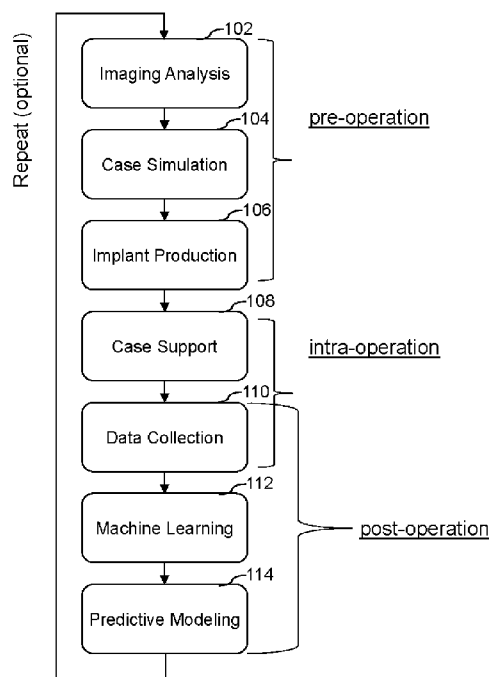




- (51) **International Patent Classification:**
A61B 34/10 (2016.01) *A61F 2/44* (2006.01)
A61B 17/70 (2006.01)
- (21) **International Application Number:** PCT/IB2018/000551
- (22) **International Filing Date:** 20 April 2018 (20.04.2018)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
62/488,077 21 April 2017 (21.04.2017) US
62/518,305 12 June 2017 (12.06.2017) US
62/518,310 12 June 2017 (12.06.2017) US
62/597,035 11 December 2017 (11.12.2017) US
62/612,260 29 December 2017 (29.12.2017) US
- (71) **Applicant:** MEDICREA INTERNATIONAL [FR/FR];
5389 Route de Strasbourg, Vancia, 69140 Rillieux La Pape (FR).
- (72) **Inventors:** SOURNAC, Denys; 345 Montée de Bellevue, 01600 Reyrieux (FR). RYAN, David; 33 rue Pierre Terrier, 69660 Collonges au Mont d'Or (FR). MOSNIER, Thomas; 935 rue du Musée, 69270 Rochetaillée sur Saône (FR). JAVELOT, Christophe; 1 bis rue Bournes, 69004 Lyon (FR).
- (74) **Agent:** LLR; 26 Quai Claude Bernard, 69007 Lyon (FR).
- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,

(54) **Title:** A SYSTEM FOR DEVELOPING ONE OR MORE PATIENT-SPECIFIC SPINAL IMPLANTS

FIG. 1



(57) **Abstract:** The disclosure herein relates to systems, methods, and devices for developing patient-specific spinal treatments, operations, and procedures. In some embodiments, systems, methods, and devices described herein for developing patient-specific spinal treatments, operations, and procedures can comprise an iterative virtuous cycle. The iterative virtuous cycle can further comprise pre-operative, intra-operative, and post-operative techniques or processes. For example, the iterative virtuous cycle can comprise imaging analysis, case simulation, implant production, case support, data collection, machine learning, and/or predictive modeling. One or more techniques or processes of the iterative virtuous cycle can be repeated.



OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:

14 February 2019 (14.02.2019)

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/000551

A. CLASSIFICATION OF SUBJECT MATTER
 INV. A61B34/10
 ADD. A61B17/70 A61F2/44

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)
 A61B A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	spontech medical AG: "Vertaplan - die Software für Wirbelsäulenchirurgen", 29 August 2013 (2013-08-29), XP054978644, Retrieved from the Internet: URL:https://www.youtube.com/watch?v=q0qhW1T1cp8&list=PLpchNfi-I3gj5A_Iabkd9Nw-SN7qD2d1Y&index=3&t=0s [retrieved on 2018-08-29] the whole document ----- -/--	1-20

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	Date of mailing of the international search report
4 December 2018	12/12/2018

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Roudaut, Tanguy
--	---

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/000551

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Clemens Reinshagen ET AL: "A novel minimally invasive technique for lumbar decompression, realignment, and navigated interbody fusion - ScienceDirect", Journal of Clinical Neuroscience, 1 September 2015 (2015-09-01), pages 1484-1490, XP055503028, Retrieved from the Internet: URL:https://www.sciencedirect.com/science/article/pii/S096758681500185X [retrieved on 2018-08-29] page 16; figure Supplementary fig. 1 -----	1-20
A	RICKERT M ET AL: "Posterior lumbar interbody fusion implants", ORTHOPAEDE, SPRINGER VERLAG, BERLIN, DE, vol. 44, no. 2, 28 January 2015 (2015-01-28), pages 162-169, XP035457088, ISSN: 0085-4530, DOI: 10.1007/S00132-014-3072-X [retrieved on 2015-01-28] page 163, column 3, paragraph 4 - page 166, column 2, paragraph 2; figures 3,4 -----	1-14
A	WO 2017/064719 A1 (MAZOR ROBOTICS LTD [IL]) 20 April 2017 (2017-04-20) page 23, paragraph 2 - page 25, paragraph 1; figures 2,5 -----	1-14
A	WO 2017/066518 A1 (MIGHTY OAK MEDICAL INC [US]) 20 April 2017 (2017-04-20) abstract; figures 2,39 -----	1-14
A	US 2016/242857 A1 (SCHOLL THOMAS [US]) 25 August 2016 (2016-08-25) abstract; figures 13-62 -----	1-14
A	WO 2016/032875 A1 (DEPUY SYNTHES PRODUCTS INC [US]) 3 March 2016 (2016-03-03) paragraph [0026] - paragraph [0037]; figures 3-8 -----	1-14
A	US 2013/131486 A1 (COPF FRANZ [DE] ET AL) 23 May 2013 (2013-05-23) figures 8,9,12-19,23-29 paragraph [0178] - paragraph [0180] paragraph [0193] - paragraph [0199] paragraph [0206] - paragraph [0216] paragraph [0219] - paragraph [0225] -----	15-20
A	WO 2008/002588 A2 (PACHECO HECTOR O [US]) 3 January 2008 (2008-01-03) abstract; figures 20-25 -----	15-20
	-/--	

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/000551

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010/217336 A1 (CRAWFORD NEIL R [US] ET AL) 26 August 2010 (2010-08-26) paragraph [0023] - paragraph [0024]; figures 1,2 paragraph [0027] - paragraph [0029] paragraph [0034] paragraph [0036] paragraph [0039] -----	15-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/IB2018/000551

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
WO 2017064719	A1	20-04-2017	CN 108289660 A EP 3361958 A1 US 2018301213 A1 WO 2017064719 A1	17-07-2018 22-08-2018 18-10-2018 20-04-2017
WO 2017066518	A1	20-04-2017	US 2017135706 A1 WO 2017066518 A1	18-05-2017 20-04-2017
US 2016242857	A1	25-08-2016	US 2016242857 A1 US 2016262800 A1 US 2017367738 A1	25-08-2016 15-09-2016 28-12-2017
WO 2016032875	A1	03-03-2016	US 2016058320 A1 US 2016058523 A1 US 2018256067 A1 WO 2016032875 A1	03-03-2016 03-03-2016 13-09-2018 03-03-2016
US 2013131486	A1	23-05-2013	CN 102770093 A EP 2538885 A1 US 2013131486 A1 WO 2011104028 A1	07-11-2012 02-01-2013 23-05-2013 01-09-2011
WO 2008002588	A2	03-01-2008	AU 2007265472 A1 CA 2654995 A1 CN 101478913 A EP 2032023 A2 HK 1134001 A1 JP 5052608 B2 JP 2009542327 A KR 20090045201 A US 2008009945 A1 WO 2008002588 A2	03-01-2008 03-01-2008 08-07-2009 11-03-2009 15-07-2011 17-10-2012 03-12-2009 07-05-2009 10-01-2008 03-01-2008
US 2010217336	A1	26-08-2010	NONE	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2018/000551

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.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
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:

3. Claims Nos.:
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:

see additional sheet

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 fees, this Authority did not invite payment of additional fees.

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-14

A system for developing one or more patient-specific spinal implants wherein the cage selection is based on increasing a posterior height of each of the one or more cages until the length of the posterior curve substantially matches or does not exceed the length of the posterior longitudinal ligament; and increasing lordosis of each of the one or more cages while maintaining the length of the anterior curve shorter than the anterior longitudinal ligament; determine, based at least in part on the simulation of implantation of the one or more cages, one or more dimensions of each of one or more patient-specific cages for the vertebral segment of interest, wherein the one or more dimensions of each of the one or more patient-specific cages comprises posterior height and anterior height thereof;

2. claims: 15-20

A system for developing one or more patient-specific spinal implants wherein the cage selection is based on the following steps: determine, from the one or more medical images, a height of each of one or more discs on a vertebral segment of interest; determine, for each of the one or more discs on the vertebral segment of interest, disc height as a percentage of total disc height of the vertebral segment of interest and/or disc angulation as a percentage of total disc angulation of the vertebral segment of interest; analyze the determined disc height percentage and/or determined disc angulation percentage of each of the one or more discs on the vertebral segment of interest by comparing the determined disc height percentage and/or determined disc angulation percentage of each of the one or more discs on the vertebral segment of interest with predetermined disc height percentages and/or predetermined disc angulation percentages of one or more corresponding discs of an asymptomatic population, wherein the predetermined disc height percentages and/or the predetermined disc angulation percentages of one or more corresponding discs of an asymptomatic population are updated periodically and/or continuously; simulate, on the one or more medical images, implantation of one or more cages to one or more intervertebral spaces within the vertebral segment of interest based at least in part on the comparison of the determined disc height percentage and/or the determined disc angulation percentage of each of the one or more discs on the vertebral segment of interest with predetermined disc height percentages and/or predetermined disc angulation percentages of the one or more corresponding discs of the asymptomatic population.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

[Empty rectangular box for further information]