Sheathless Guide, Rapid Exchange Dilator and Associated Methods

Dilators, such as rapid exchange dilators, configured for percutaneous access are disclosed. The dilator may be configured to be disposable within, or couplable with, a catheter. In some embodiments, the dilator, or the coupled dilator and the catheter, may be configured such that a sheath is not required for percutaneous access. In other embodiments, the dilator may comprise a plug such that a guide wire may be directed from a distal end of the dilator through a port, such as a rapid exchange port, in a side-wall of the dilator. The plug may also be configured to permit passage of fluid through a lumen of the dilator while inhibiting passage of the guide wire through a length of the dilator.
SHEATHLESS GUIDE, RAPID EXCHANGE DILATOR AND ASSOCIATED METHODS

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 61/870,082, filed on August 26, 2013 and titled "Rapid Exchange Dilator and Associated Methods," which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to dilators configured for percutaneous access. The disclosed dilators may also be disposable in, and/or couplable with, catheters for use during vascular procedures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The embodiments disclosed herein will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. These drawings depict only typical embodiments, which will be described with additional specificity and detail through use of the accompanying drawings in which:

[0004] Figure 1 is a perspective view of a first embodiment of a dilator.
[0005] Figure 2A is a perspective view of a distal portion of the dilator of Figure 1.
[0006] Figure 2B is a top view of the distal portion of the dilator of Figure 1.
[0007] Figure 2C is a cross-sectional view of the portion of the dilator of Figure 2B taken through line 2C-2C.
[0008] Figure 2D is a cross-sectional view of the portion of the dilator of Figure 2C taken through line 2D-2D.
[0009] Figure 3A is a perspective view of a distal portion of a second embodiment of a dilator.
[0010] Figure 3B is a top view of the portion of the dilator of Figure 3A.
[0011] Figure 3C is a cross-sectional view of the portion of the dilator of Figure 3B taken through line 3C-3C.
[0012] Figure 3D is a cross-sectional view of the portion of the dilator of Figure 3C taken through line 3D-3D.
[0013] Figure 4A is a perspective view of a distal portion of a third embodiment of a dilator.
[0014] Figure 4B is a top view of the portion of the dilator of Figure 4A.
[0015] Figure 4C is a cross-sectional view of the portion of the dilator of Figure 4B taken through line 4C-4C.
[0016] Figure 4D is a cross-sectional view of the portion of the dilator of Figure 4C taken through line 4D-4D.
[0017] Figure 5A is a perspective view of a distal portion of a fourth embodiment of a dilator.
[0018] Figure 5B is a top view of the portion of the dilator of Figure 5A.
[0019] Figure 5C is a cross-sectional view of the portion of the dilator of Figure 5B taken through line 5C-5C.
[0020] Figure 5D is a cross-sectional view of the portion of the dilator of Figure 5C taken through line 5D-5D.
[0021] Figure 6A is a perspective view of a distal portion of a fifth embodiment of a dilator.
[0022] Figure 6B is a top view of the portion of the dilator of Figure 6A.
[0023] Figure 6C is a cross-sectional view of the portion of the dilator of Figure 6B taken through line 6C-6C.
[0024] Figure 6D is a cross-sectional view of the portion of the dilator of Figure 6C taken through line 6D-6D.
[0025] Figure 7A is a perspective view of a distal portion of a sixth embodiment of a dilator.
[0026] Figure 7B is a top view of the portion of the dilator of Figure 7A.
[0027] Figure 7C is a cross-sectional view of the portion of the dilator of Figure 7B taken through line 7C-7C.
[0028] Figure 7D is a cross-sectional view of the portion of the dilator of Figure 7C taken through line 7D-7D.
[0029] Figure 8 is a perspective view of an embodiment of a vascular access system.
[0030] Figure 9 is a perspective view of a portion of the vascular access system of Figure 8.
Figure 10A is a view showing introduction of a needle into a vessel.

Figure 10B is a view showing introduction of a first guide wire into the vessel through a lumen of the needle.

Figure 10C is a view showing removal of the needle from the vessel.

Figure 10D is a view showing threading of a proximal end of the first guide wire through a distal end of a dilator wherein the dilator is disposed within a catheter.

Figure 10E is a view showing disposition of the dilator and the catheter in the vessel.

Figure 10F is a view showing removal of the first guide wire from the vessel.

Figure 10G is a view showing removal of the dilator from the vessel.

Figure 10H is a view showing disposition of a second guide wire through the catheter.

Figure 10I is a view showing disposition and visualization of the disposition of a distal end of the catheter at a therapy site.

Figure 10J is a view showing performance and visualization of the performance of a vascular procedure at the therapy site.

Figure 10K is a view showing removal of the catheter from the vessel.

**DETAILED DESCRIPTION**

A dilator may be configured for percutaneous access. Percutaneous access may be made at an artery, such as the brachial artery, femoral artery, radial artery, carotid artery; a vein such as the jugular vein; or another physiological feature, including other locations of the vasculature. The dilator may be configured to be disposable within, or couplable with, a catheter. In some embodiments, the dilator, or the coupled dilator and catheter, may be configured such that a sheath is not utilized during percutaneous access. Percutaneous access may allow introduction of a medical device into a vessel of a patient and disposition of the medical device at or adjacent a therapy site within the vessel. Introduction of a medical device into a vessel may be used for performance a vascular procedure. Medical devices that may be introduced into a vessel include, but are not limited to, atherectomy devices (i.e., rotoblades), aspirators, balloon catheters, diagnostic catheters, guiding catheters, interventional catheters, snares, and stents.
[0043] It will be readily understood by one of skill in the art having the benefit of this disclosure that the components of the embodiments, as generally described and illustrated in the figures herein, could be arranged and designed in a variety of configurations. Thus, the following more detailed description of various embodiments, as represented in the figures, is not intended to limit the scope of the disclosure, but is merely representative of various embodiments. While the various aspects of the embodiments are presented in drawings, the drawings are not necessarily drawn to scale unless specifically indicated.

[0044] The phrases "connected to," "coupled to," and "in communication with" refer to any form of interaction between two or more entities, including mechanical, electrical, magnetic, electromagnetic, fluid, and thermal interaction. Two components may be coupled to each other even though they are not in direct contact with each other. For example, two components may be coupled to each other through an intermediate component.

[0045] As used herein, the term "dilator" refers to an elongate medical device configured to expand or enlarge an opening in a vessel as the dilator is advanced through the opening. Therefore, in some embodiments, a dilator may comprise a taper at a first end. In certain embodiments, a dilator may be utilized in combination with a catheter and/or sheath. A dilator may also be stiffer than a catheter and/or sheath. A relatively stiff dilator may be configured to facilitate advancement of a relatively flexible catheter through the wall of a body lumen. Still further, a tapered dilator may be configured to provide a smooth transition between the outside diameter of a guide wire and the outside diameter of a catheter (and/or sheath) as the dilator and catheter (and/or sheath) is advanced along the guide wire into a body lumen.

[0046] The terms "proximal" and "distal" refer to opposite ends of a medical device. With respect to dilators and vascular access systems disclosed herein, the proximal end refers to the end nearest a practitioner when the device is in use.

[0047] Figure 1 is perspective view of a first embodiment of a dilator 100, which may be configured as a rapid exchange dilator. In some embodiments, the dilator 100 may be flexible, plastic, and/or pliable. In the illustrated embodiment, the dilator 100 comprises an elongate member 102, wherein the elongate member 102
comprises both a proximal end 104 and a distal end 106. In some embodiments, the dilator 100 may comprise a lumen 108 disposed within at least a portion of the elongate member 102. The illustrated dilator 100 further comprises a port 110, which may be configured as a rapid exchange port, disposed in a sidewall of the elongate member 102, wherein the port 110 may be in fluid communication with the lumen 108. As illustrated, the port 110 is elongate. In other embodiments, the port 110 may be circular, rectangular, square, triangular, or otherwise shaped. Ports 110 of any size and/or shape are within the scope of this disclosure. In other embodiments, there may be more than one port 110, for example, there may be two ports, three ports, four ports, and so on. In some embodiments, the lumen 108 may extend from the proximal end 104 to the distal end 106 of the elongate member 102, or the lumen 108 may extend through only a portion of the elongate member 102. In other embodiments, there may be more than one lumen 108, for example, there may be two lumens, three lumens, four lumens, and so on.

[0048] In some embodiments, at least a portion of the dilator 100 may be radiopaque. For example, the dilator 100 may comprise one or more radiopaque bands 124. The radiopaque bands 124 may assist a practitioner in determining and/or visualizing the location or position of the dilator 100 within a patient. For example, the practitioner may use a fluoroscope, or other imaging device, to visualize the location of the dilator 100 within the vasculature of the patient by locating the positions of the radiopaque bands 124. In some embodiments, the radiopaque bands 124 may be positioned at predetermined points along a length of the dilator 100. For example, a radiopaque band 124 may be positioned at or adjacent to the distal end 106 of the dilator 100 as illustrated in Figure 1.

[0049] Also, the distal end 106 of the illustrated dilator 100 is tapered. Other configurations of the dilator 100, however, such as a dilator lacking a tapered end or a dilator comprising a longer or shorter tapered portion, are also within the scope of this disclosure. In some embodiments, at least a portion of the dilator 100 may be hydrophilic or otherwise lubricious. For example, a portion of an outside surface of the dilator 100 may be hydrophilic such that the outside surface of the dilator 100 is lubricious, slippery, and/or smooth such that the dilator 100 may be disposed or
moved through a percutaneous access site and/or a tortuous and/or narrow vascular anatomy.

[0050] In some embodiments, a portion of an outside surface of the dilator 100, extending from a proximal end 111 of the port 110, may comprise a recess configured to accommodate a portion of a guide wire. Such a configuration may aid in disposition or movement of the dilator 100 in combination with a guide wire through a percutaneous access site and/or through a patient's vasculature.

[0051] An apparatus for a percutaneous access site is also within the scope of this disclosure. The apparatus may comprise an elongate member, like elongate member 102, configured for passage of a fluid or fluids through at least a portion of the elongate member. The elongate member may be further configured for passage of a guide wire through only a portion of the elongate member. In other embodiments, the elongate member may be configured for passage of a fluid or fluids along substantially an entire length of the elongate member. In some embodiments, the guide wire may be displaceable along a portion of the elongate member through a first opening of the elongate member and the elongate member may be configured to direct the guide wire out of a second opening of the elongate member. For example, the elongate member may comprise an angled guiding surface configured to direct the guide wire out of the second opening of the elongate member. In certain embodiments, the second opening may be disposed in a sidewall of the elongate member.

[0052] Figures 2A-2D are various views of a distal portion of the dilator 100 of Figure 1. Figure 2A is a perspective view of the distal portion of the dilator 100 of Figure 1. Figure 2B is a top view of the distal portion of the dilator 100 of Figure 1; Figure 2C is a cross-sectional view of the portion of the dilator 100 of Figure 2B taken through line 2C-2C; and Figure 2D is a cross-sectional view of the portion of the dilator 100 of Figure 2C taken through line 2D-2D. As illustrated in Figures 2A-2D, the dilator 100 may further comprise a plug 114 disposed in the lumen 108, proximal to at least a portion of the port 110. In some embodiments, the plug 114 may be disposed at a position more proximal to the port 110 than is illustrated. While in other embodiments, a distal end 116 of the plug 114 may be disposed at a position more distal to a proximal end 111 of the port 110 than is illustrated.
In the illustrated embodiment of Figure 2D, the distal end 116 of the plug 114 defines an angled surface 118 extending from a surface of the lumen 108 opposite of the port 110 to a position at or adjacent a proximal end 111 of the port 110. Stated another way, the distal end 116 of the plug 114 may be wedge-shaped. In other embodiments, the distal end 116 of the plug 114 may comprise a concave curve or a convex curve. Other configurations of the distal end 116 of the plug 114 are also within the scope of this disclosure. The angled surface 118 may be configured to direct a guide wire or other medical device advanced through an opening 101 at the distal end 106 of the elongate member 102 through the port 110. The angled surface 118 may be configured such that the guide wire or other medical device does not get caught or stuck at a junction between the plug 114 and the elongate member 102. In some embodiments, the angled surface 118 may be configured such that the guide wire or the other medical device makes a smooth transition as it moves from an interior of the dilator to an exterior of the dilator 100. In some embodiments, the guide wire or other medical device may be introduced or threaded into the dilator 100 through the port 110, into the lumen 108 of the elongate member 102, and out the opening 101 at the distal end 106 of the dilator 100. In such an embodiment, the angled surface 118 may also be configured such that the guide wire or other medical device smoothly transitions as it moves or is displaced from the exterior of the dilator 100 to the interior of the dilator 100.

The plug 114, as illustrated in Figure 2D, is configured such that it occludes the lumen 108. In such a configuration, the dilator 100 may be configured such that fluid communication through the lumen 108 between the proximal end and the distal end 106 of the elongate member 102 is blocked, inhibited, or substantially inhibited at the plug 114.

In other embodiments, the lumen 108 may extend from the distal end 106 of the elongate member 102 to the port 110. In such embodiments, a portion of the elongate member 102 proximal to the lumen 108 may be solid. The lumen 108 may also be configured to direct a guide wire extending from the distal end 106 of the elongate member 102 through the port 110.

In certain embodiments, the plug 114 may be coupled to the elongate member 102. For example, the plug 114 may be bonded or glued to the elongate
member 102. In other embodiments, the plug 114 may be integrally formed with the elongate member 102. For example, the plug 114 may be extruded and/or molded as an integral or intrinsic part of the elongate member 102.

[0057] Figures 3A-3D are various views of a distal portion of a second embodiment of a dilator 200. Figure 3A is a perspective view of the distal portion of the second embodiment of the dilator 200. Figure 3B is a top view of the portion of the dilator 200 of Figure 3; Figure 3C is a cross-sectional view of the portion of the dilator 200 of Figure 3B taken through line 3C-3C; and Figure 3D is a cross-sectional view of the portion of the dilator 200 of Figure 3C taken through line 3D-3D. The embodiment of Figures 3A-3D may include components that resemble components of the embodiment of Figures 2A-2D in some respects. For example, the embodiment of Figure 3A includes a dilator 200 that may resemble the dilator 100 of Figure 2A. It will be appreciated that all the illustrated embodiments have analogous features. Accordingly, like features are designed with like reference numerals, with leading digits added to increment each reference numeral by 100. (For instance, the dilator is designated "100" in Figure 2A and an analogous dilator is designated as "200" in Figure 3A.) Relevant disclosure set forth above regarding similarly identified features thus may not be repeated hereafter. Moreover, specific features of the dilator shown in Figures 3A-3D may not be shown or identified by a reference numeral in the drawings or specifically discussed in the written description that follows. However, such features may clearly be the same, or substantially the same, as features depicted in other embodiments and/or described with respect to such embodiments. Accordingly, the relevant descriptions of such features apply equally to the features of the dilator of Figures 3A-3D. Any suitable combination of the features, and variations of the same, described with respect to the dilator illustrated in Figures 2A-2D, can be employed with the dilator of Figures 3A-3D, and vice versa. This pattern of disclosure applies equally to further embodiments depicted in subsequent figures and/or described hereafter.

[0058] In the embodiment of Figures 3A-3D, the dilator 200 comprises a plug 214 disposed in a lumen 208 proximal to at least a portion of a port 210. In some embodiments, the plug 214 may be configured such that fluid communication is allowed or permitted between the proximal end and the distal end 206 of the
elongate member 202. In the illustrated embodiment of Figures 3C and 3D, the plug 214 does not completely occlude the lumen 208 of the elongate member 202, in contrast to the plug 114 illustrated in Figure 2D. The plug 214 comprises a substantially planar first surface 220. The first surface 220, as illustrated, provides a recess in the plug 214 such that a gap 226, or fluid passage, is present between the first surface 220 of the plug 214 and a portion of the inside surface of the lumen 208. In some embodiments, a portion of an outside surface of the plug 214 may comprise one or more recesses such that one or more gaps 226 are formed or present between the portion of the outside surface of the plug 214 and a portion of the surface of the lumen 208. The gap 226 formed or created by the first planar surface 220 may be further configured such that passage of a guide wire through the gap 226 is not allowed or permitted. For example, the size of the gap 226 may be such that the gap 226 is too small to allow or permit passage of a guide wire. The gap 226 may also be configured such that upon threading of a distal end of a guide wire through the lumen 208 and/or the port 210 of the dilator 200, the distal end of the guide wire does not get caught or stuck at or adjacent an entrance of the gap 226. In some embodiments, a practitioner may flush a dilator comprising one or more gaps 226 with a saline solution, a heparinized saline solution, water, and/or another physiologically compatible sterile fluid prior to use, or during use, of the dilator.

[0059] As described above for the plug 114, the plug 214 may be coupled to the elongate member 202. For example, the plug 214 may be bonded or glued to the elongate member 202. In other embodiments, the plug 214 may be integrally formed with the elongate member 202. For example, the plug 214 may be extruded and/or molded as an integral or intrinsic part of the elongate member 202.

[0060] Figures 4A-4D are various views of a distal portion of a third embodiment of a dilator 300. Figure 4A is a perspective view of a distal portion of the third embodiment of the dilator 300. Figure 4B is a top view of the portion of the dilator 300 of Figure 4A; Figure 4C is a cross-sectional view of the portion of the dilator 300 of Figure 4B taken through line 4C-4C; and Figure 4D is a cross-sectional view of the portion of the dilator 300 of Figure 4C taken through line 4D-4D. In the embodiment of Figures 4A-4D, the illustrated dilator 300 comprises a plug 314 disposed in a lumen 308 proximal to at least a portion of a port 310. Again, in some embodiments,
such as illustrated in Figures 3C and 3D, a plug may be configured such that fluid communication is permitted between the proximal end and the distal end of the elongate member. Likewise, in the illustrated embodiment of Figure 4C, the plug 314 does not block or completely occlude the lumen of the elongate member, in contrast to the plug 114 of Figures 2A-2D.

[0061] The illustrated plug 314 comprises a substantially planar first surface 320a and a substantially planar second surface 320b (Figure 4C). Both of the first surface 320a and the second surface 320b, as illustrated, provide recesses in the plug 314 such that gaps 326, or fluid passages, are formed or present between both of the first surface 320a and the second surface 320b of the plug 314 and portions of the inside surface of the lumen. In some embodiments, a portion or portions of an outside surface of the plug 314 may comprise a plurality of recesses such that a plurality of gaps 326 are formed or present between portions of the outside surface of the plug 314 and portions of the surface of the lumen. The gaps 326 created by the first and second planar surfaces 320a, 320b may be configured such that passage of a guide wire through the gaps 326 is not allowed or permitted. For example, the size of the gaps 326 may be such that the gaps 326 are too small to allow or permit passage of a guide wire. The gaps 326 created by the first and second planar surfaces 320a, 320b may also be configured such that upon threading of a distal end of a guide wire through the lumen of the dilator and/or through the port, the guide wire does not get caught or stuck at or adjacent an entrance to one or more of the gaps.

[0062] As described above for other embodiments of the plug, the plug 314 may be coupled to the elongate member 302 (Figures 4A, 4B, and 4D). For example, the plug 314 may be bonded or glued to the elongate member 302. In other embodiments, the plug 314 may be integrally formed with the elongate member 302. For example, the plug 314 may be extruded and/or molded as an integral or intrinsic part of the elongate member 302.

[0063] Figures 5A-5D are various views of a distal portion of a fourth embodiment of a dilator 400. Figure 5A is a perspective view of a distal portion of the fourth embodiment of the dilator 400. Figure 5B is a top view of the portion of the dilator 400 of Figure 5A; Figure 5C is a cross-sectional view of the portion of the dilator 400
of Figure 5B taken through line 5C-5C; and Figure 5D is a cross-sectional view of the portion of the dilator 400 of Figure 5C taken through line 5D-5D. In the embodiment of Figures 5A-5D, the dilator 400 comprises a plug 414 disposed in a lumen 408 proximal to at least a portion of a port 410. Again, in some embodiments, such as illustrated in Figures 3C and 3D, a plug may be configured such that fluid communication is permitted between the proximal end and the distal end of the elongate member. Likewise, in the illustrated embodiment of Figures 5A-5D, the plug 414 does not completely occlude the lumen 408 of the elongate member 402, in contrast to the plug 114 of Figures 2A-2D. The illustrated plug 414 is at least partially fluted on a portion of an outside surface of the plug 414. As illustrated, the plurality of flutes provide a plurality of recesses in the plug 414 such that a plurality of gaps 426, or fluid passages, are formed or present between a portion of the outside surface of the plug 414 and a portion of the inside surface of the lumen 408. As illustrated, each gap 426 of the fluted plug 414 is substantially semicircular. In other embodiments, the gaps 426 may be ovoid, square, and/or triangular. Other shapes, or combinations of shapes, of gaps 426 are also contemplated. The gaps 426 may be configured such that passage of a guide wire through the gaps 426 is not allowed or permitted. For example, the size of the gaps 426 may be such that the gaps 426 are too small to allow or permit passage of a guide wire. The gaps 426 may also be configured such that upon threading of a guide wire through the lumen 408 of the dilator 400 and/or through the port 410 of the dilator 400, the distal end of the guide wire does not get caught or stuck at or adjacent an entrance of one or more of the gaps 426. In other embodiments, the plug 414 may comprise a hole or holes passing through an interior of the plug 414 as opposed to a gap or gaps 426 passing along the outside surface of the plug 414.

[0064] As described above for other embodiments of the plug, the plug 414 may be coupled to the elongate member 402. For example, the plug 414 may be bonded or glued to the elongate member 402. In other embodiments, the plug 414 may be integrally formed with the elongate member 402. For example, the plug 414 may be extruded and/or molded as an integral or intrinsic part of the elongate member 402.

[0065] Figures 6A-6D are various views of a distal portion of a fifth embodiment of a dilator 500. Figure 6A is a perspective view of a distal portion of the fifth
embodiment of the dilator 500. Figure 6B is a top view of the portion of the dilator 500 of Figure 6A; Figure 6C is a cross-sectional view of the portion of the dilator 500 of Figure 6B taken through line 6C-6C; and Figure 6D is a cross-sectional view of the portion of the dilator 500 of Figure 6C taken through line 6D-6D. In the embodiment of Figures 6A-6D, the dilator 500 comprises a plug 514 disposed in a lumen 508 proximal to at least a portion of a port 510. Again, in some embodiments, such as illustrated in Figures 3C and 3D, a plug may be configured such that fluid communication is permitted between the proximal end and the distal end of the elongate member. Likewise, in the embodiment of Figures 6A-6D, the plug 514 is configured to not completely occlude the lumen 508 of the elongate member 502, in contrast to the plug 114 of Figures 2A-2D. The illustrated plug 514 comprises an elongate member 538 and a lumen 540, or fluid passage, disposed longitudinally within the elongate member 538 (Figure 6D). The plug 514 further comprises an opening 542 at or adjacent a proximal end of the plug 514. At a distal end of the plug 514 an upper sidewall of the plug 514 extends distally in relation to a lower sidewall of the plug 514. The extension of the upper sidewall of the plug 514 defines an angled surface extending from a surface of the lumen 508 at or adjacent the port 510 to a surface of the lumen 508 opposite of the port 510 forming a check valve 544. A distal end of the check valve 544 is not bonded or fixed to the elongate member 502. The check valve 544 may transition from a closed configuration, as illustrated in Figure 6D, to an open configuration when, for example, a practitioner flushes a saline solution, a heparinized saline solution, water, and/or another sterile physiologically compatible fluid through the lumen 508 of the dilator 500. Fluid pressure distal of the plug 514 may open the check valve 544 while the check valve 544 may return to a closed configuration upon removal of a fluid pressure from the lumen 508.

[0066] As illustrated, the check valve 544 may also be configured such that upon threading of a guide wire through the lumen 508 of the dilator and/or through the port 510, the distal end of the guide wire does not get caught or stuck at or adjacent a junction of the plug 514 and the elongate member 502.

[0067] As described above for other embodiments of the plug, the plug 514 may be coupled to the elongate member 502. For example, the plug 514 may be bonded
or glued to the elongate member 502. In other embodiments, the plug 514 may be integrally formed with the elongate member 502. For example, the plug 514 may be extruded and/or molded as an integral or intrinsic part of the elongate member 502.

[0068] Figures 7A-7D are various views of a distal portion of a sixth embodiment of a dilator 600. Figure 7A is a perspective view of the distal portion of the sixth embodiment of the dilator 600. Figure 7B is a top view of the portion of the dilator 600 of Figure 7A; Figure 7C is a cross-sectional view of the portion of the dilator 600 of Figure 7B taken through line 7C-7C; and Figure 7D is a cross-sectional view of the portion of the dilator 600 of Figure 7C taken through line 7D-7D. In the embodiment of Figures 7A-7D, the dilator 600 comprises a plug 614 disposed in a lumen 608 proximal to at least a portion of a port 610. Again, in some embodiments, such as illustrated in Figures 3C and 3D, a plug may be configured such that fluid communication is permitted between the proximal end and the distal end of the elongate member. Likewise, in the illustrated embodiment of Figures 7C and 7D, the plug 614 does not completely occlude the lumen 608 of an elongate member 602, in contrast to the plug 114 of Figures 2A-2D. The illustrated plug 614 comprises a substantially planar surface 620 along a proximal portion of the plug 614. A distal end 616 of the plug 614 defines an angled surface 618 extending from a surface of the lumen opposite of the port 610 to a position at or adjacent a proximal end 611 of the port 610 and substantially in line with an outside surface of the elongate member 602 (Figure 7D). Thus a substantially L-shaped gap 626, or fluid passage, is formed between the upper surface of the plug 614 and surfaces of both of the lumen 602 and the port 610. As a proximal end of the angled surface 618 of the plug 614 is substantially in line with the outside surface of the elongate member 602, the angled surface 618 may not interfere with threading of a guide wire through the lumen 608 and/or port 610 of the dilator 600. Stated another way, the plug 614 may be configured such that the distal end of the guide wire does not get caught or stuck as it passes into or out of the dilator 600.

[0069] As described above for other embodiments of the plug, the plug 614 may be coupled to the elongate member 602. For example, the plug 614 may be bonded or glued to the elongate member 602. In other embodiments, the plug 614 may be
integrally formed with the elongate member 602. For example, the plug 614 may be extruded and/or molded as an integral or intrinsic part of the elongate member 602.

[0070] Figure 8 is a perspective view of an embodiment of a vascular access system 730. The vascular access system 730 of Figure 8 may be configured for use during a vascular procedure. Vascular procedures that may be performed using the illustrated vascular access system 730 include, but are not limited to, atherectomy, aspiration, balloon catheterization, diagnostic catheterization, interventional catheterization, snare capture/retrieval, and stent placement/removal. As shown in Figure 8, the vascular access system 730, may comprise a catheter 732 and a dilator 700 disposed within the catheter 732. The catheter 732 may comprise a sheathless catheter—or a catheter configured for use without an introducer sheath—such as a sheathless guiding catheter or a sheathless guide. Catheters 732 that may be utilized in the vascular access system 730 include, but are not limited to, balloon catheters, diagnostic catheters, guiding catheters, and interventional catheters. In some embodiments, the dilator 700 may be disposable within the catheter 732. In certain embodiments, the dilator 700 may be axially disposable within the catheter 732. In some other embodiments, the dilator 700 may be couplable to the catheter 732. For example, the dilator 700 may be couplable to the catheter 732 at a hub portion 734.

[0071] In some embodiments, the dilator 700 may be stiffer, firmer, or more resistant to bending than the catheter 732. Also, in certain embodiments, the dilator 700 may be longer than the catheter 732.

[0072] Referring again to the embodiment of Figure 8, the illustrated dilator 700 comprises an elongate member 702 comprising a proximal end 704 and a distal end 706. The dilator 700 may also comprise a lumen 708 disposed within at least a portion of the elongate member 702. As illustrated, the dilator 700 further comprises a port 710 disposed within a sidewall of the elongate member 702, wherein the port 710 may be in fluid communication with the lumen 708. In some embodiments, the port 710 may be disposed transversely through the sidewall of the elongate member 702. In some other embodiments, the lumen 708 may extend from the proximal end 704 to the distal end 706 of the elongate member 702.
The dilator 700 of the vascular access system 730 may also comprise other elements and/or features of the dilator 100, 200, 300, 400, 500, or 600 described above in connection with Figures 1-7D. For example, the dilator 700 may further comprise a plug, similar to plug 114, 214, 314, 414, 514, or 614 illustrated in Figures 2A-7D, disposed in the lumen 708 proximal to a portion of the port 710. Furthermore, a distal end of the plug may define an angled surface, similar to angled surface 118 of Figure 2D, extending from a surface of the lumen opposite of the port 710 to a position at or adjacent to a proximal portion of the port 710.

Similar to the plug 114 illustrated in Figures 2A-2D, the plug of the dilator 700 may occlude the lumen 708 such that fluid communication through the lumen 708 between the proximal end 704 and the distal end 706 of the elongate member 702 is blocked, inhibited, or substantially inhibited at the plug. Alternatively, similar to the plugs 214, 314, 414, 514, and 614 illustrated in Figures 3A-7D, the plug of the dilator 700 may be configured such that fluid communication is allowed or permitted between the proximal end 704 and the distal end 706 of the elongate member 702 via a gap and/or via a fluid passage. In some embodiments, a fluid passage may comprise a channel or passageway through an inside portion of the plug.

Figure 9 is a perspective view of a portion of the vascular access system 730 of Figure 8. In some embodiments, at least a portion of at least one of the catheter 732 and/or the dilator 700 may be radiopaque. For example, the catheter 732 and/or the dilator 700 may comprise one or more radiopaque bands 724. The one or more radiopaque bands 724 may assist a practitioner in determining and/or visualizing the location or position of the vascular access system 730 within a patient. For example, the practitioner may use a fluoroscope, or other imaging device, to visualize the location of the vascular access system 730 within the vasculature of the patient by locating the positions of the one or more radiopaque bands 724. In some embodiments, the radiopaque bands may be positioned at predetermined points along a length of the vascular access system 730. For example, a radiopaque band 724 may be positioned at or adjacent to the distal end 706 of the dilator 700. In another example, a radiopaque band 724 may be positioned at or adjacent to the distal end 736 of the catheter 732.
In some other embodiments, at least a portion of the vascular access system 730 may be hydrophilic or otherwise lubricious. For example, a portion of an outside surface of both the dilator 700 and the catheter 732 may be hydrophilic such that the outside surface of the vascular access system 730 is lubricious, slippery, and/or smooth such that the vascular access system 730 may be disposed or moved through a percutaneous access site and/or a tortuous and/or narrow vasculature.

In other embodiments, a portion of an outside surface of one or both of the catheter 732 and the dilator 700 of the vascular access system 730 extending from a proximal end 711 of a port 710 may comprise a recess configured to accommodate a portion of a guide wire. Such a configuration may aid in disposition or movement of the vascular system in combination with a guide wire through a percutaneous access site and/or through the vasculature.

In some embodiments, the catheter 732 and the dilator 700 may be couplable such that the dilator 700 may be partially disposed within the lumen of the catheter 732. In other embodiments, the catheter 732 and the dilator 700 may be coupled at a hub portion 734 (Figure 8).

Referring again to Figure 9, the distal end 706 of the illustrated dilator 700 extends distally relative to a distal end 736 of the catheter 732 when the catheter 732 and the dilator 700 are in a coupled configuration. Also, the illustrated port 710 is disposed distally relative to the distal end 736 of the catheter 732 when the catheter 732 and the dilator 700 are in a coupled configuration. Further, the distal end 736 of the illustrated catheter 732 is tapered such that there is a substantially smooth transition between the distal end 736 of the catheter 732 and the dilator 700. In other embodiments, the distal end 706 of the illustrated dilator 700 is tapered. In certain embodiments, a tapered portion of the dilator 700 may be longer than a tapered portion of the catheter 732. Other configurations of the catheter 732 and the dilator 700, such as catheters and dilators lacking tapered ends, are also within the scope of this disclosure.

Methods of accessing a percutaneous site of a patient are also disclosed. The methods may facilitate completion of a procedure in fewer steps such that less equipment and/or fewer components may be utilized. In some instances, conducting
fewer steps and/or utilizing fewer components may result in smaller access sites such that the methods may result in a lower incidence of arterial spasm and improved and/or quicker patient healing. In certain embodiments, methods of accessing a percutaneous access site may comprise introduction of a needle 850 into a vessel 854 of a patient. Figure 10A is a view showing introduction of the needle 850 into the vessel 854. In some embodiments, a practitioner 852 may introduce the needle 850 into the vessel 854 of a patient. In other embodiments, the vessel 854 may include, but is not limited to, the radial artery, the brachial artery, or the femoral artery. For example, the dilators and/or vascular access systems of the present disclosure may be adapted for use in accessing the femoral artery, in contrast to accessing the radial artery, by the use of a larger needle, dilator, catheter, guide wire, and/or other components.

[0081] In some embodiments, the methods may further comprise introducing a first guide wire 856 into the vessel 854 via the introduced needle 850. Figure 10B is a view showing introduction of the first guide wire 856 into the vessel 854 through a lumen 851 of the needle 850. In certain embodiments, the practitioner 852 may introduce the first guide wire 856 into the vessel 854 through the lumen 851 of the needle 850. In other embodiments, the practitioner 852 may introduce more than one guide wire into the vessel 854, for example, two guide wires, three guide wires, and so on. The arrows, as shown in Figure 10B, illustrate the introduction of the first guide wire 856 into the vessel 854 via the needle 850. Different sizes of guide wires may be used in the disclosed method. In some embodiments, a 0.018 inch diameter guide wire 856 may be used. In other embodiments, 0.021 inch, 0.025 inch, 0.032 inch, 0.035 inch, or 0.038 inch diameter guide wires 856 may be used. In some other embodiments, guide wires 856 of other diameters may be used.

[0082] The methods may also further comprise extraction of the needle 850 from the vessel 854. Figure 10C is a view showing removal of the needle 850 from the vessel 854. In some embodiments, the practitioner 852 may remove the needle 850 from the vessel 854 while leaving the first guide wire 856 disposed within the vessel 854. The arrows, as shown in Figure 10C, illustrate the removal of the needle 850 from the vessel 854.
In some embodiments, the methods may further comprise introduction of the first guide wire 856 into a dilator 800. Figure 10D is a view showing threading of the first guide wire 856 through an opening 801 at a distal end 806 of the dilator 800, wherein the dilator 800 is disposed within a catheter 832. In certain embodiments, the practitioner 852 may insert a proximal end 858 of the first guide wire 856 through the opening 801 at or adjacent to the distal end 806 of the dilator 800, as indicated by the arrows. As illustrated, a portion of the dilator 800 is disposed within the catheter 832. In certain embodiments, a portion of the dilator 800 may be axially disposed within the catheter 832. In other embodiments, the dilator 800 may not be disposed within a catheter 832. In some embodiments, the size of the catheter 832 may be 5F (French size). In some other embodiments, the catheter 832 may be 6F, 7F, or 8F. Other sizes of catheters 832 are also contemplated.

The methods may further comprise introducing the dilator 800 and/or the catheter 832 into the vessel 854. Figure 10E is a view showing disposition of the dilator 800 and the catheter 832 into the vessel 854. In some embodiments, the practitioner 852 may introduce both of the dilator 800 and the catheter 832 into the vessel 854 of the patient along at least a portion of the first guide wire 856. In other embodiments, the practitioner may flush the dilator 800 and/or catheter 832 with saline solution, heparinized saline solution, water, and/or another physiologically compatible sterile fluid prior to introduction of the dilator 800 and/or catheter into the vessel 854 of the patient.

In certain embodiments, the methods may further comprise extracting the first guide wire 856 and/or the dilator 800 from the vessel 854. Figure 10F is a view showing removal of the first guide wire 856 from the vessel 854. In some embodiments, the practitioner 852 may remove the first guide wire 856 from both of the dilator 800 and the vessel 854. Figure 10G is a view showing removal of the dilator 800 from the vessel 854. In other embodiments, the practitioner 852 may remove the dilator 800 from both of the vessel 854 and the catheter 832, as indicated by the arrows. The dilator 800 may be decoupled from the catheter 832 at a hub portion 834. In some other embodiments, the dilator 800 may not be coupled to the catheter 832 at a hub portion 834.
In some embodiments, the methods may comprise introduction of a second guide wire 857 through the catheter 832. Figure 10H is a view showing introduction of the second guide wire 857 into or through the catheter 832. The practitioner 852 may displace a distal end 859 of the second guide wire 857 through the vessel 854 to a position at or adjacent a therapy site 860. The catheter 832 may then be advanced or threaded along the second guide wire 857 such that a distal end 836 of the catheter 832 is disposed at or adjacent the therapy site 860.

The methods may further comprise placement of the catheter 832 at a therapy site 860 without threading or displacing the catheter 832 along a guide wire, such as the second guide wire 857 illustrated in Figure 10H. Figure 10I is a view showing disposition and visualization of the disposition of a distal end 836 of the catheter 832 at a therapy site 860. The therapy site 860 may be the site, for example, of an embolus, an occlusion, a plaque, or another feature. In some embodiments, the practitioner 852 may displace the catheter 832 through the vessel 854 such that a distal end 836 of the catheter 832 is disposed at or adjacent to the therapy site 860 within the patient. An imaging device 862, such as a fluoroscope, may be used to visualize the placement or positioning of the distal end 836 of the catheter 832.

In certain embodiments, the methods may further comprise conducting a vascular procedure. Figure 10J is a view showing performance and visualization of the performance of a vascular procedure at the therapy site 860. In some embodiments, the practitioner 852 may displace a medical device 864 through a lumen of the catheter 832 such that the medical device 864 is disposed at or adjacent to the therapy site 860 within the vessel 854 of the patient. The practitioner 852 may then perform a vascular procedure at or adjacent to the therapy site 860 within the vessel 854 of the patient. An imaging device 862, such as a fluoroscope, may be used to visualize the performance of the vascular procedure at the therapy site 860. The medical device 864 may include, but is not limited to, an atherectomy device, an aspirator, a balloon catheter (as illustrated in Figure 10J), a diagnostic catheter, a guiding catheter, an interventional catheter, a snare, or a stent.

In other embodiments, the methods may further comprise extraction of the catheter 832 from the patient. Figure 10K is a view showing removal of the catheter
832 from the vessel 854. In some embodiments, the practitioner 852 may remove the medical device 864 and/or the catheter 832 from the vessel 854 of the patient as indicated by the dashed arrows.

Exemplary Embodiments

[0090] The following embodiments are illustrative and exemplary and not meant as a limitation of the scope of the present disclosure in any way.

[0091] 1. Dilators for Percutaneous Access

[0092] In one embodiment, a dilator configured for percutaneous access comprises: (1) an elongate member comprising a proximal end and a distal end; (2) a lumen disposed within at least a portion of the elongate member; and (3) a port disposed in a sidewall of the elongate member, wherein the port is in fluid communication with the lumen.

[0093] The lumen may extend from the proximal end to the distal end of the elongate member.

[0094] The dilator may further comprise a plug disposed in the lumen proximal to a portion of the port.

[0095] A distal end of the plug may define an angled surface extending from a surface of the lumen opposite of the port to a position at or adjacent a proximal portion of the port.

[0096] The angled surface may be configured to direct a guide wire extending from the distal end of the elongate member through the port.

[0097] The plug may occlude the lumen such that fluid communication through the lumen between the proximal end and the distal end of the elongate member is inhibited at the plug.

[0098] The plug may be configured such that fluid communication is permitted between the proximal end and the distal end of the elongate member.

[0099] The plug may comprise a fluid passage.

[0100] The plug may comprise a check valve.

[0101] The plug may be coupled to the elongate member.

[0102] The lumen may extend from the distal end of the elongate member to the port.
The lumen may be configured to direct a guide wire extending from the distal end of the elongate member through the port.

A portion of the elongate member may be radiopaque.

A portion of the distal end of the elongate member may be tapered.

A portion of the elongate member may be hydrophilic.

A portion of an outside surface of the elongate member extending from a proximal end of the port may comprise a recess configured to accommodate a portion of a guide wire.

II. Apparatuses for Percutaneous Access

In one embodiment, an apparatus configured for a percutaneous access site, comprises: an elongate member configured for passage of fluid through at least a portion of the elongate member; wherein the elongate member is configured for passage of a guide wire through only a portion of the elongate member; and wherein the guide wire is displaceable along a portion of the elongate member through a first opening of the elongate member and wherein the elongate member comprises an angled guiding surface configured to direct the guide wire out a second opening of the elongate member.

The elongate member may be configured for passage of fluid along substantially an entire length of the elongate member.

The second opening may be disposed in a sidewall of the elongate member.

III. Vascular Access Systems

In one embodiment, a vascular access system configured for use during a vascular procedure comprises: (1) a catheter; and (2) a dilator disposable within the catheter, wherein the dilator comprises: (a) an elongate member comprising a proximal end and a distal end, (b) a lumen disposed within at least a portion of the elongate member, and (c) a port disposed in a sidewall of the elongate member, wherein the port is in fluid communication with the lumen.

The lumen may extend from the proximal end to the distal end of the elongate member.

The dilator may further comprise a plug disposed in the lumen proximal to a portion of the port.
[001 16] A distal end of the plug may define an angled surface extending from a surface of the lumen opposite of the port to a position at or adjacent a proximal portion of the port.

[001 17] The plug may occlude the lumen such that fluid communication through the lumen between the proximal end and the distal end of the elongate member is inhibited at the plug.

[001 18] The plug may be configured such that fluid communication is permitted between the proximal end and the distal end of the elongate member.

[001 19] The plug may comprise a fluid passage.

[00120] The system may be configured such that a guide wire cannot pass through the fluid passage.

[00121] A portion of at least one of the catheter or the dilator may be radiopaque.

[00122] A portion of one or both of the catheter and the dilator may be hydrophilic.

[00123] A portion of an outside surface of one or both of the catheter and the dilator extending from a proximal end of the port may comprise a recess configured to accommodate a portion of a guide wire.

[00124] The catheter and the dilator may be couplable such that the dilator is partially disposed within a lumen of the catheter.

[00125] A distal end of the dilator may extend distally relative to a distal end of the catheter when the catheter and the dilator are coupled.

[00126] The port may be disposed distally relative to the distal end of the catheter when the dilator and the catheter are coupled.

[00127] The distal end of the catheter may be tapered such that there is a smooth transition between the distal end of the catheter and the dilator, and wherein the distal end of the dilator is tapered.

[00128] A tapered portion of the dilator may be longer than a tapered portion of the catheter.

[00129] The dilator may be stiffer than the catheter.

[00130] The dilator may be longer than the catheter.

[00131] IV. Method of Accessing Percutaneous Sites

[00132] In one embodiment, a method of accessing a percutaneous site of a patient, comprises: (1) inserting a proximal end of a first guide wire through an
opening at or adjacent a distal end of a dilator, wherein a portion of the dilator is disposed within a catheter; (2) threading the first guide wire through both of a portion of a lumen of the dilator and a port disposed in a sidewall of the dilator; and (3) introducing both the dilator and the catheter into a vessel of the patient along a portion of the first guide wire.

[00133] The method may further comprise: (1) introducing a needle into the vessel; (2) introducing the first guide wire into the vessel through a lumen of the needle; and (3) removing the needle from the vessel prior to inserting the proximal end of the first guide wire through the opening at or adjacent the distal end of the dilator.

[00134] The method may further comprise: (1) removing the first guide wire and the dilator from the vessel; and (2) displacing the catheter through the vessel such that a distal end of the catheter is disposed at or adjacent a therapy site within the patient subsequent to introducing both the dilator and the catheter into the vessel along a portion of the first guide wire.

[00135] The method may further comprise: (1) removing the first guide wire and the dilator from the vessel; (2) introducing a second guide wire through the catheter; (3) disposing a distal end of the second guide wire at or adjacent a therapy site; and (4) advancing the catheter along the second guide wire such that a distal end of the catheter is disposed at or adjacent the therapy site.

[00136] The method may further comprise displacing a medical device through the catheter such that the medical device is disposed at or adjacent a therapy site within the vessel.

[00137] The method may further comprise performing a vascular procedure at or adjacent the therapy site within the vessel.

[00138] The medical device may be selected from at least one of: an atherectomy device, an aspirator, a balloon catheter, a diagnostic catheter, a guiding catheter, an interventional catheter, a snare, or a stent.

[00139] The examples and embodiments disclosed herein are to be construed as merely illustrative and exemplary, and not a limitation of the scope of the present disclosure in any way. It will be apparent to those having skill in the art with the aid of the present disclosure that changes may be made to the details of the above-described embodiments without departing from the underlying principles of the
disclosure herein. Moreover, the order of the steps or actions of the methods disclosed herein may be changed by those skilled in the art without departing from the scope of the present disclosure. In other words, unless a specific order of steps or actions is required for proper operation of the embodiment, the order or use of specific steps or actions may be modified. It is intended that the scope of the invention be defined by the claims appended hereto and their equivalents.
Claims

1. A dilator configured for percutaneous access, the dilator comprising:
   an elongate member comprising a proximal end and a distal end;
   a lumen disposed within at least a portion of the elongate member; and
   a port disposed in a sidewall of the elongate member, wherein the port
   is in fluid communication with the lumen.

2. The dilator of claim 1, wherein the lumen extends from the proximal end to the
   distal end of the elongate member.

3. The dilator of any one of claims 1-2, further comprising a plug disposed in the
   lumen proximal to a portion of the port.

4. The dilator of claim 3, wherein a distal end of the plug defines an angled
   surface extending from a surface of the lumen opposite of the port to a
   position at or adjacent a proximal portion of the port.

5. The dilator of claim 4, wherein the angled surface is configured to direct a
   guide wire extending from the distal end of the elongate member through the
   port.

6. The dilator of any one of claims 3-5, wherein the plug occludes the lumen
   such that fluid communication through the lumen between the proximal end
   and the distal end of the elongate member is inhibited at the plug.

7. The dilator of any one of claims 3-5, wherein the plug is configured such that
   fluid communication is permitted between the proximal end and the distal end of
   the elongate member.

8. The dilator of claim 7, wherein the plug comprises a fluid passage.
9. The dilator of claim 8, wherein the plug comprises a check valve.

10. The dilator of any one of claims 1-9, wherein the lumen extends from the distal end of the elongate member to the port.

11. The dilator of claim 10, wherein the lumen is configured to direct a guide wire extending from the distal end of the elongate member through the port.

12. The dilator of any one of claims 1-11, wherein a portion of the elongate member is hydrophilic.

13. The dilator of any one of claims 1-12, wherein a portion of an outside surface of the elongate member extending from a proximal end of the port comprises a recess configured to accommodate a portion of a guide wire.

14. An apparatus configured for a percutaneous access site, comprising:
   an elongate member configured for passage of fluid through at least a portion of the elongate member;
   wherein the elongate member is configured for passage of a guide wire through only a portion of the elongate member; and
   wherein the guide wire is displaceable along a portion of the elongate member through a first opening of the elongate member and wherein the elongate member comprises an angled guiding surface configured to direct the guide wire out a second opening of the elongate member.

15. The apparatus of claim 14, wherein the elongate member is configured for passage of fluid along substantially an entire length of the elongate member.

16. The apparatus of any one of claims 14-15, wherein the second opening is disposed in a sidewall of the elongate member.
17. A method of accessing a percutaneous site of a patient, comprising:

inserting a proximal end of a first guide wire through an opening at or adjacent a distal end of a dilator, wherein a portion of the dilator is disposed within a catheter;

threading the first guide wire through both of a portion of a lumen of the dilator and a port disposed in a sidewall of the dilator; and

introducing both the dilator and the catheter into a vessel of the patient along a portion of the first guide wire.

18. The method of claim 17, further comprising:

removing the first guide wire and the dilator from the vessel; and

displacing the catheter through the vessel such that a distal end of the catheter is disposed at or adjacent a therapy site within the patient subsequent to introducing both the dilator and the catheter into the vessel along a portion of the first guide wire.

19. The method of any one of claims 17-18, further comprising:

displacing a medical device through the catheter such that the medical device is disposed at or adjacent a therapy site within the vessel.

20. The method of claim 19, wherein the medical device is selected from at least one of: an atherectomy device, an aspirator, a balloon catheter, a diagnostic catheter, a guiding catheter, an interventional catheter, a snare, or a stent.
INTERNATIONAL SEARCH REPORT

INTERNATIONAL APPLICATION No. PCT/US2014/052520

A. CLASSIFICATION OF SUBJECT MATTER

A61M 29/00(2006.01)i, A61M 25/09(2006.01)i, A61B 17/34(2006.01)i, A61M 39/02(2006.01)i, A61M 39/20(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61M 29/00; A61M 5/00; A61B 17/00; A61M 25/09; A61B 17/34; A61M 39/02; A61M 39/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic database consulted during the international search (name of database and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: rapid exchange dilator, port, plug, guide wire

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>US 2007-0185521 Al (BUI, B. et al.) 9 August 2007</td>
<td>1-5, 14-16</td>
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<td>See abstract, claims 1-3, 12, 15, 17, and figure 1.</td>
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<td>US 7727251 B2 (SPURCHISE, M. et al.) 1 June 2010</td>
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<td>US 5496344 A (KANESAKA, N. et al.) 5 March 1996</td>
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
  "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
27 November 2014 (27.11.2014)

Date of mailing of the international search report
28 November 2014 (28.11.2014)

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
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Authorized officer
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Telephone No. +82-42-481-3362

Form PCT/ISA/210 (second sheet) (July 2009)
Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [ ] Claims Nos.: 17-20  
   because they relate to subject matter not required to be searched by this Authority, namely:
   Claims 17-20 pertain to methods for treatment of the human and thus relate to a subject-matter which this International Searching Authority is not required to search under PCT Article 17(2)(a)(i) and PCT Rule 39.1(iv).

2. [ ] Claims Nos.: 8-9, 11  
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
   Claims 8-9, 11 are unclear, because they refer to multiple dependent claims which do not comply with PCT Rule 6.4(a).

3. [ ] Claims Nos.: 6-7, 10, 12-13  
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 

Remark on Protest  
[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[ ] No protest accompanied the payment of additional search fees.
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