharya S, Uzzaman A, Mazumdar S. Morphometric study of variation of sacral hiatus among West Bengal population and clinical implications. *Italian Journal of Anatomy and Embryology;* 2016; 121 (2): 165-171.
- [25]. Singh P, Singh R, Rani A, Diwan R K, Verma R K, Kori D and Tandon S. Morphological and morphometrical study of sacral hiatus in North Indian population; *J. Biol. Chem. Research* Sep 2016 ; 33 (2): 616-628.
- [26]. Pundge SJ, Mane U, Joshi D. Study of sacral index and sacral hiatus – In adult dry sacra. *March* 2017; 1 (3): 57-60
- [27]. Singh R. Anatomical variations of sacral hiatus and associated clinical relevance -A review. *International journal of anatomy.* 2017; 10 (4): 96-98.
- [28]. Singh H, Saxena AK, Prachi S. Study of sacral hiatus in dry human sacrum in north Indian population and its clinical implication in caudal epidural block . *International journal of medical research.* 2017; 3 (5): 174-176.
- [29]. William FM, Jaiswal P, Gupta S, Koser T, Rathore KB. Morphometric study of sacral hiatus in central part of rajasthan& its correlation with caudal epidural block. *Journal of dental and medical sciences.* April 2017; 16 (4): 23-31.
- [30]. R. Sasikumar, K. Praveena Kumara, K. Manivannan, H.R. Krishna Rao. The study on morphological and morphometric analysis of sacral hiatus in dry human sacra. *International journal of anatomy and research.* 2018; 6 (4.1): 5727-32.
- [31]. Pareek Bharti Ramswaroop, Dr. R. P. Busar, Dr.Chitranha Dhakarey, Shilpa Rani, Rahul Sharma, Pankaj Sinsinwar, Devesh Kumar Sharma. A Morphometric and Morphological Study of Sacral Hiatus and its Clinical Significance in Caudal Epidural Anesthesia *International Journal of Science and Research (IJSR)* Feb 2020; 9(2):129-135.
- [32]. Mustafa MS, Mahmoud OM, El Raouf HH, Atef HM. Morphometric study of sacral hiatus in adult human Egyptian sacra: Their significance in caudal epidural anesthesia. *Saudi J Anaesth* 2012; (6): 350-7.
- [33]. Chhabra N. An anatomical study of size and position of sacral hiatus; its importance in caudal epidural block. *Int J of Health Sciences and Research* Nov 2014; 4(12):189-96.
- [34]. Nadeem G. Importance of knowing the level of sacral hiatus for caudal epidural anesthesia. *J. Morphol. Sci* 2014; 31(1): 9-13.
- [35]. Upendhar Reddy Pulluru, M. Venkateshwar Reddy. Human Sacral Hiatus in Dry Bones of Telangana Region & Its Clinical Significance During Caudal Epidural Anesthesia – A Morphological; Morphometrical Study. *Int J Anat Res* July 2020; 8(3.1):7609-7616.