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Original Article

Learning about Dermatome Maps and Innervation of Peripheral Cutaneous Nerves Using OHP film-Overlapping

Mi-Sun Hur[1], Su Jin Chae[2], Sungha Yoon[3], Seunggyu Lee[4], Chang-Seok Oh[5]

[1]*Department of Anatomy, Daegu Catholic University School of Medicine*
[2]*Department of Medical Education, University of Ulsan College of Medicine, Asan Medical Center*
[3]*Institute of Mathematical Sciences, Ewha Womans University*
[4]*Division of Applied Mathematical Science, Korea University*
[5]*Department of Anatomy and Cell Biology, Sungkyunkwan University School of Medicine*

Abstract : Dermatome maps and the illustrations of cutaneous nerve innervation often described together in medical textbooks are difficult for some students to understand their differences and meanings. A novel pedagogical method using commercial limb models covered with white cotton pantyhose was introduced to improve the education around dermatomes and innervation of peripheral cutaneous nerves, which was previously difficult to apply in the classroom as students struggled to handle and store the large commercial models. The method of the present study was developed to solve the difficulties of the method using commercial models, and included transparent overhead projector (OHP) films and A4-sized papers imprinted with dermatome maps and cutaneous nerve maps, respectively. The maps were illustrated on upper and lower limbs with consistent shapes and sizes. These OHP films and papers were provided during class to each student, who were instructed to overlap the transparent OHP films and the papers, which improved their understanding of the differences between dermatomes and cutaneous nerve innervation and their meanings. A feedback survey with a 5-point Likert scale was conducted after the course to determine the utility of this method, and the mean values for effectiveness, satisfaction, understanding, learning engagement, and concentration all exceeded 4.0. These results indicated that the OHP film-overlapping method was useful for learning about dermatome and cutaneous nerve innervation, and it can be applied to other subjects of anatomy education.

Keywords : Dermatome, Peripheral cutaneous nerve, Overlapping method

INTRODUCTION

Dermatome maps and the innervation of peripheral cutaneous nerves are often described together in the upper and lower limbs anatomical sections of medical textbooks. Some students may have difficulty understanding their differences and meanings. It is because several components conjoin into a spinal nerve at the cervical and lumbosacral plexuses, and neighboring dermatomes often

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Correspondence to: Chang-Seok Oh, MD, PhD (Department of Anatomy, Sungkyunkwan University School of Medicine, 2066, Seobu-Ro, Jangan-Gu, Suwon-Si, Gyeonggi-Do, 16419, Republic of Korea)
E-mail: changoh@skku.edu

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overlap. Furthermore, dermatome maps in textbooks or at clinics can differ, further increasing the confusion experienced by students [1-3]. A novel pedagogical method using SOMSO models of upper limb, pantyhose marked with the outlines of dermatomes, and colored transparencies expressing the cutaneous nerve distribution was introduced to improve the simplicity and clarity of the education around dermatomes and innervation of peripheral cutaneous nerves [4]. But the method was previously difficult to apply in the classroom as students struggled to handle and store the large SOMSO models, which also restricted the time and space student want to use after class. Hence, an overhead projector (OHP) film-overlapping method was developed to overcome the difficulties of the method using SOMSO models, with modifying the latter. This method included transparent OHP films and A4-sized paper imprinted with dermatome maps and illustrations of the innervation of peripheral cutaneous nerves, respectively, which made it easier for students to overlap them and comprehend their differences and meanings.

MATERIALS AND METHODS

Textbook images [5] of the innervation of peripheral cutaneous nerves in the upper and lower limbs were scanned and printed in color on A4-sized paper. Upper and lower limbs with identical contours from the textbook were drawn with lines representing dermatomes [6] using Adobe Illustrator (Adobe) and Adobe Photoshop (Adobe). The contours and lines of the dermatomes in the upper and lower limbs were printed onto transparent OHP films.

Approximately 55 students from the Catholic Kwandong University College of Medicine attended the peripheral cutaneous nerve lessons of its anatomy course in the second and third years of their 6-year program. The students were provided with the transparent OHP films with the imprinted contours and dermatomes of the upper and lower limbs and the colored paper print outs of the innervation of peripheral cutaneous nerves on the same limbs. Students were instructed to overlap the transparent OHP films and the colored papers to identify the innervation of peripheral cutaneous nerves within each dermatome (Fig. 1).

Feedback surveys were conducted at the end of the cutaneous nerve of the upper and lower limbs in anatomy course in 2018 and 2019. The survey comprised 2 open-ended and 14 questions (Table 1), the latter of which evaluated objective/expectancy levels (questions 1, 9, and 12), motivation (questions 2, 3, and 6), usefulness (questions 5 and 10), effectiveness (question 11), learning engagement (question 4), concentration (question 8), understanding (question 7), satisfaction (question 13), and teacher effort (question 14) of the OHP film-overlapping method for education of dermatomes and the innervation of peripheral cutaneous nerves. Survey questions scored using a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) were based on the "student class activity" questionnaires from the National Assessment of Student Engagement in Learning [7].

Cronbach's alpha values were calculated to estimate the internal consistency of the survey questions. These values for upper and lower limbs education were 0.95 and 0.95, respectively, for second-year students, and 0.94 and 0.95 for third-year students.

In 2018, 60 third-year students (42 males and 18 females) participated in the survey. Responses related to the upper and lower limbs were obtained from 59 (41 males and 18 females) and 55 students (42 males and 13 females), respectively. In 2019, 54 second-year students (33 males and 21 females) participated in the survey. Responses related to the upper and lower limbs were obtained from 51 (30 males and 21 females) and 50 students (29 males, and 21 females), respectively (Table 2).

RESULTS

The survey results indicated that the OHP film-overlapping method received a positive reception from the students. The scores for the upper limbs in 2018 and 2019 were 4.2 ± 0.7 and 3.9 ± 0.6, respectively, for objective/expectancy level, 4.1 ± 0.8 and 4.0 ± 0.7 for motivation, 4.4 ± 0.6 and 4.1 ± 0.7 for learning engagement, 4.3 ± 0.7 and 4.1 ± 0.7 for usefulness, 4.3 ± 0.7 and 4.1 ± 0.7 for understanding, 4.2 ± 0.8 and 4.0 ± 0.8 for concentration, 4.4 ± 0.7 and 4.2 ± 0.7 for effectiveness, 4.4 ± 0.6 and 4.3 ± 0.6 for satisfaction, and 4.3 ± 0.8 and 4.3 ± 0.8 for teacher effort (Figs. 2A and B). The scores for the lower limbs in 2018 and 2019 were 4.0 ± 0.6 and 4.0 ± 0.6, respectively, for objective/expectancy level, 3.9 ± 0.7 and 4.0 ± 0.7 for motivation, 4.1 ± 0.7 and 4.1 ± 0.7 for learn-

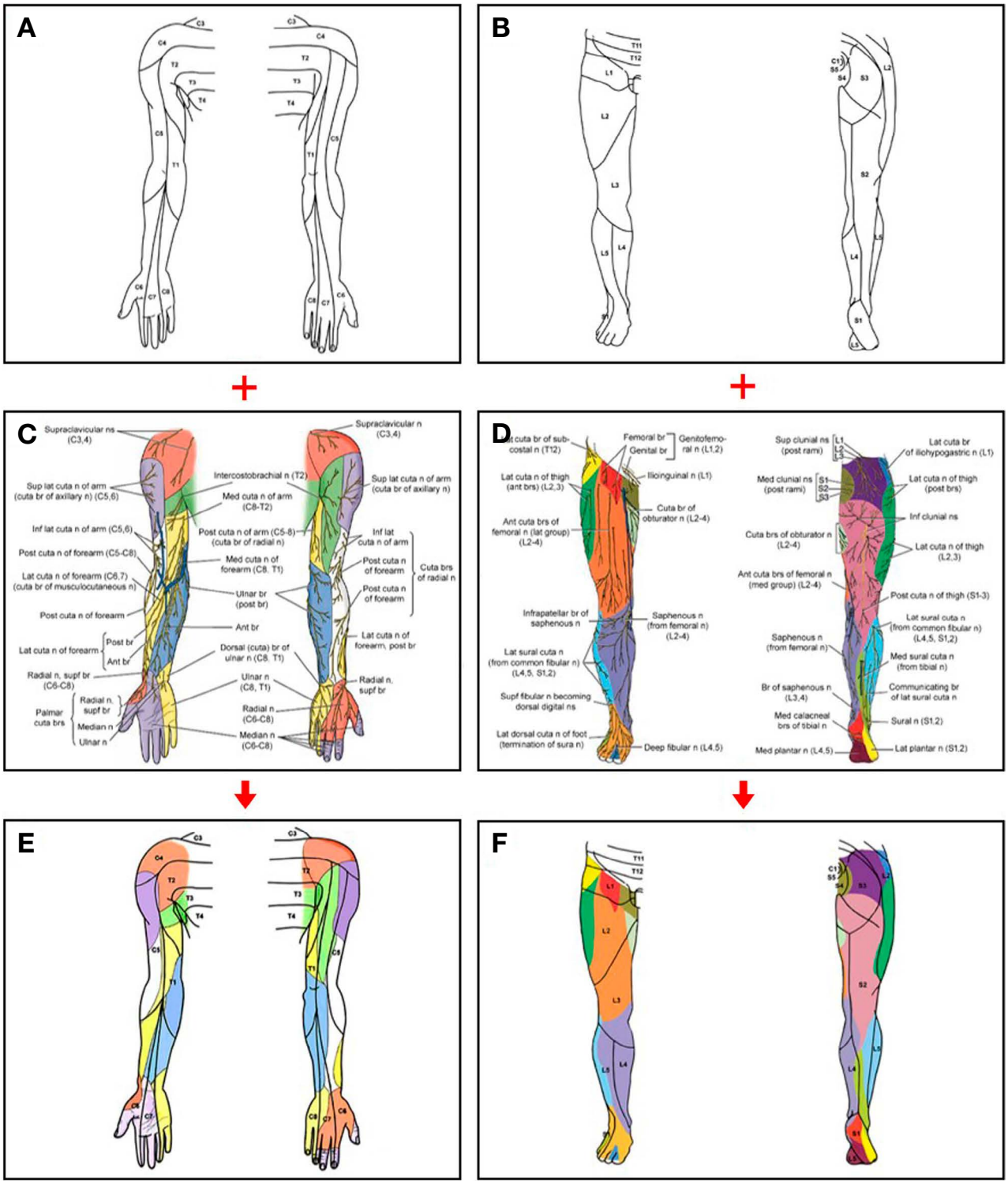

Fig. 1. OHP film-overlapping method for the upper and lower limbs. The students were provided with transparent OHP films containing printed contours and dermatomes for the upper (A) and lower (B) limbs, and colored papers with the innervation of peripheral cutaneous nerves for the upper (C) and lower (D) limbs. Students were instructed to overlap the transparent OHP films and the colored papers to identify the innervation of peripheral cutaneous nerves in each dermatome of the upper (E) and lower (F) limbs. ant, anterior; br, branch; brs, branches; cuta, cutaneous; lat, lateral; med: medial; n, nerve; ns, nerves; post, posterior.

Table 1. Survey questionnaire on learning about dermatome maps and the innervation of peripheral cutaneous nerves using the OHP film-overlapping method

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. I think that the objective and expectancy level of the class using OHP film-overlapping method was clear.	①	②	③	④	⑤
2. The class using OHP film-overlapping method was enjoyable.	①	②	③	④	⑤
3. I think that the OHP film-overlapping method was helpful to make me interested in the class activities.	①	②	③	④	⑤
4. I actively participated in the class since the OHP film-overlapping method was a new method.	①	②	③	④	⑤
5. I think that I could learn a lot from the OHP film-overlapping method.	①	②	③	④	⑤
6. I think that the OHP film-overlapping method motivated me to study anatomy.	①	②	③	④	⑤
7. I think that the OHP film-overlapping method was helpful to understanding the lecture.	①	②	③	④	⑤
8. I think that the OHP film-overlapping method made me focus on the class.	①	②	③	④	⑤
9. The subject that I learned from the OHP film-overlapping method was my favorite one.	①	②	③	④	⑤
10. I think that what I learned in this class is useful.	①	②	③	④	⑤
11. I think that the OHP film-overlapping method would be more effective to understand the dermatome and cutaneous nerve innervation than the class not using the OHP film-overlapping method.	①	②	③	④	⑤
12. I recommend the OHP film-overlapping method to be maintained for the class next year.	①	②	③	④	⑤
13. I am generally satisfied with the OHP film-overlapping method.	①	②	③	④	⑤
14. I think that the anatomy teacher made efforts to understand students' difficulties in studying anatomy.	①	②	③	④	⑤

Table 2. Demographics of the participating students

Year	Sex	N	Age
2018	Male	42	22.1±1.7
	Female	18	22.5±2.8
2019	Male	33	21.9±2.1
	Female	21	20.9±1.3

ing engagement, 4.0±0.7 and 4.1±0.6 for usefulness, 4.2±0.7 and 4.1±0.6 for understanding, 4.1±0.7 and 4.1±0.6 for concentration, 4.1±0.7 and 4.2±0.7 for effectiveness, 4.2±0.7 and 4.2±0.6 for satisfaction, and 4.4±0.7 and 4.3±0.7 for teacher effort (Figs. 2C and D). There were no significant differences in all subjects between the 2018 and 2019 classes, male and female students, or the upper and lower limbs. Many students stated in open comments that the most beneficial aspect of the OHP film-overlapping method was its helpfulness in improving their intuitive understanding and facilitating their ability to make comparisons of dermatomes and cutaneous nerve maps at a glance.

DISCUSSION

Since the proposal of the first dermatome map one century ago, which was based on clinical observations of herpes zoster eruptions [8], other maps have also been developed based on clinical observations of anesthesia after

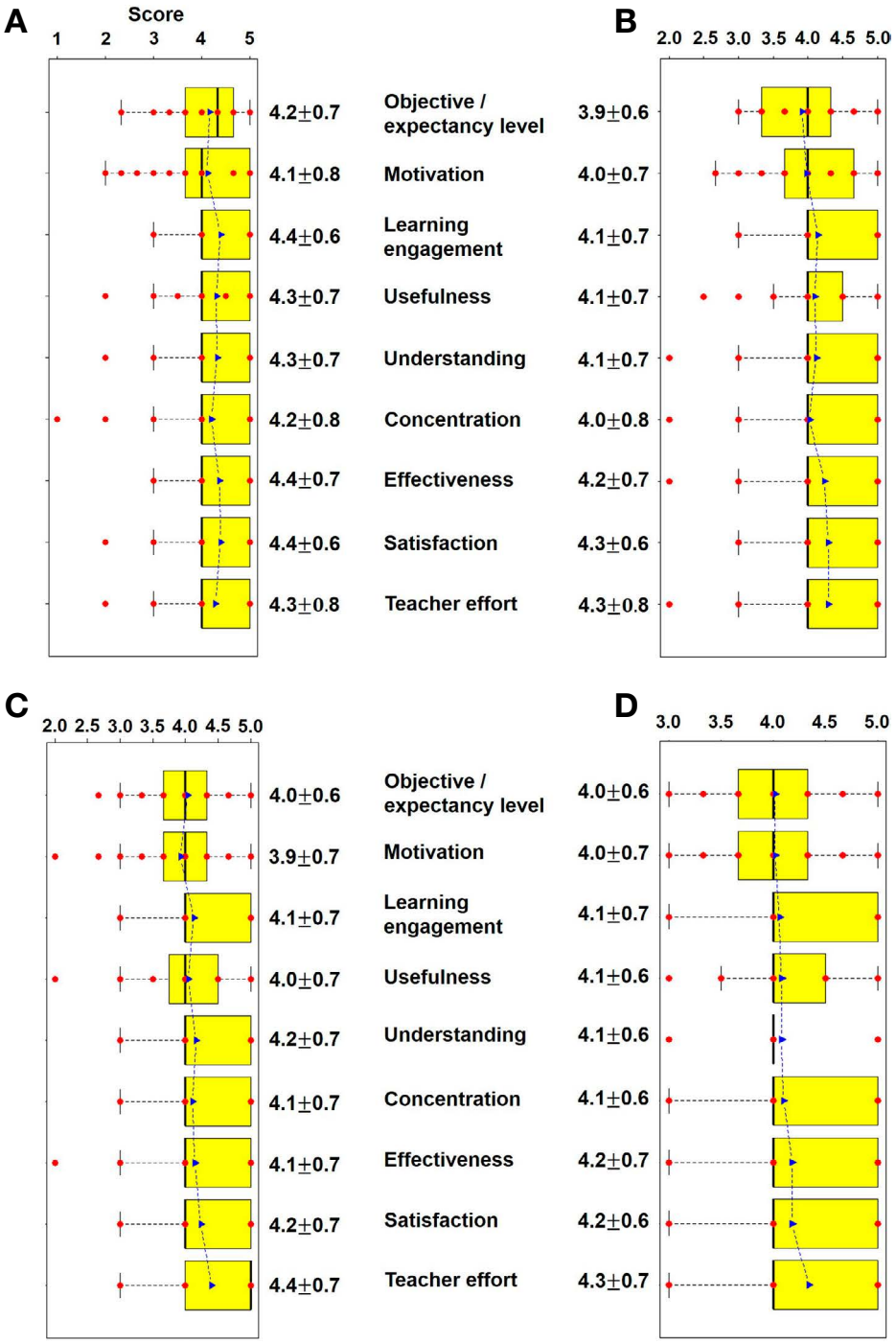

Fig. 2. Results of the feedback survey. Data are presented as mean±SD values of the 5-point Likert scale scores (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) for both the upper and lower limbs. A: Third-year students in 2018 for the upper limb. B: Second-year students in 2019 for the upper limb. C: Third-year students in 2018 for the lower limb. D: Second-year students in 2019 for the lower limb.

rhizotomy, hypoalgesia due to a single nerve root being compressed by a herniated disc, or single-root anesthesia [6,9]. The latter two maps have been referred to numerous times in anatomy and physical therapy textbooks [1,2], and an evidence-based map was introduced by Lee et al. (2008) [1]. This evidence-based map was based on isolating a

single dorsal nerve root, dividing several adjacent dorsal nerve roots, electrical skin stimulation, herpes zoster reactivation, and local anesthetic spinal nerve block. However, inconsistencies were observed among the dermatome maps, which adversely affects the knowledge and confidence of students [3]. Moreover, dermatome maps are often described next to cutaneous nerve maps of the upper and lower limbs in anatomy textbooks, which may make the difference between dermatomes and cutaneous nerve innervation confusing for novice learners. This is because dermatome maps illustrating the areas of skin innervated by each spinal nerve differ from cutaneous nerve maps showing the areas of skin innervated by each peripheral cutaneous nerve.

To reduce the above-mentioned confusion, and to facilitate student understanding of a three-dimensional (3D) integration of dermatomes and peripheral cutaneous nerve distribution, a novel teaching tool was developed that included commercially available models, pantyhose marked with outlines of dermatomes, and colored transparencies to mimic cutaneous nerve distribution [4]. The authors of the present study developed a new method with modifying the original method using the commercial models, which consisted of transparent OHP film depicting the dermatome map and A4-sized paper depicting the cutaneous nerve map of consistent size and shape of limbs. This approach was prompted based on the limitations of the original method in terms of how students handle and store the anatomical models in the classroom. These OHP films and papers were provided during class to each student, who were instructed to overlap them. During the overlapping process, students appeared to understand the relationship and differences between dermatomes and cutaneous nerve innervation by observing the two maps with a single glance. In the open comments of the feedback survey, the intuitive understanding and overlapping comparisons were most frequently described to improve the effectiveness of the current method. In these comments, some students mentioned that "it was enjoyable" or "helpful for memory." Regardless of the year (class of 2018 or 2019) and parts of the upper and lower limbs, the results of the 14 feedback survey questions were also fairly positive for all evaluation items. The mean student satisfaction value scored the highest in upper limb survey of 2019 and 2018 classes, and the second highest just below teacher effort in lower limb survey of both classes.

LIMITATIONS OF THE STUDY

The present study had several limitations. There was no control group due to the smallness of the sample (~60 students) and since the superiority of using the experimental OHF film-overlapping method would have unethically disadvantaged any students or classes assigned to a control group. Any correlation between the survey results and examination scores could also not be evaluated since the survey was conducted anonymously.

CONCLUSIONS

The OHP film-overlapping method was satisfactory for the education of cutaneous nerve innervation with no financial burden, and students easily referred to the materials of OHP films and papers at any time and place they want after class. This method can be easily adopted by anatomy teachers in other institutes, and applied to other subjects of anatomy education.

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