Estimados alumnos,

La Universidad de Málaga ha editado un CD-Rom multimedia interactivo en titulado *"Album de signos radiológicos"* que en mi opinión es una excelente puerta de entrada para la Semiología (signos y síntomas en las imágenes radiológicas).

Los autores nos lo han cedido para la que podamos utilizarlo durante este curso.

Aunque la información que te envio está en una revista de nuestro área en inglés, el CD-Rom esta realizado en español.

Saludos cordiales

Informatics in Radiology (*info*RAD)

Album of Radiologic Signs: A Useful Tool for Training in Radiologic Semiology[1]

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The importance of radiologic semiology can be seen from the large number of articles, books, and Web pages dealing with radiologic signs. Recognition of these signs forms an important part of the training process for radiologists. Computer-assisted instruction complements traditional techniques for teaching radiology and provides an appropriate method of collecting, organizing, and presenting radiologic signs. A computer application that includes more than 350 radiologic signs has been created with Microsoft PowerPoint (version 2002 for Windows). The user can navigate freely to see the signs from a menu that provides access according to anatomic region or from an interactive dictionary that includes 779 terms. From the presentation of each sign, the user can access one or more representative images, information about the examination wherein the sign appears, an explanation of the meaning of the sign and the corresponding diagnosis, additional comparative images (pathologic or normal), and relevant references. This album of radiologic signs is a useful tool for training in radiologic semiology and also allows a quick consultation based on the name of the sign. Although designed for interns and residents, it will also be useful in pregraduate teaching of radiology, as a reference, and in continuing medical education.

RadioGraphics

Introduction

Ever since computers were first used for educational purposes in the 1960s, radiology has been in the vanguard of computer-assisted learning in the field of medicine (1). This is because our specialty is essentially visual and has long involved up-to-date techniques, including those related to information technology. Several different types of computer-assisted learning programs have been developed for the various disciplines involved in radiology, mainly because of advances in the design of these programs, which allow them to be used by laypersons rather than just by expert computer programmers. These computer-assisted education programs are an adjunct to the more traditional teaching methods (2).

Almost 20 years ago, the Association of American Medical Colleges recommended the inclusion of computer science in the curriculum (3). Actually, computer applications take up part of the day-to-day practice of radiology, including teaching and learning. In Spain, several university departments of radiology are currently researching the subject of computer-assisted education, resulting in the publication of various doctoral theses (1,4,5).

We describe herein a hypermedia teaching tool based on a large collection of radiologic signs and designed to teach radiologic semiology. While multimedia is a way of presenting computer data in multiple formats, such as text, illustrations, sound, and animation, to help with attention to and retention of new information, the term *hypermedia* refers to a nonlinear, branched presentation that allows the user to navigate more freely and variably than multimedia (6).

The increasing interest surrounding knowledge of radiologic signs is evident. Since January 1998, the journal *Radiology* has published a section devoted to semiology called "Signs in Imaging," and many books have been published on the subject, one of the most important being Eisenberg's (7)

TAKE-HOME POINTS

- Recognition of radiologic signs forms an important part of learning radiology.
- To our knowledge, this is the largest and most complete collection of signs and the first dictionary of radiologic signs.

atlas of radiologic signs. Interesting Internet Web sites also exist, such as the "Interactive Atlas of Signs in Musculoskeletal Radiology" by Gentili et al (8). There is no doubt that the visual memory plays an important part in learning to recognize radiologic signs. Therefore, the aim of our radiologic album is to help the user recognize radiologic signs as easily as he or she recognizes a friend or relation from a photographic album.

Materials and Methods

The first step consisted of the search for signs from over 50 relevant books and journals, as well as from general and specialized Internet search engines, such as the online editions of *Radiology*, *RadioGraphics*, and the *American Journal of Roentgenology* (AJR). In order to organize and manage all the information, a database was created in Lotus Approach (Version 9 for Windows) (International Business Machines, Armonk, NY) with the following fields: name of the sign in Spanish, name of the sign in English, anatomic region, bibliographic reference, description of the sign, related signs, and number of images corresponding to the sign.

The database currently includes a total of 779 registries, corresponding to 684 different radiologic signs. All the various imaging techniques are represented, except for scintigraphy, which in Spain comes under a different specialty, named *nuclear medicine*. There are more registries than signs because some signs have more than one name (eg, Rigler's sign or double wall sign) and others have more than one translation in Spanish.

The second step involved the search for images. Over 3,000 radiographic images and patient charts were reviewed to obtain the images corresponding to the different signs. Other images were kindly provided by specialists in different radiologic fields from their personal files. Images corresponding to unusual diseases, such as the "black pleura" sign in alveolar microlithiasis, were found on the Internet. The owners of all images used have given their permission to include them in the album.

A second database was created for these images, again in Lotus Approach, with the following fields: number of photographs, technique (type of radiologic study), name of the sign, name of the patient, chart number, study number (computed tomography or magnetic resonance imaging), other data referring to the location of the original image, and observations (about such things as the

Figure 1. Start-up screen for the program, from which the user can choose one of several possibilities.

Figure 2. Screen shows the main menu with its six groups corresponding to different anatomic regions.

quality of the image). Over 1,500 photographs were taken, of which some 400 were rejected for poor quality or lack of pedagogical interest. The photographs were all taken with a digital camera (Camedia C920 Zoom, 1.3 megapixel, standard quality; Olympus Imaging, Tokyo, Japan), and the computer programs Camedia Master 1.1 (Olympus Imaging) and Paint Shop Pro (Version 7 for Windows) (Corel, Minneapolis, Minn) were used to upload the photographs into a computer file. When necessary, the images were retouched with PhotoShop (Version 6.0 for Windows) (Adobe Systems, San Jose, Calif) in order to improve their quality (eg, convert to scale of grays, modify the brightness or contrast, trimming, modify the size), obtain more central views, or convert the file format to reduce the amount of computer memory required. Most of the images are in Joint Photographic Experts Group (JPEG) format.

Finally, the teaching presentation was designed by using PowerPoint (Microsoft, Redmond, Wash). The whole application consists of 395 linked files, organized in 21 folders and subfolders, occupying 630 MB. PowerPoint was chosen for its user-friendliness, both for designing the program and from the viewpoint of the end user. High-quality images, sound, and animation can all be incorporated into the several different components of each slide; transitions and links can be made to other files, presentations, or programs; and all the interface elements can be designed.

The presentation shows 353 of the 684 signs available. Unusual signs, signs relating to unusual diseases, and signs found with obsolete imaging techniques are not included.
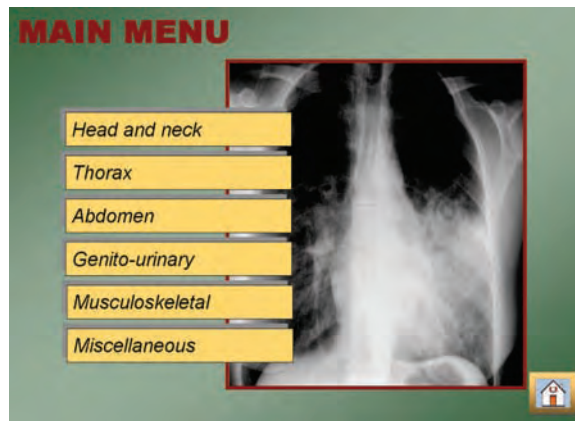
Navigation around the Application

After an initial welcoming slide giving the name of the program and the author, the user is invited to enter and access the start screen (Fig 1). Different buttons then provide access to the various sections:

1. Presentation: a brief explanation of the aims and content of the album and how to navigate around the various screens.

2. Bibliography: a text document with all the bibliographic references used.

3. About: a screen describing the materials and methods used.

4. Acknowledgments: a text document with a list of the persons who have contributed images and technical or other help.

5. Main menu: described later.

6. Dictionary of signs: the first screen of the dictionary, showing links to the letters from A to Z.

7. Exit: to leave the program.

The different signs can be accessed in two ways, either via the dictionary or via the main menu (Fig 2). The main menu is organized by anatomic region and the signs are classified, for teaching purposes, into six groups, most with subgroups:

1. Head and neck.

2. Thorax (lung, mediastinum and hila, pleura and chest wall).

3. Abdomen—general and digestive (nonobstructive digestive diseases; obstructive disease and abnormal lumenogram; liver, gallbladder, and spleen; abdominal cavity, mesentery, and abdominal wall).
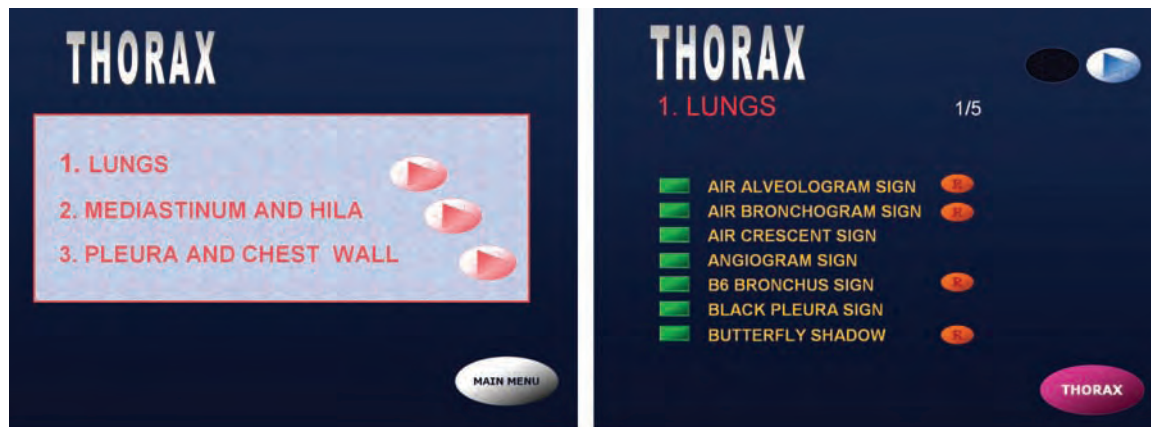
a.

b.

Figure 3. **(a)** Screen for the anatomic region of the thorax shows its subdivisions. After selecting an anatomic region, the user is presented with a subclassification giving further choices. At the bottom right, there is a button for returning to the main menu. **(b)** Screen for the thorax and the subdivision of the lungs. This is the first of various pages (five in this example) listing signs related to the subgroup. The rectangular green buttons on the left lead to the presentations of the signs. The oval orange buttons on the right labeled with an *R* lead to groups of related signs. At the top right, there are buttons for going forward and back to the other pages. Because this is the first of five pages, the back button is dulled out to show that it is unavailable. At the bottom right is a button for returning to the previous screen.
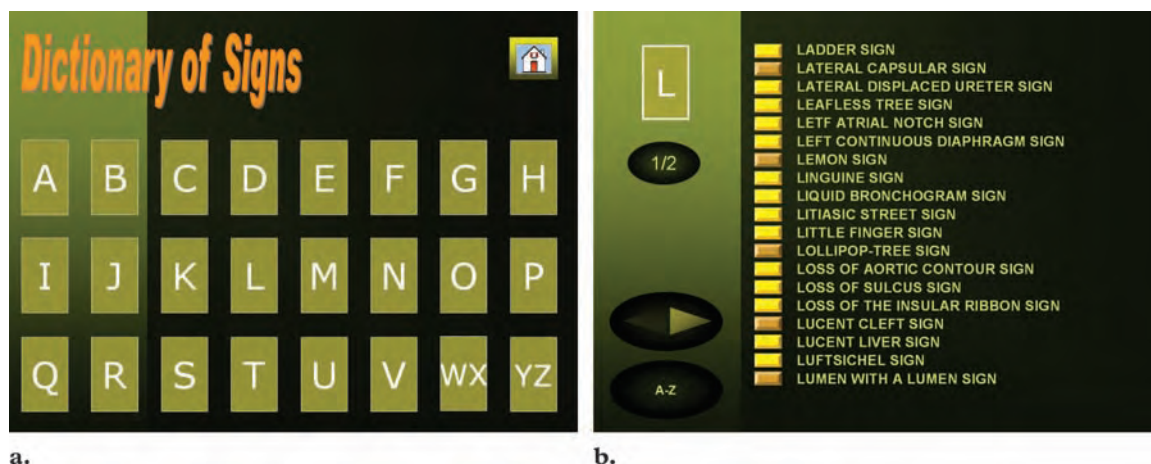

a.

b.

Figure 4. **(a)** Screen for the main dictionary page. Selecting any letter displays the list of signs beginning with that letter. At the top right is a button for returning to the previous screen. **(b)** Screen shows the first of two pages listing signs beginning with the letter *L*. The yellow buttons lead to the presentations of individual signs. The brown buttons each lead to another screen with further information about that sign.

4. Genitourinary (kidney and ureter, bladder and pelvic organs).

5. Musculoskeletal (skull and spine, rest of the skeleton and soft tissues).
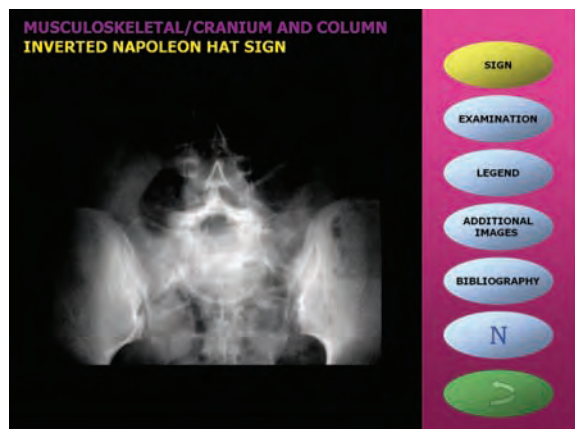
6. Miscellaneous (vascular, other).

The user advances from the main menu via the different groups and subgroups (Fig 3a) to the list of relevant signs in alphabetical order (Fig 3b). From here, the user can access any particular sign via a rectangular green button to the left of the name. Some signs have a circular button to the right with an "R," leading to families of related

signs (ie, groups of signs associated with the same disease), for instance, pneumoperitoneum or thromboembolism.

All the signs can also be accessed straight from the dictionary (Fig 4). Those signs with images selected for presentation according to anatomic region are accessible via a yellow button to the left of the sign. Signs without accompanying images can be accessed via a brown button, which leads to a list relating the name to its examination and disease.
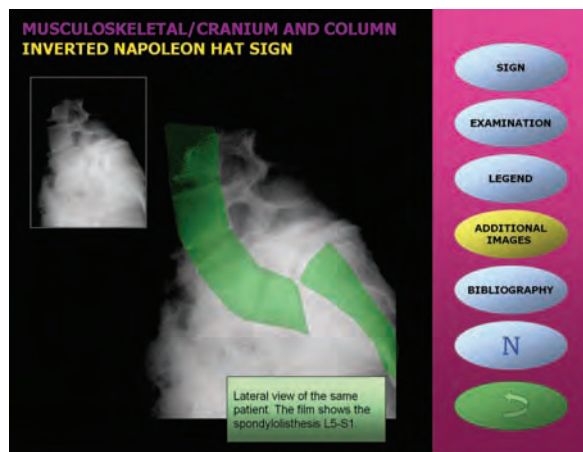
The presentations of each sign all have a similar structure (Fig 5a). At the top are the anatomic location and the name of the sign. The image it-

a.
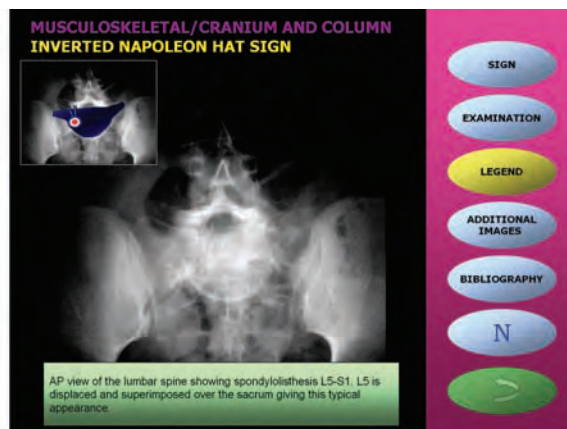
b.

c.

Figure 5. **(a)** Screen shows the first page of the presentation for the inverted Napoleon hat sign. The anatomic group and subgroup are given at the top. The initial screen shows just the sign with no additional information or arrows. To the right is a panel of buttons with the yellow button at the top highlighted. **(b)** Screen shows an explanatory legend added to the previous screen. The inset image shows the inverted "hat" over the sacrum. **(c)** Screen shows some of the additional images that are available. These show a lateral view of the same patient with spondylolisthesis and an explanatory text, with the spinal displacement shown in green.

self occupies most of the screen. To the right is a panel of seven buttons that link to the remaining pages of the presentation. The button corresponding to the page selected is highlighted in a different color (the Sign button in Fig 5a).

The Examination button provides further information concerning the study shown. The Legend button (Fig 5b) describes the sign, its importance, and the diagnosis or differential diagnosis. As well as the explanatory texts, there are also moving arrows, schemes, animations, and other elements that facilitate comprehension of the sign.

Most of the presentations of signs have additional images showing other projections, imaging techniques, and patients. These images also include an explanatory text and pointing elements (Fig 5c). In those presentations of signs that have no additional images, the relevant button is not active and is dulled out. The Bibliography page shows a small notebook with one or two important references.

A button with the letter "N" links to a normal image in a healthy subject. Finally, a button with an arrow closes that particular presentation and returns us to the start point (main menu or dictionary).

As it is important that the users know at all times where they are in the presentation, help in navigation is always available via buttons, such as ones allowing the user to go forward, go back, return to the main menu, and go back to the relevant group or subgroup.

Discussion

Computer-assisted training is a didactic method that provides an important source of information that complements but does not replace traditional methods of teaching radiology, such as books, radiographic files, and direct instruction from a professor (2,9).

Multimedia and hypermedia presentations have certain advantages. They allow the student to control the pace and content and can be used at any time and in almost any place (10,11); the user can adjust the content to his or her level of knowledge (12); unlike with traditional passive methods, the user is actively involved in the process (2); and the programs can easily be updated (2,13).

RadioGraphics

This album of radiologic signs is a useful tool for training in radiologic semiology, as it enables the user to easily learn the meaning of the signs included in it, allowing comparing abnormal images to normal ones. Additionally, the dictionary provides the possibility of a quick consultation from the name of the sign.

Although the application was designed with interns and residents in mind, this unique program, with the largest and most complete collection of radiologic images to date and the first to contain a dictionary of radiologic signs, will also be of use in the pregraduate teaching of radiology, as a work of reference, and in continuing medical education.

Studies on the users' relationship with the application (easy of use, interactivity, quality of images, comprehension, etc) and on its effectiveness in the learning process are being carried out.

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