Technology Insight Report

Knee Problems, Diagnosis and Treatments

Patent iNSIGHT Pro
Transform Patents to Intelligence

Knee is one of the most important joints of our body. It plays an essential role in movement related to carrying the body weight in horizontal (running and walking) and vertical (jump) directions.

Knee joint is made up of bone, cartilage, ligaments and fluid. Muscles and tendons help the knee joint move.

When any of these structures are hurt or diseased, we have knee problems. Knee problems can cause pain and difficulty in walking.

This report takes a look into the patenting activity around knee anatomy uncovering the key companies, inventors, and trends across various diagnostic methods and treatments.

Overview

The knee joint joins the thigh with the leg and consists of two articulations: one between the femur and tibia, and one between the femur and patella. It is the largest joint in the human body and is very complicated. Knee is a pivotal hinge joint, which permits flexion and extension as well as a slight medial and lateral rotation. Since in humans the knee supports nearly the whole weight of the body, it is vulnerable to various injuries.

Knee is a hinge type synovial joint, which is composed of three functional compartments: the femoropatellar articulation consists of the patella, or "kneecap", and the patellar groove on the front of the femur through which it slides; and the medial and lateral femorotibial articulations linking the femur, or thigh bone, with the tibia, the main bone of the lower leg. The joint is bathed in synovial fluid which is contained inside the synovial membrane called the joint capsule. The crutiate ligament is an area that has recently been the subject of renewed scrutiny and research.

In this report, we focus on the patents covering knee ailments, diagnostic methods and treatments involved. Our search strategy as shown in next section highlights the same.

With the help of Patent iNSIGHT Pro, we will analyze the patent data around Knee Problems to find answers to the following:

- What does the IP publication trend for knee anatomy look like and how have the filings evolved?
- Who are the top assignees or key players in knee anatomy and what are their technology wise trends?
- How is research in knee anatomy spread across different countries?
- How is assignee portfolio spread across various knee problem areas?
- How is the assignee portfolio spread across different diagnostic methods?
- How is assignee portfolio spread across various treatment procedures?
- How do the key diagnostic methods compare across various knee problem areas?
- How are different kinds of treatments related to different problem areas?

Search Strategy

Using the commercial patent database PatBase as our data source we used the following search query to create our patent set.

FT- Full Text TAC – Title Abstract Claims IC – International Class

(FT=(orthopaedic* or orthopedic*))

AND

(TAC=(knee* or ligament* or cartilage* or femur* or femul or femular* or fibula* or menisc* or patella* or tibia or (shin w/2 bone*) or menisectomy* or femoral* or synovium or synovitis or synovial or condyle* or (joint w/2 (mouse or mice)) or myositis or lyme* or pseudogout* or suprapatellar* or inotophoresis* or phonophoresis* or endoprosthesis* or patellar* or palpation or arthrocentesis* or "joint aspiration" or poplite* or scleroderma or gout* or (discoid* w/2 menisc*) or osteoporosis or enthesitis or sacs* or lining or baker* or strain or tendon* or tendinitis or psoriasis or endoscop* or osteophyte* or (bone w/2 spur*) or fibromyalgia or cortisone* or hyperexten* or menisci* or shinbone* or lupus or musculoskelet* or viscosupplementation* or viscosupplementasion* or apophysis or kneepan or fracture* or limb or orthosis* or prepatellar* or autograft* or graft~ or osteotom* or prosthesis or prosthetic* or corticosteroid* or bursitis or bursa* or chondromalacia or "kneecap" or (knee w/2 cap) or rheumatic or rheumatoid or (knee w/2 (brace* or bracing)) or osteotomy or larua or ((true or fibrous) w/2 ligament*) or plicae or plica or tibiofibular* or patellofemoral or "runnerknee" or ((jumper* or runner*) w/2 knee*) or "osteochondritis dissecans")

AND

((tomograph* or MRI or "magnetic resonance imaging" or CT or xray* or (X w/2 ray*) or ultrasound* or gait* or arthroscop* or "electron paramagnetic resonance" or EPR or arthrograph* or radiolog* or biomarker* or phonophoresis* or itonophoresis* or "Osgood-Schlatter" or ultrasonograph* or serelogical or radionuclide* or sutur~)))

AND

(IC= A61B or A61F or A61H or A61K or A61L or A61M or A61N or A61P)

Class Descriptions of Classes used in Search Strategy

A61B: diagnosis; surgery; identification

A61F: filters implantable into blood vessels; prostheses; devices providing patency to, or preventing collapsing of, tubular structures of the body, e.g. stents; orthopaedic, fomentation; bandages, dressings or absorbent pads

A61H: physical therapy apparatus, e.g. devices for locating or stimulating reflex points in the body; artificial respiration; massage; bathing devices for special therapeutic or hygienic purposes or specific parts of the body

A61K: preparations for medical purposes

A61L: methods or apparatus for sterilising materials chemical aspects of bandages, dressings, absorbent pads, or surgical articles; materials for bandages, dressings, absorbent pads, or surgical articles

A61M: devices for introducing media into, or onto, the devices for transducing body media or for taking media from the body

A61N: electrotherapy; magnetotherapy; radiation therapy; ultrasound therapy

The queries were combined using the 'AND' operator to search in full text and title, abstract, claims and a patent set of 1167 records with one publication per family was generated.

The publications included in the report are updated as of 14th May, 2012.

Patent Categorization

To get deeper insights the patent set has been classified as follows:

By Problem Areas

- Arthritis
  a) Juvenile
  b) Osteoarthritis
  c) Others
  d) Psoriatic
  e) Rheumatoid
- Bursitis
- Crutiate Ligament
- Others
- Patella
- Synovium

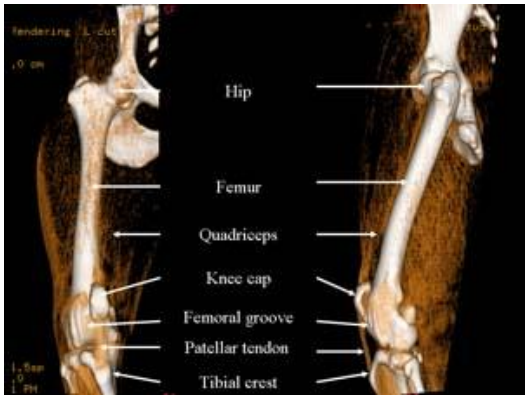
Note: Other Problem Areas include: knee injuries, strains, inflammation, plicae

By Treatments

Image Source:
http://en.wikipedia.org/wiki/Knee_replacement
http://www.medicinenet.com/knee_pain/article.htm

- ACL
- Non Surgical
  a) Drug Administration
  b) Orthotic Devices
  c) Therapies
- Surgical
  a) Arthroplasty
  b) Graft
  c) Implants
- Viscosupplementation

By Diagnosis

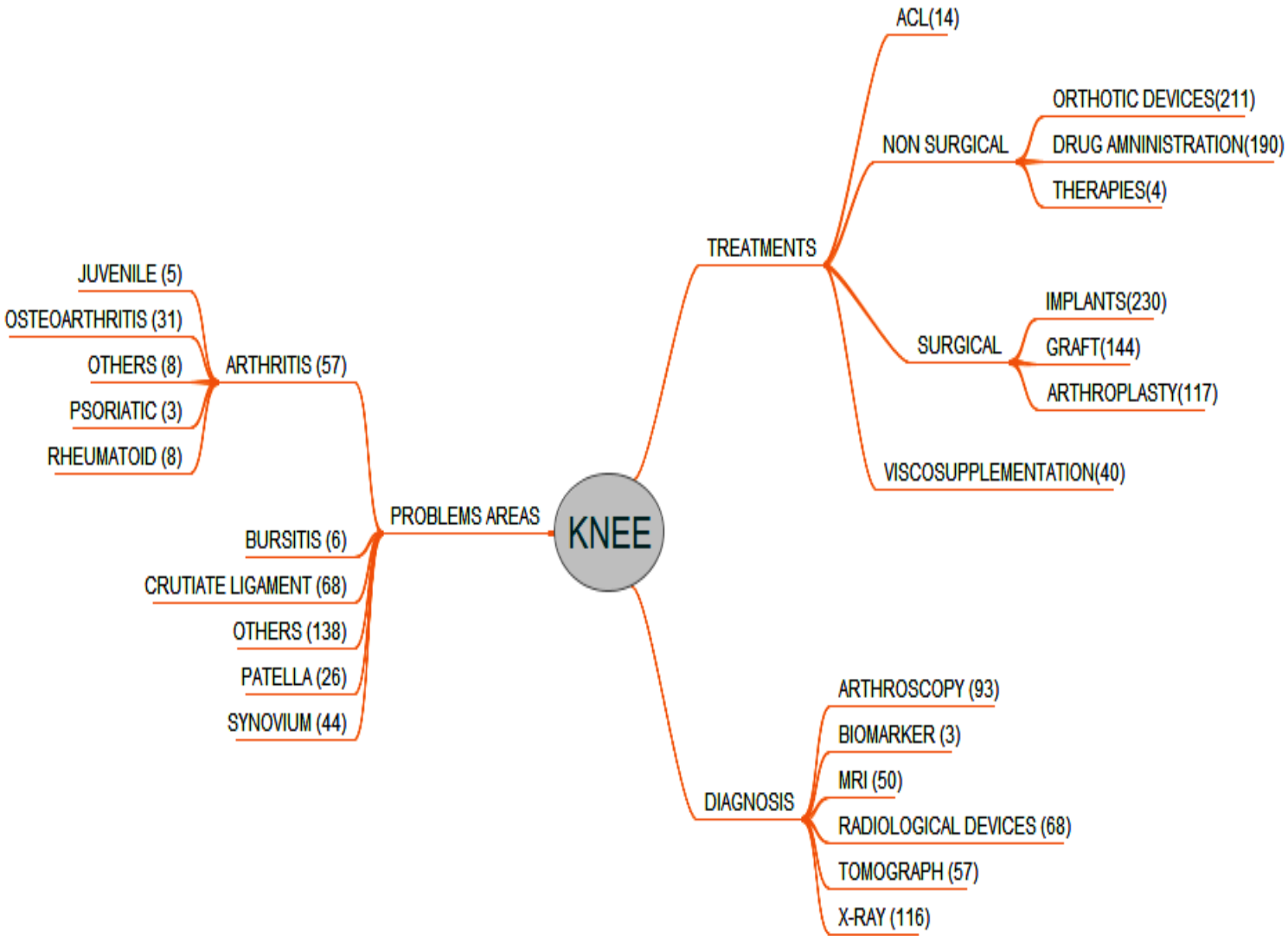


Arthroscopic Image

- Arthroscopy
- Biomarker
- MRI
- Radiological Devices
- Tomograph
- X-ray

The illustration below shows the different categories prepared and the number of records in each. The categorization involved defining a search strategy for each topic and then conducting the search using the Advanced Searching capability in Patent iNSIGHT Pro. Details of search strings used for each category are given in Appendix B.

Categorization Tree

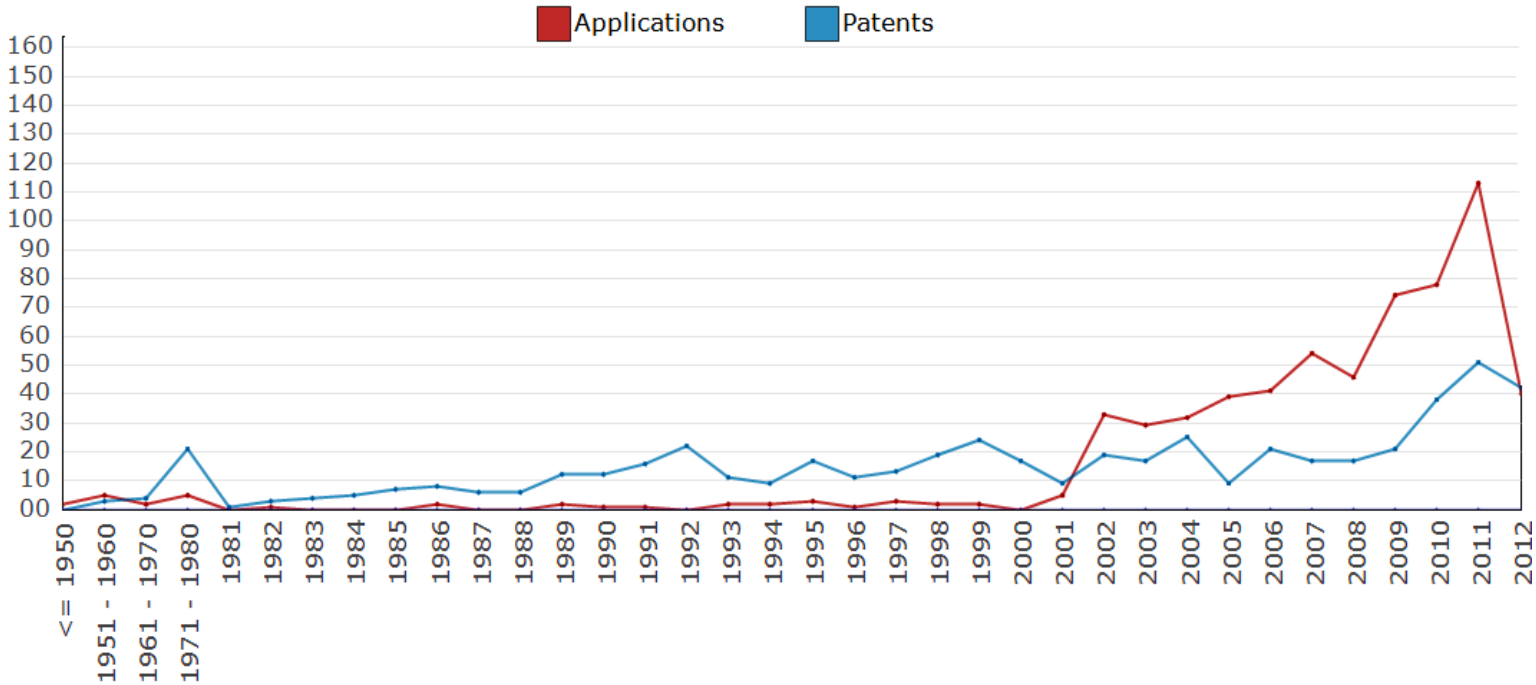


Publication Trend

What has been the IP publication trend for knee anatomy?

Patents related to knee anatomy can be traced back to 1951 and the real surge in the activity around this technology has happened in the last 5 years. Noticeably there was an increase in applications from 2008 onwards.

It's clear the current activity around these technologies is likely to continue seeing more innovation in the near future.

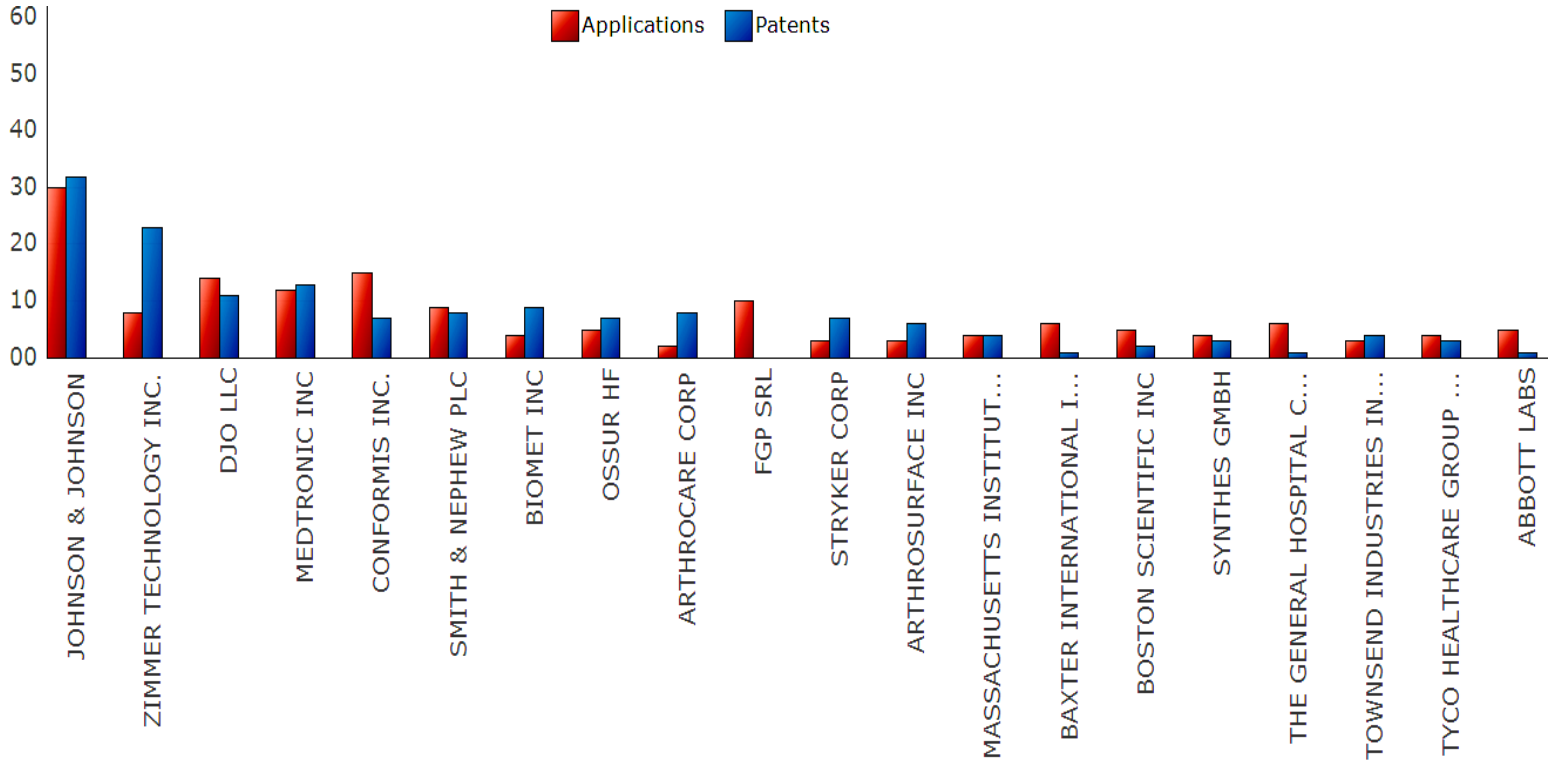


How we did it?

Once the patents were populated in Patent iNSIGHT Pro, the publication trend chart was generated on a single click using the dashboard tool.

Top Assignees

Who have been the top assignees or the key players within this area?



The top assignees are:

1. JOHNSON & JOHNSON
2. ZIMMER TECHNOLOGY INC
3. DJO LLC
4. MEDTRONIC INC
5. CONFORMIS INC
6. SMITH & NEPHEW PLC
7. BIOMET INC
8. OSSUR HF
9. ARTHROCARE CORP
10. FGP SRL
11. STRYKER CORP
12. ARTHROSURFACE INC
13. MASSACHUSETTS INSTITUTE OF TECHNOLOGY
14. BAXTER INTERNATIONAL INC
15. BOSTON SCIENTIFIC INC
16. SYNTHES GMBH
17. THE GENERAL HOSPITAL CORP
18. TOWNSEND INDUSTRIES INC
19. TYCO HEALTHCARE GROUP LP
20. ABBOTT LABS

How we did it?

Once the patents were populated in Patent iNSIGHT Pro, the assignee clean- up tools were used to normalize the names. Different cleanup tools were leveraged:

- To locate assignees for unassigned records
- To clean up records having multiple assignees
- To locate the correct assignee names for US records using the US assignments database
- To merge assignees that resulted from a merger or acquisition or name change.

Please refer Appendix A for more details on Assignee merging.

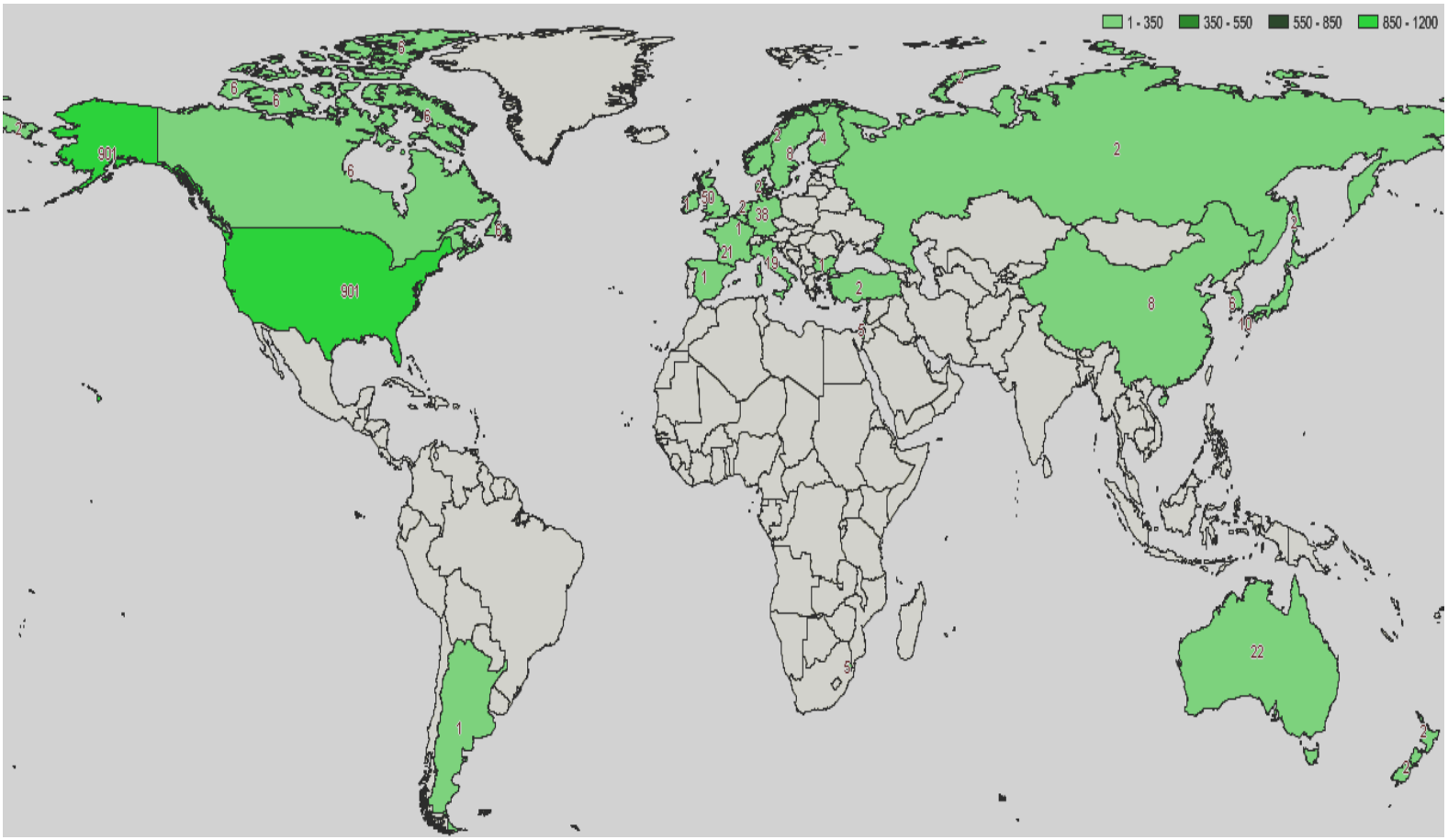
Once the Assignee names were cleaned up, the dashboard tool within Patent iNSIGHT Pro was used to find the top 20 assignees within the given patent set. A visual graph was created based on the results of the top assignees with the number of patents alongside each one.

The complete Assignee table in available in the following Excel file:
http://www.patentinsightpro.com/techreports/0612/List%20of%20Assignees.xls

Top Countries

How is research around knee anatomy spread across different countries?

In terms of regional pockets where patent protection is being sought most frequently for these technologies, US leads the count, followed by GB and DE. The table below ranks top priority countries and helps provide an indication of where innovation in this area is originating:



How we did it?

The map was generated using the Priority country coverage map option provided in the dashboard tool within Patent iNSIGHT Pro.

Country Code	Total
US	901
GB	50
DE	38
EP	29
AU	22

Assignee - Key Statistics

Here we summarize key parameters of Top 15 Assignees such as filing trend, Avg. number of Forward citations per record, Top inventors in each Assignee, Top Co-Assignees and Coverage of underlying patent families

Assignee	Total No. of Records	Avg. No. of Fwd Cites per Patents	Filing Trend (Absolute)	Filing Year Range	Key Inventor (Top 5)	Co-Assignees	Coverage (Includes families)						
							US	EP	WO	JP	DE	AU	CA
JOHNSON & JOHNSON	62 (5.3%)	43.45		1991-2011	SCHWARTZ HERBERT E(5) JAMIOLKOWSKI DENNIS D(4) MALAVIYA PRASANNA(4) ZANNIS ANTHONYD(4) ORTIZ MARK S(4)	GC LLC(1)	59	0	2	0	0	1	0
ZIMMER TECHNOLOGY INC	31 (2.7%)	46.45		1982-2011	LOZIER ANTONYJ(3) GOBLE E MARLOWE(3) MEYERS JOHNE(3) HAWKINS MICHAEL E(2) BENEDICT JAMESJ(2)	No Co-Assignee Present	30	0	0	0	0	0	0
DJO LLC	25 (2.2%)	16.32		1985-2009	GILDERSLEEVE RICHARD E(5) NATHANSON JEREMYJ.(4) TILLINGHAST THEODOREV.(3) BASTYR CHARLESA(3) SELIGMAN SCOTT(3)	No Co-Assignee Present	24	1	0	0	0	0	0
MEDTRONIC INC	25 (2.2%)	64.8		2002-2010	MCKAY WILLIAMF(4) SHIMP LAWRENCEA(4) WOHABREBBI AMIRA(3) BOYCE TODD M(3) GIL CARLOS(2)	No Co-Assignee Present	25	0	0	0	0	0	0

CONFORMIS INC	22 (1.9%)	7.55		2002-2010	LANG PHILIPP(21) DANIEL STEINES(18) FITZ WOLFGANG(11) VARGAS VORACEK RENE(7) TSOUGARAKIS KONSTANTINOS(6)	No Co-Assignee Present	13	7	0	0	0	2	0
SMITH & NEPHEW PLC	17 (1.5%)	25.88		1957-2011	DOW JAMES(2) JANI SHILESH C(2) COTTON NICHOLAS JOHN(2) THOMPSON ANDREW(1) LENZ NATHANIEL M(1)	No Co-Assignee Present	11	2	2	0	0	0	0
BIOMET INC	13 (1.1%)	47.23		1993-2011	MERIDEW JASOND(4) STONE KEVIN T(4) WALTERS TROY(3) KAISER RYAN A(2) ROMAN SHAWN D(1)	No Co-Assignee Present	14	0	0	0	0	0	0
OSSUR HF	12 (1%)	24.33		1987-2009	GRIM TRACY E(7) IGLESIAS JOSEPHM.(4) WYATT STACY(2) CASTILLO JAMES D.(2) BOBROFF ALEC D(2)	No Co-Assignee Present	12	0	0	0	0	0	0
ARTHROCARE CORP	10 (0.9%)	76		1995-2007	FOERSTER SETHA(5) EGGERS PHILIPE(3) THAPLIYAL HIRAV(3) WOLOSZKO JEAN(3) TASTO JAMES P(2)	No Co-Assignee Present	13	0	0	0	0	0	0

FGP SRL	10 (0.9%)	0		2004-2010	TURRINI ALBERTO(10) FERRIGOLO MORENO(9) WILBOURNE EDWARD G.(1)	No Co-Assignee Present	4	5	1	0	0	0	0
STRYKER CORP	10 (0.9%)	106.7		1986-2008	COLLAZO CARLOS E.(2) CURRY ALEXANDER(1) LYNCH MICHAEL D.(1) PARCHINSKI THOMAS J(1) DICKHUDT EUGENE A(1)	No Co-Assignee Present	9	1	0	0	0	0	0
ARTHROSURFACE INC	9 (0.8%)	13.44		2001-2008	EK STEVEN W(5) TALLARIDA STEVEN J(5) STEVEN J TALLARIDA(4) STEVEN W EK(4)	No Co-Assignee Present	2	3	0	0	0	4	0
MASSACHUSETTS INSTITUTE OF TECHNOLOGY	8 (0.7%)	97		1992-2011	LANGER ROBERTS(3) DA SILVA FERREIRA LINO(1) GOODSHIP ALLENE(1) FINK GERALD R(1) HUCKLE JAMES WILLIAM(1)	THE GENERAL HOSPITAL CORP(1)	9	0	0	0	0	0	0
BAXTER INTERNATIONAL INC	7 (0.6%)	151		1995-2010	HUNTER WILLIAML(5) GRAVETT DAVIDM(4) TOLEIKIS PHILIPM(4) LIGGINS RICHARDT(2) LOSS TROY A E(2)	No Co-Assignee Present	7	0	0	0	0	0	0
BOSTON SCIENTIFIC INC	7 (0.6%)	79.43		1997-2011	ATANASOSKA LILIANA(2) WARNER ROBERT(1) FREYMAN TOBY(1) NAIMARK	No Co-Assignee Present	7	0	0	0	0	0	0

					WENDY(1) PALASIS MARIA(1)								

How we did it?

From the Assignee 360° report options, we selected Top 15 Assignees and the different pieces of information we wanted to include in the singular display and then ran the report. The generated report was then exported to Excel using the option provided for the same.

Inventor - Key Statistics

Here we summarize key parameters of Top 15 Inventors such as filing trend, average number of forward citations per record, key associated companies and top 5 co-inventors.

Inventor	Total No. of Records	Average No. of Fwd Cites per Patents	Filing Trend (Absolute)	Filing Year Range	Key Assignees (Top 5)	Co-Inventors
LANG PHILIPP	21 (1.8%)	7.9		2002-2010	CONFORMIS INC(21)	DANIEL STEINES(18) FITZ WOLFGANG(11) VARGAS VORACEK RENE(7) TSOUGARAKIS KONSTANTINOS(6) BOUADI HACENE(5)
DANIEL STEINES	18 (1.6%)	8.67		2002-2010	CONFORMIS INC(18)	LANG PHILIPP(18) FITZ WOLFGANG(10) VARGAS VORACEK RENE(7) TSOUGARAKIS KONSTANTINOS(6) BOUADI HACENE(5)
FITZ WOLFGANG	11 (0.9%)	8		2003-2010	CONFORMIS INC(11)	LANG PHILIPP(11) DANIEL STEINES(10) VARGAS VORACEK RENE(7) BURDULIS ALBERT G(5) TSOUGARAKIS KONSTANTINOS(5)
TURRINI ALBERTO	10 (0.9%)	0		2004-2010	FGP SRL(10)	FERRIGOLO MORENO(9) WILBOURNE EDWARD G.(1)

FERRIGOLO MORENO	9 (0.8%)	0		2004-2010	FGP SRL(9)	TURRINI ALBERTO(9) WILBOURNE EDWARD G.(1)
GRIM TRACY E	9 (0.8%)	41.11		1988-2009	OSSUR HF(7) ROYCE MEDICAL CO(2)	IGLESIAS JOSEPH M.(4) BOBROFF ALEC D.(2) COBAR HUGO A.(2) WYATT STACY(2) BATMAN JANELLE R.(1)
MANSMANN KEVIN A	7 (0.6%)	30.14		1998-2008	MANSMANN KEVIN A(6) POPPER PETER(1) POTTER ALVIN A(1) ARTHRO ALLIANCE LLC(1)	POPPER PETER(1) POTTER ALVIN A(1)
MURATOGLU ORHUN K	7 (0.6%)	11.14		2006-2011	THE GENERAL HOSPITAL CORP(5) CAMBRIDGE POLYMER GROUP INC(2) MASSACHUSETTS INSTITUTE OF TECHNOLOGY(1)	ORAL EBRU(3) SPIEGELBERG STEPHEN H(3) BRAGDON CHARLES R(1) HARRIS WILLIAM H(1) JASTY MURALI(1)
TOWNSEND JEFFREY H.	7 (0.6%)	7.29		1988-2005	TOWNSEND INDUSTRIES INC(6) TOWNSEND IND INC(1)	KNECHT STEVEN S.(4) WILLIAMS ROBERT J.(1)
VARGAS VORACEK RENE	7 (0.6%)	10.43		2003-2010	CONFORMIS INC(7)	DANIEL STEINES(7) FITZ WOLFGANG(7) LANG PHILIPP(7) BURDULIS ALBERT G(5) TSOUGARAKIS KONSTANTINOS(5)

BURDULIS ALBERT G	6 (0.5%)	12.17		2004-2008	CONFORMIS INC(6)	DANIEL STEINES(5) FITZ WOLFGANG(5) LANG PHILIPP(5) VARGAS VORACEK RENE(5) BOUADI HACENE(3)
GOBLE E MARLOWE	6 (0.5%)	120.7		1985-2006	ZIMMER TECHNOLOGY INC(3) GOBLE E M(1) GCL L.C.(1) JOHNSON & JOHNSON(1) MEDICINELODGE INC(1)	JUSTIN DANIEL F(2) CHERVITZ ALAN(1) CREGER CARLYE J(1) DEHART LARRY(1) DEVER JOEL(1)
REILEY MARK A	6 (0.5%)	14.67		2001-2011	WRIGHT MEDICAL TECHNOLOGY INC(3) ARCHUS ORTHOPEDICS INC(1) REILEY MARK A(1) MEDTRONIC INC(1)	DAVIDSON JAMES(1) GREENBERG LOUIS E.(1) ICO CESAR(1) MAULDIN GARRETT R.(1) REISS PAUL(1)
TSOUGARAKIS KONSTANTINOS	6 (0.5%)	12.67		2002-2010	CONFORMIS INC(6)	DANIEL STEINES(6) LANG PHILIPP(6) FITZ WOLFGANG(5) VARGAS VORACEK RENE(5) BIJAN TIMSARI(3)
BOUADI HACENE	5 (0.4%)	17.2		2003-2005	CONFORMIS INC(5)	DANIEL STEINES(5) LANG PHILIPP(5) MILLER DAVID(5) BURDULIS ALBERT G(3) FITZ WOLFGANG(3)

How we did it?

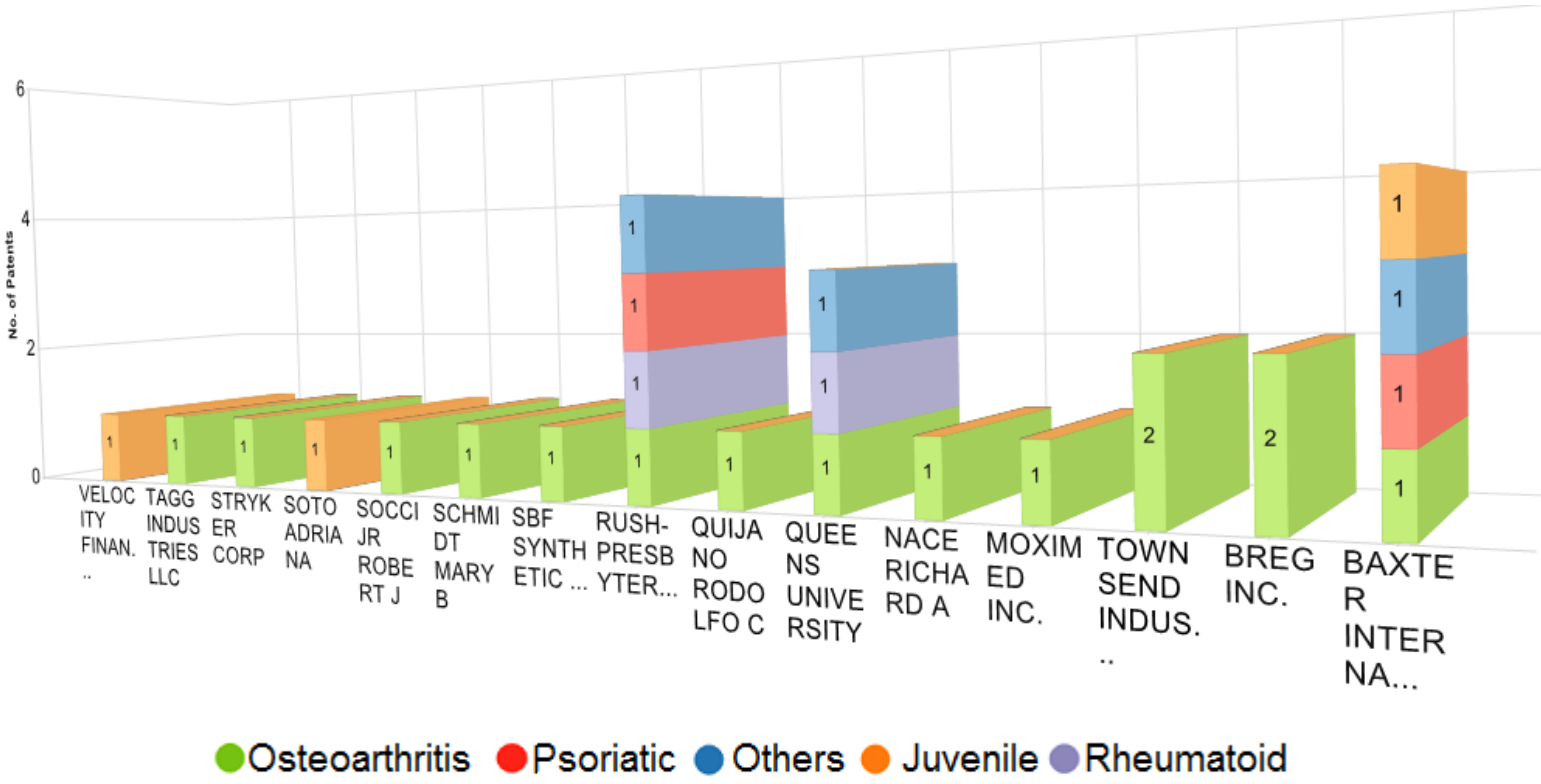
From the Inventor 360° report options, we selected the different pieces of information we wanted to include in the singular display and then ran the report. The generated report was then exported to Excel using the option provided for the same.

Company Portfolio spread across various knee problem areas

Medtronic Inc focuses more towards Synovium. Baxter International Inc on the other hand has patents dealing with Arthritis.

Problem Areas(Columns) / Assignees(Rows)	Total	Other Problem Areas	Arthritis	Crutiate Ligament	Patella	Synovium
Total	60	26	7	17	9	11
JOHNSON & JOHNSON	14	9	1	4		2
ZIMMER TECHNOLOGY INC	5	1	1	1	2	
MEDTRONIC INC	5	1				5
MASSACHUSETTS INSTITUTE OF TECHNOLOGY	4	2	1	1		1
SMITH & NEPHEW PLC	3	2		1	1	
OSSUR HF	3	2			1	
MUSCULOSKELETAL TRANSPLANT FOUNDATION	3			3	3	
MANSMANN KEVIN A	3	1			1	2
DJO LLC	3		1	1	1	
CHILDRENS MEDICAL CENTER CORP	3			3		1
BOSTON SCIENTIFIC INC	3	3				
BAXTER INTERNATIONAL INC	3		3			
ARTHROCARE CORP	3	2		1		
ARTHREX INC	3	1		2		
FIDIA ADVANCED BIOPOLYMERS SRL.	2	2				

The chart below shows patent portfolio for different arthritis types across top 15 assignees



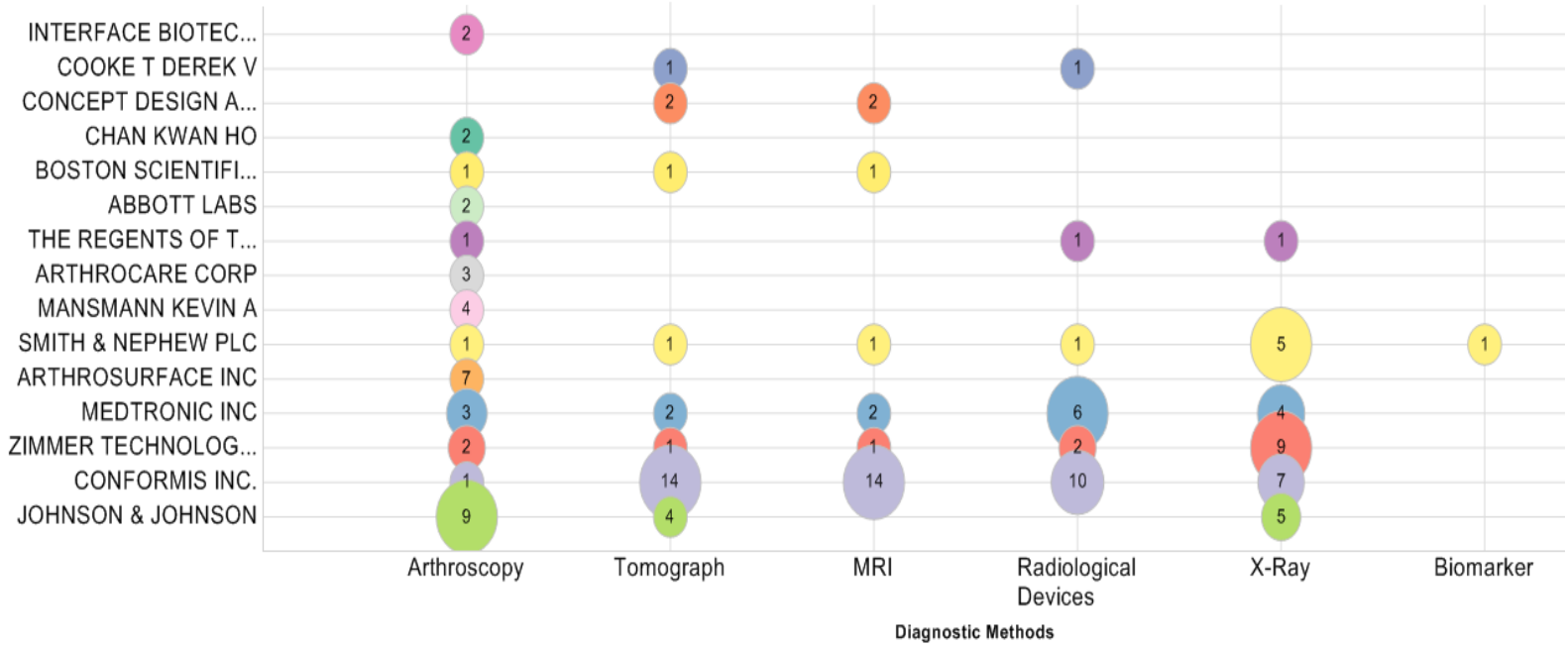
How we did it?

First the various types of knee problem areas were identified by online research. Then by using a combination of semantic analysis tools such as the clustering tools and searching tools available in Patent iNSIGHT Pro, patents were categorized under the different types. A co-occurrence matrix was generated to map the knee problem areas with assignees. The matrix was filtered for the top 15 assignees and then exported to Excel.

Similarly, a matrix for top 15 assignees was generated after applying filters to second level categories and then the resulting matrix was converted into a 3-D stacked column chart.

Key Companies vs. Diagnostic Methods

Which assignees hold the maximum inventions across different diagnostic methods?



Conformis Inc dominates patent holdings for tomography, MRI and radiological devices. Arthrosurface Inc is only active in arthroscopy.

How we did it?

Once various diagnostic methods were identified by online research, patents were categorized accordingly. Using the co-occurrence analyzer, the records were mapped with top 20 assignees and the resulting matrix was converted into a bubble chart.

Key Companies vs Knee Treatment Methods

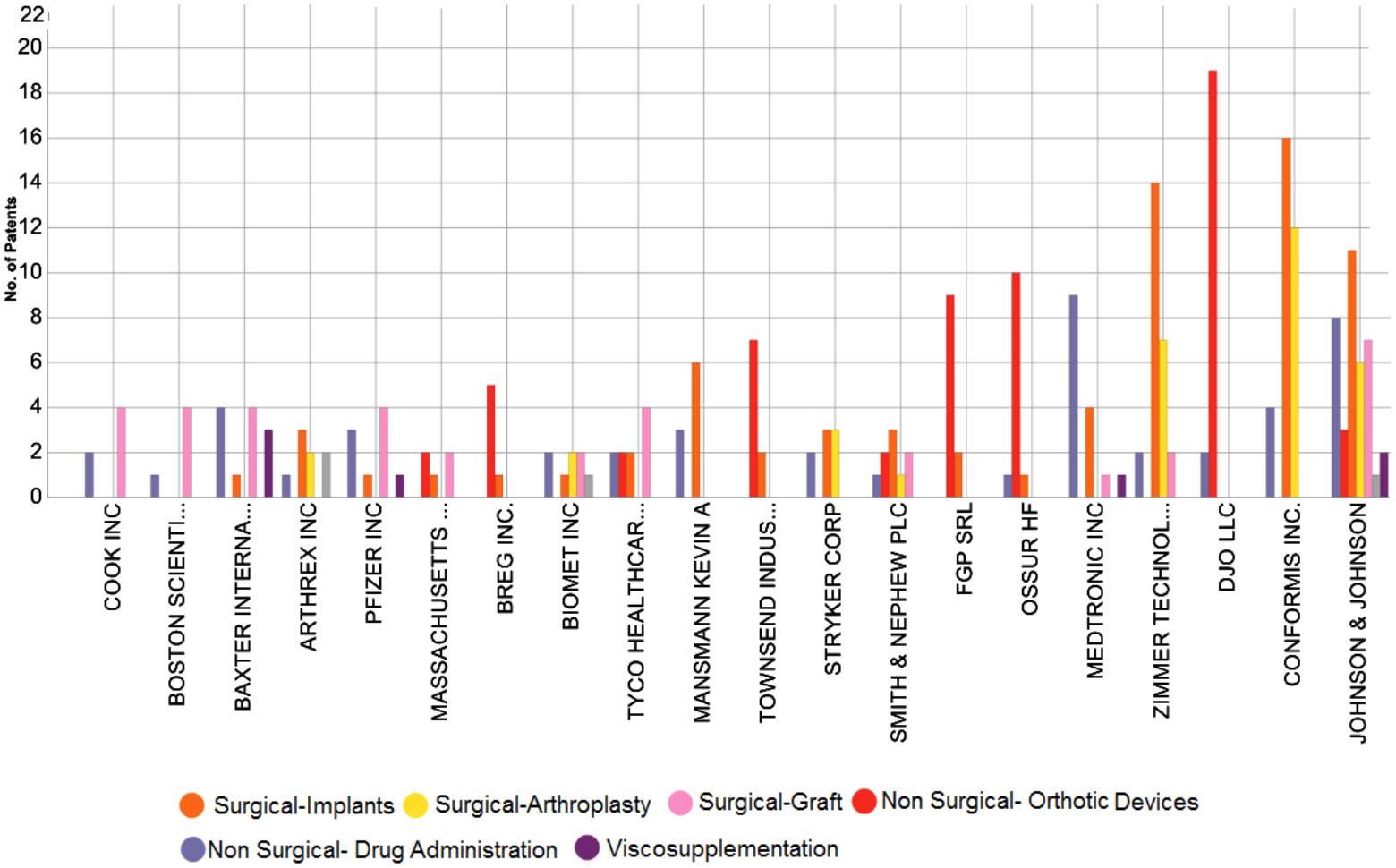
How is assignee portfolio spread across various treatment procedures?

Conformis Inc leads the patents on implants with 16 records. DJO LLC is actively involved in Orthotic Devices research. Johnson & Johnson has presence over the complete treatment portfolio.

Treatments (Rows) / Key Assignees (Columns)	Total	NON SURGICAL		SURGICAL			ACL	Viscosupplementation
		Drug Administration	Orthotic Devices	Implants	Arthroplasty	Graft		
Total	185	47	59	72	33	36	4	7
JOHNSON & JOHNSON	27	8	3	11	6	7	1	2
CONFORMIS INC	20	4		16	12			
ZIMMER TECHNOLOGY INC	19	2		14	7	2		
DJO LLC	19	2	19					
OSSUR HF	11	1	10	1				
MEDTRONIC INC	11	9		4		1		1
FGP SRL	9		9	2				
TOWNSEND INDUSTRIES INC	7		7	2				
STRYKER CORP	7	2		3	3			

SMITH & NEPHEW PLC	7	1	2	3	1	2		
TYCO HEALTHCARE GROUP LP	6	2	2	2		4		
MANSMANN KEVIN A	6	3		6				
PFIZER INC	5	3		1		4		1
MASSACHUSETTS INSTITUTE OF TECHNOLOGY	5		2	1		2		
BREG INC	5		5	1				
BIOMET INC	5	2		1	2	2	1	
COOK INC	4	2				4		
BOSTON SCIENTIFIC INC	4	1				4		
BAXTER INTERNATIONAL INC	4	4		1		4		3

The below chart represents the graphical interpretation of the above matrix

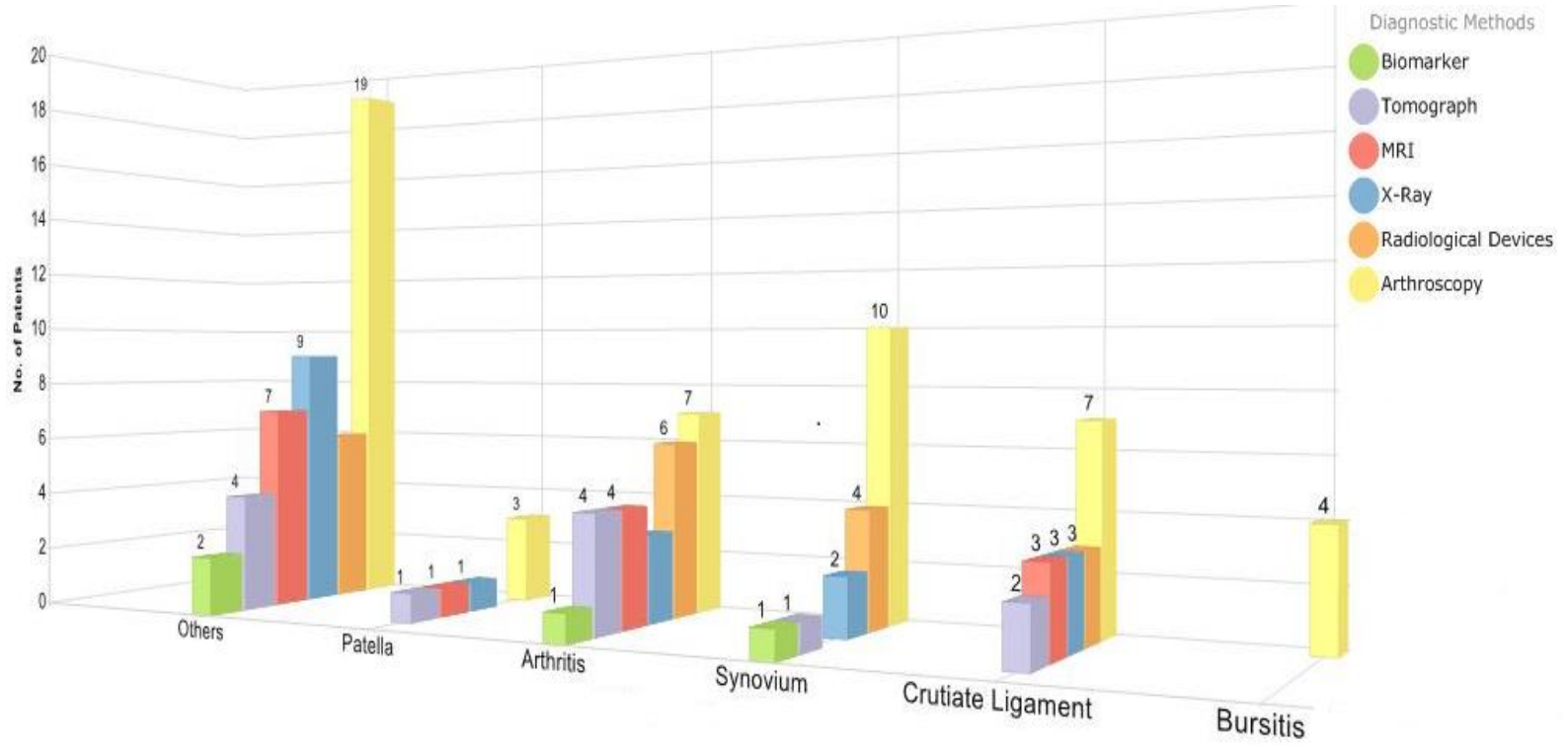


How we did it?

The clusters that were created for the analysis were correlated using the co-occurrence analyzer and then the resulting matrix was exported to Excel and a clustered column chart was generated.

Knee Problems vs Diagnostic Methods

What are the different diagnostic methods used for various knee problem?



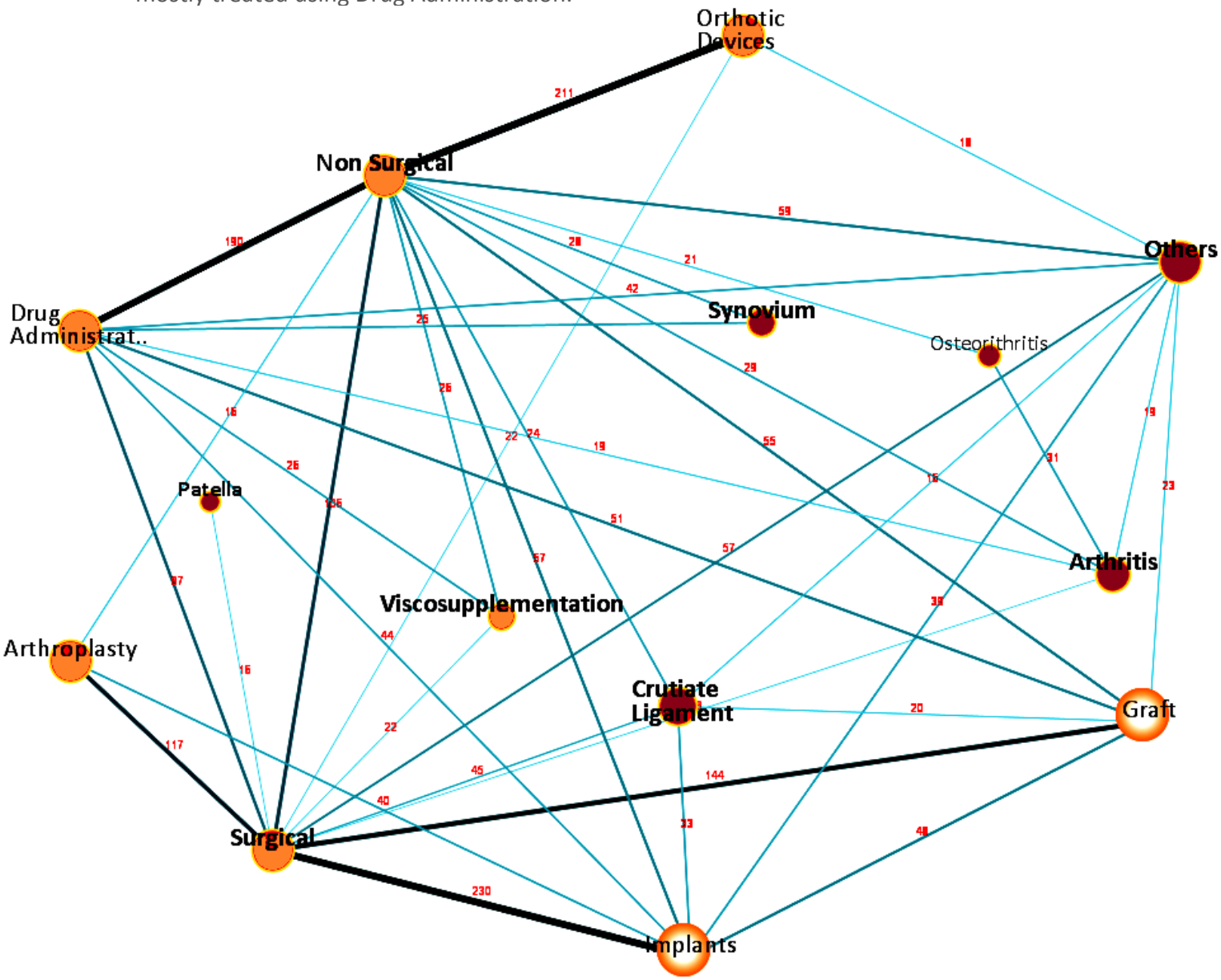
We can see problems relating to Synovium, Crutiate Ligament and Arthritis can possibly be diagnosed using arthroscopy.

How we did it?

The clusters that were created for the previous analysis were correlated using the co-occurrence analyzer and then the resulting matrix was converted into a 3-D column chart.

Key Problem Areas vs Treatments

In the map, each treatment method is connected through links whose thickness and color intensity is directly proportional to the number of records relating them. The number (in red) next to each line represents the number of records present in a particular treatment type and problem areas.
It can be seen that surgical treatments are more performed on Patella. Also, Synovium is mostly treated using Drug Administration.



Note: The darker nodes represent the Problem areas, whereas remaining nodes refer to the Treatment methods.

How we did it?

The clusters that were created for the previous analysis were correlated using the co-occurrence analyzer and then the resulting matrix was represented as Correlation Map.

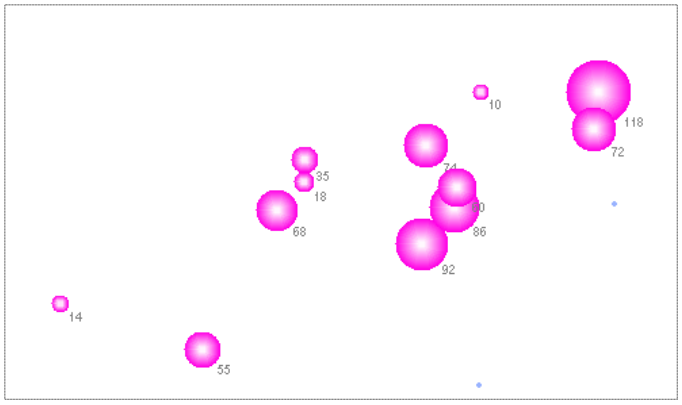
Co-Citation Based Visual Clustering

Which patents of key assignees have been co-cited and what technology areas are they dealing with?

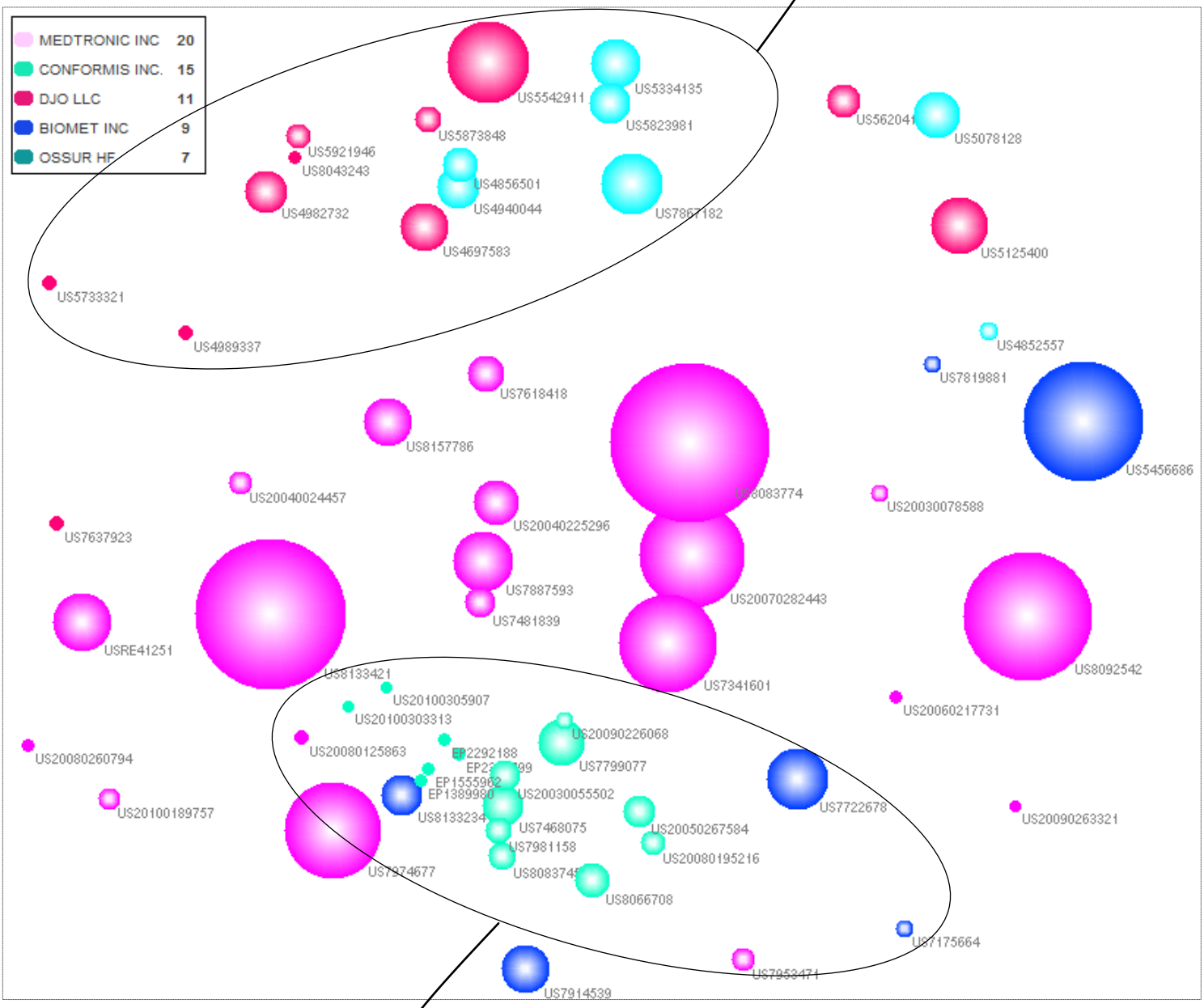
The map shows the portfolios of top 5 assignees based on their co-citations. The co-cited patents get clustered together. The map also shows the various technologies these cluster of co-citing patents are dealing with.

The VizMAP tool in Patent iNSIGHT Pro was used for this analysis. First the patents of top 5 assignees were loaded on the map. The map was then clustered in VizMAP in the co-citation mode. In this mode those patents that have share a high number of co-cites get clustered together in VizMAP. The record nodes were then inflated based on the number of forward citations they had and labeled the nodes with respective patent numbers.

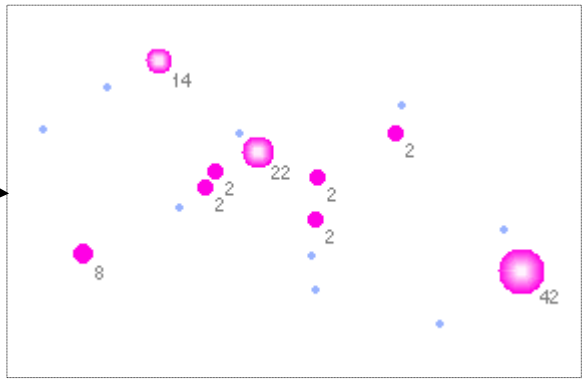
Finally, we used advanced search option in Vizmap to identify technology clusters over the co-citation map that was generated. Specifically we looked for records relating to Knee Braces and Knee Implants. Two clear separate clusters were identified and these have been highlighted in the image below.



Knee Brace Cluster: This cluster covers the set of records on knee braces. The magnified image shows the hit count for number of occurrences for the query: (brace* or bracing) w/3 knee in full text of the records.



Knee Implant Cluster: This cluster covers records on knee implants. The magnified image shows the hit count for number of occurrences for the query: (knee w/3 implant*) in full text of the records.

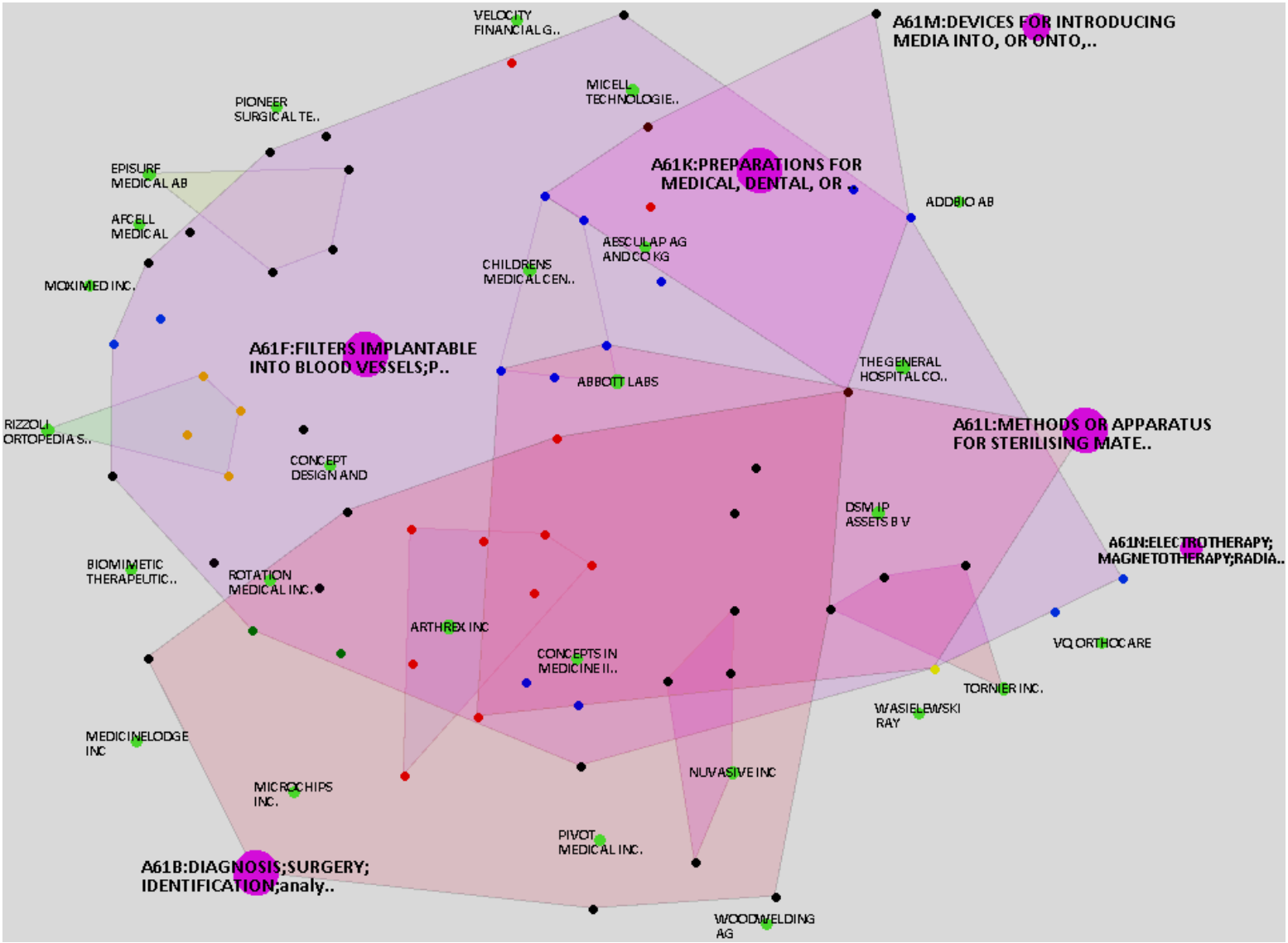


How we did it?

The VizMAP tool in Patent iNSIGHT Pro was used for this analysis. First the patents of key assignees were loaded on the map. The map was then analyzed in the co-citation mode. The advanced search option in Vizmap was used to search for the records talking about Knee Braces.

New Companies in the last 5 years having 2 or more records

The generated map below highlights patents of unique assignees present in our data set in the last 5 years having 2 or more records within key IPC.
Nuvasive Inc and Arthrex Inc are actively filing patents in A61B as compared to other classes.



How we did it?

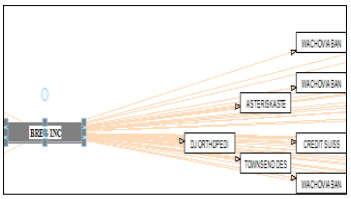
Using the Assignee Activity feature in VizMAP tool, we first set the filter definition for New Assignees to be equivalent to "All Patents Issued In/After 2006". Clicking on New Assignees then generated the above map. We then restricted the map to those Assignees having 2 or more filings in the last 5 years.
These were then expanded by key IPC classes. The VizShade option was used to shade the assignees with potential overlapping IPC classes between them.

Portfolio Citation Analysis

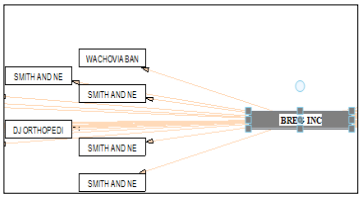
Patent citations provide significant information on technological advancements, importance of a technology, in addition to patent biblio data, enabling the R&D team to research accordingly. A portfolio that is highly interconnected may indicate that the company holding these patents is building a strong portfolio, with one patent building off and supporting others.

We randomly selected Breg Inc which had relatively smaller patent portfolio but with a higher degree of forward citations. The records of Breg Inc were grouped together and using the citation analysis option in the software, citation tree for forward and backward citations was generated.

Please click on image below for full size images of forward and backward citation trees for Breg Inc.



Forward Citations



Backward Citations

The biblio details for the forward cited patents for Breg Inc were exported to Excel. The table is shown below:

Patent Number Title	Assignee	Issue Date	Summary
US8048013 Orthopedic brace and component for use therewith	OSSUR HF	2011/11/01	An orthopedic device includes a rigid frame assembly having rigid frame supports connected by joints
USD529180 Knee brace	OSSUR HF	2006/09/26	
WO12037275 Posterior Cruciate Ligament Support Brace	STEADMAN PHILIPPON RESEARCH INST	2012/03/22	This disclosure describes systems, methods, and apparatus for a knee brace providing a dynamic resistance or anterior force to a shank of a leg in order to replicate PCL forces of a healthy PCL.
US7059329 Knee Brace providing dynamic tracking of the patello-femoral joint	BREG INC	2006/06/13	A knee orthosis is provided having upper and lower arms and a hinge assembly positionable about the knee to one side of the patella.

US6878126 Contoured knee brace frame	DJO LLC	2005/04/12	The present invention provides an improved knee brace that is configured to improve comfort to the user and reduce interference with the natural motion of the users leg.
US7311687 Osteoarthritis brace	DJO LLC	2007/12/25	An osteoarthritis brace having relatively large semi-rigid cuffs for abutting the wearers thigh and calf.
US7011640 Vacuum orthosis and associated methods	SARMIENTO AUGUSTO MD	2006/03/14	The vacuum orthotic device includes the use of an inner sleeve, a single or multi-piece shell, and an outer sleeve.
USD657879 Orthopedic device	OSSUR HF	2012/04/17	The ornamental design for an orthopedic device, as shown and described.
WO03068115 Brace hinge with telescoping condyle pad	DJ ORTHOPEDICS LLC	2003/08/21	A brace hinge is provided having an adjustable pressure-applying assembly mounted to an inside of the hinge.
US8128587 CABLE-BASED ORTHOPEDIC BRACING SYSTEM	SP DESIGN LLC	2012/03/06	An orthopedic bracing system for providing support to a joint of an individual is provided.
WO0149222 KNEE BRACE LOAD SENSOR CAPTEUR DE CHARGE POUR PROTHESE DE GENOU	DJ ORTHOPEDICS LLC	2001/07/12	A method and apparatus is provided for measuring the treatment force exerted by the contact pad (98, 222) of an orthopedic brace (10) upon the joint (130) of a wearer.
WO11154779 ARTICULATED JOINT FOR KNEE BRACE TO CORRECT VARUS OR VALGUS KNEE JONCTION ARTICULEE POUR ATTELLE DE GENOU POUR CORRIGER UN GENOU VARUS OU VALGUS	FGP SRL	2011/12/15	A knee brace consisting of a device designed to correct varus or valgus knee, this knee brace substantially consisting of a joint (10) formed by two bars (11, 12) which are united in correspondence with an articulated joint (13), the joint (13) of the knee brace being equipped with a cap (14) which, due to the action of the mechanism, moves away from or closer to the joint at right angles with respect to the plane on which the joint moves angularly, like a sort of pantograph.
USD517248 Patella cup protector	ASTERISKASTERISK LLC	2006/03/14	
US7524296 Vacuum orthosis and associated methods	SARMIENTO AUGUSTO MD	2009/04/28	The vacuum orthotic device includes the use of an inner sleeve, a single or multi-piece shell, and an outer sleeve.

US6890314 Knee brace hinge deflector	DJO LLC	2005/05/10	A knee brace hinge deflector is provided for preventing interference and/or locking of the medial hinges of bilateral knee braces.
US6623439 Contoured knee brace frame	DJO LLC	2003/09/23	The present invention provides an improved knee brace that is configured to improve comfort to the user and reduce interference with the natural motion of the users leg.
US8167829 Orthotic apparatus	BELLACURE INC	2012/05/01	In one embodiment of the invention, an orthotic apparatus includes a frame structure having an upper frame portion moveable relative to a lower frame portion.
US8100956 Method of and system for thermally augmented wound care oxygenation	THERMOTEK INC	2012/01/24	An oxygenation and temperature thermal therapy and oxygenation treatment pad with a plurality of air chambers is disclosed for treatment of skin wound tissues.
USD637942 Strap retainer	OSSUR HF	2011/05/17	The ornamental design for a strap retainer, as shown and described.
US6895969 Orthopedic traction device	COMPOSITE MFG INC	2005/05/24	An orthopedic traction apparatus includes in coaxial arrangement, a first tubular member anchored to a operating table or other stationary structure supporting a patient, and a second tubular member telescopically moving within the first one.
WO02060360 Anatomical brace with rapid-release securement members	ASTERISKASTERISK LLC	2002/08/08	An exteriorly positionable anatomical brace for protecting a uniting pivoting joint disposed between a first limb structure and a second limb structure of a living being.
EP1854434 JOINT ORTHOSIS	OTTO BOCK HEALTHCARE GMBH	2007/11/14	A joint orthosis including an upper member, a lower member operably connected to the upper member by one or more swivel axes at a joint mechanism, and a pad attached to the joint mechanism and positioned between the joint mechanism and the body part, wherein the joint mechanism includes a clip connection for securing the pad to the joint mechanism.
US6527733 Hinge assembly for an orthopedic knee brace and knee brace incorporating the hinge assembly	DJO LLC	2003/03/04	A hinge assembly is provided for an orthopedic knee brace.
US7806842	SP DESIGN LLC	2010/10/05	An orthopedic bracing system for providing support to a joint of an individual is provided.

CABLE-BASED ORTHOPEDIC BRACING SYSTEM			
US6793641 Anatomical brace with rapid-release securement members	ASTERISKASTERISK LLC	2004/09/21	An exteriorly positionable anatomical brace for protecting a uniting pivoting joint disposed between a first limb structure and a second limb structure of a living being.
AU2003209124 Brace hinge with telescoping condyle pad	DJ ORTHOPEDICS LLC	2003/09/04	A brace hinge is provided having an adjustable pressure-applying assembly mounted to an inside of the hinge.
US6752775 Brace hinge with telescoping condyle pad	DJO LLC	2004/06/22	A brace hinge is provided having an adjustable pressure-applying assembly mounted to an inside of the hinge.
US7485103 Rotational hinge assembly for a knee brace having an osteoarthritis treatment function	BREG INC	2009/02/03	A hinge assembly for a knee brace includes a screw seat, a screw seat gear, an adjustment screw, a condyle engagement member, and an adjustment actuator gear.
US7804686 Thermal control system for rack mounting	THERMOTEK INC	2010/09/28	A thermal control system of a 3U height includes various modules for providing temperature control in a rack environment.
US6913587 Traction splint	THE UNIVERSITY OF NEW MEXICO	2005/07/05	The present invention provides a splint that may be telescopically extendable, coarsely and finely adjustable, and providing a mechanical advantage while being readily transportable
USD548844 Knee brace	ASTERISKASTERISK LLC	2007/08/14	
US7749183 Orthopedic brace and component for use therewith	OSSUR HF	2010/07/06	An orthopedic device includes a rigid frame assembly having rigid frame supports connected by joints
US8062242 Hinge assembly for an orthopedic knee brace and knee brace incorporating the	DJO LLC	2011/11/22	A hinge assembly is provided for an orthopedic knee brace

hinge assembly			
US7306572 Hinge assembly for an orthopedic knee brace and knee brace incorporating the hinge assembly	DJO LLC	2007/12/11	A hinge assembly is provided for an orthopedic knee brace.
US6413232 Orthopedic knee brace having an adjustable knee pad support	TOWNSEND DESIGN	2002/07/02	An orthopedic knee brace has a pair of femoral and tibial links, a hinge mechanism connecting the femoral and tibial links, a condylar knee pad support fixedly positioned on the lateral side of the brace and made adjustable by a spring-loaded ratchet mechanism featuring a series of interlocking teeth that allows for the axial displacement of the condylar pad to supply corrective force to the lateral knee joint and prevent of any unintended change in correction force.
USD588753 Patella protector assembly	OSSUR HF	2009/03/17	
US7204819 Guard structure for protecting the lower limbs of the human body	ALPINESTARS RESEARCH SRL	2007/04/17	Guard structure (10) for protecting a lower limb, comprising a number of substantially rigid members (14, 26, 32), which are adapted to be removably and adjustably applied on to the thigh and the calf of the user.
DE102006021789 JOINT ORTHOSIS	OTTO BOCK HEALTHCARE GMBH	2007/11/22	A joint orthosis including an upper member, a lower member operably connected to the upper member by one or more swivel axes at a joint mechanism, and a pad attached to the joint mechanism and positioned between the joint mechanism and the body part, wherein the joint mechanism includes a clip connection for securing the pad to the joint mechanism.
US7909861 Critical care thermal therapy method and system	THERMOTEK INC	2011/03/22	A critical care thermal therapy system incorporating a remote temperature sensor in association with a thermal module adapted for delivering a fluid to a patient in response to the sensed temperature thereof.
US8142486 Method of and system for thermally augmented wound care oxygenation	THERMOTEK INC	2012/03/27	An oxygenation and temperature thermal therapy and oxygenation treatment pad with a plurality of air chambers is disclosed for treatment of skin wound tissues.
US7435234 Non-surgical correcting abnormal	THE REGENTS OF THE UNIVERSITY OF COLORADO	2008/10/14	The invention provides hinges for use in knee braces to correct and prevent knee pathology.

knee loading			
US7887496 JOINT ORTHOSIS	OTTO BOCK HEALTHCARE GMBH	2011/02/15	A joint orthosis including an upper member, a lower member operably connected to the upper member by one or more swivel axes at a joint mechanism, and a pad attached to the joint mechanism and positioned between the joint mechanism and the body part, wherein the joint mechanism includes a clip connection for securing the pad to the joint mechanism. The upper and lower members include a means for attaching the joint orthosis to a body part of a user, such as an extremity.
US8128672 Method of and system for thermally augmented wound care oxygenation	THERMOTEK INC	2012/03/06	An oxygenation and temperature thermal therapy and oxygenation treatment pad with a plurality of air chambers is disclosed for treatment of skin wound tissues.

Technology Patent Mapping

The tables below highlight trademarks for key technologies in US. They also map the patents according to technology relevance within our data set.

How we did it?

We searched for Trademarks for each assignee relating to the product line. Then we searched for records for the particular technology, manually reviewed and finally mapped them using the software.

DJO LLC

Relevance	Trademarks	Overall No of Patents	Patents Mapped	Patent Numbers
Braces	▪ AIR DONJOY ▪ AIRCAST ▪ BELL-HORN ▪ CPB ▪ DEFIANCE ▪ DONJOY ▪ MONTANA ▪ OADJUSTER ▪ PERFORMER ▪ PRO STYLE ▪ PROCARE ▪ REHAB 3 ▪ SPIDER PAD	**25**	**19**	EP1189558 US20010014782 US20030045822 US20030060745 US20030149386 US20030153856 US20040153017 US20050148916 US20050148917 US20080082031 US20100010409 US4697583 US4982732 US5125400 US5542911 US5620411 US5873848 US5921946 US8043243

ARTHREX INC

Relevance	Trademarks	Overall No of Patents	Patents Mapped	Patent Numbers
Suturing/ ACL Repair	▪ ALL INSIDE ▪ ARTHREX ACP ▪ ARTHREX SUTUREBRIDGE ▪ ARTHROBROSTROM ▪ BANANA SUTURELASSO ▪ BIO-CORKSCREW ▪ BIO-FASTAK ▪ BIO-POST ▪ BIO-SUTURETAK ▪ BIOWIRE ▪ BIRDBEAK ▪ BIRDBEAK EVOLUTION ▪ CORKSCREW ▪ DOUBLE SCORPION ▪ FIBERCHAIN ▪ FIBERLOOP ▪ FIBERSNARE ▪ FIBERWIRE ▪ GRAFTLINK ▪ GRAFTROPE ▪ NEEDLEPUNCH ▪ PUSHLOCK ▪ RETROPASSER ▪ SIDEWINDER ▪ SUREFIRE ▪ SUTUREMITT ▪ SUTURETAK ▪ SWIVELOCK ▪ TIGERSTICK ▪ TIGERTAIL ▪ TIGERWIRE ▪ TRIPLEPLAY ▪ V-TAK	**6**	**2**	US20070135839 US20120065732
Allograph	▪ BIOCARTILAGE		**1**	US7124762
Osteotomy	▪ CONTOURLOCK HTO PLATE		**1**	US8083746
Implants	▪ ARTHREX QUICKFIX ▪ ARTHROBROSTROM ▪ BIO-SPONGE ▪ IBALANCE ▪ PLAPLE ▪ PROSTOP		**2**	US8012206 US8162947

NUVASIVE INC

Relevance	Trademarks	Overall No of Patents	Patents Mapped	Patent Numbers
Prosthesis/ Implants	▪ AFFIX ▪ ARMADA ▪ ATTRAX ▪ BENDINI ▪ BRIGADE ▪ CERPASS ▪ COROENT ▪ CREATIVE SPINE TECHNOLOGY ▪ DBR ▪ EASYSCREEN ▪ EMBRACE ▪ EXTENSURE ▪ EXTENSURE ▪ ILIF ▪ IOS INTEGRATED OPERATIVE SOLUTIONS ▪ JJB ▪ MAS ▪ MICROLIF ▪ MICROXLIF ▪ NEUROVISION ▪ NUVASIVE ▪ NUVASIVE ▪ NVJJB ▪ OSTEOCEL ▪ PRECEPT ▪ SAGE ▪ SMARTPLATE	**4**	**3**	US20090105826 US20110054610 US20110060366

ARTHROCARE CORP

Relevance	Trademarks	Overall No of Patents	Patents Mapped	Patent Numbers
Electrosurgery/ Electrosurgical	▪ AMBIENT ▪ ARTHROCARE ▪ ARTHROWAND ▪ ATLAS ▪ CAPSURE ▪ CAVITY ▪ COBLATION ▪ COBLATION-CHANNELING ▪ COBLATOR ▪ COBLATOR IQ ▪ COVAC ▪ COVATOR ▪ DEBRIDEMENT WAND ▪ DIAMONDVAC ▪ EVAC ▪ EXCISE ▪ HIPVAC ▪ LANCELOT ▪ LOPRO ▪ MEGAVAC ▪ MENIVAC ▪ MICRO TOUCH ▪ MICROBLATOR ▪ MULTIVAC ▪ ORTHOWAND	**10**	**4**	US20030171743 US5697281 US6805130 US7717912

	▪ PARAGON T2 ▪ PROCISE ▪ PROCISE EZ VIEW ▪ REFLEX ULTRA ▪ SPINEWAND ▪ STARVAC ▪ T2 ▪ TITAN ▪ TOPAZ ▪ TRISTAR ▪ TURBINATOR ▪ TURBOVAC ▪ VERSITOR ▪ VISAGE ▪ WOUNDWAND			
Suture	▪ ATLANTECH ▪ AUTOCUFF ▪ CLEARCUT ▪ FIRSTPASS ▪ GRAFTLOK ▪ INCLINE MATTRESS ▪ LABRAFIX ▪ LOBSTER CLAW ▪ MAGNAFORCE ▪ MAGNUMWIRE ▪ OPUS ▪ OPUS MINIMAGNUM ▪ PARAFIX ▪ PARASORB ▪ PERFECTPASSER ▪ SIDEWINDER ▪ SMARTSTITCH ▪ SPEEDSTITCH		**4**	US20030195563 US6520980 US7083638 US7285124

Appendix A: Key Assignee Normalization Table

Note: The tables below include normalization from US Assignments database and so some assignees may appear under multiple normalized names.

JOHNSON & JOHNSON

DEPUY ORTHOPAEDICS INC
CAMBRIDGE SCIENT INC
ETHICON INC
MITEK SURGICAL PROD
INNOVATIVE CARE LTD
DEPUY MITEK INC
CORDIS CORP
SHERMAN JASON T DISILVESTRO MARK R
ETHICON ENDO SURGERY INC
DEPUY PRODUCTS INC

ZIMMER TECHNOLOGIES INC

SULZER ORTHOPEDICS INC
CASPARI RICHARD B ROBERTS JEFFREY G TREACE JAMES T
ZIMMER ORTHOBIOLOGICS INC
SULZER CALCITEK INC
INTERMEDICS ORTHOPEDICS INC
BIOTRON LABS INC
MAHFOUZ MOHAMED RASHWAN

DJO LLC

AIRCAST INC
TECNOL MED PROD INC
DURA-KOLD CORP
DON JOY ORTHOPEDIC INC
DEPUY INC.
SMITH AND NEPHEW DONJOY INC

MEDTRONIC INC

KYPHON INC
WARSAW ORTHOPEDIC INC
BOYCE TODD M OSTEOTECH INC SHIMP LAWRENCE A
LAURITZEN NELS J MITCHELL BRENT SHIMP LAWRENCE A

STRYKER CORP

HOWMEDICA INC
HOWMEDICA OSTEONICS CORP
SURGICAL DYNAMICS INC

BAXTER INTERNATIONAL INC

ANGIOTECH INT AG
COHESION TECH INC

Appendix B: Search Strings Used for Categorization

Categorization: Problem Areas

1. Arthritis

a. Juvenile

Juvenile	
(TAC) contains (juveni* or idiopathic* or JIA)	5 results

b. Osteoarthritis

Osteoarthritis	
(TAC) contains (osteoarthritis or proteoglycan or (degenerat* w/5 arthrit*))	31 results

c. Rheumatoid

Rheumatoid	
(TAC) contains (rheumat* or RT)	8 results

d. Psoriatic

Psoriatic	
(TAC) contains (psoriatic* or psoriasis*)	3 results

e. Others

Others	
(TAC) contains ((lyme* or "Giant cell" or Gonococcal or Granulomatous or Mycoplasmal or Reactive or gout* or pseudogout or podagra or fung* or "Reiterssyndrome" or Seronegative or Shigella or Syphilitic or Takayasus or Traumatic or Tuberculosis or TB or "Ulcerative colitis" or Yersinial or infect* or inflam* or lupus or septic or staphylococcus) and arthrit*)	8 results

2. Cruciate Ligament

Cruciate Ligament	
(TAC) contains (ACL or PCL or MCL or LCL or cruciate* or "articulate cartilage" or cranial* or hyperexten* or ((lateral or anterior or posterior) w/2 ligament*))	68 results

3. Bursitis

Bursitis	
(TAC) contains (bursa* or (bone w/2 spur*) or bursitis)	6 results

4. Synovium

Synovium	
(TAC) contains (synovial* or synovium or synovitis or lining* or subintima or intima)	44 results

5. Patella

Patella	
(TAC) contains (((fractur* or tendinitis* or tendon*) w/3 patella*) or patellofemoral* or chondromalacia or infrapatellar or prepatellar or ((runner* or jumper* or cap) w/2 knee) or “kneepan”)	26 results

6. Others

Others	
(TAC) contains (lesion* or injur* or crepitus or strain* or osteonecrosis* or Osteochondral* or Arthrofibrosis* or posterolateral* or "muscle weakness" or ((swollen or damage* or misalign* or ruptured or tear* or inflam*) w/2 knee*) or fibromyalgia or osteophyte* or chondromalacia or plicae or “knock knees” or (discoid w/3 menisc*) or ((popliteal or baker's) w/2 cyst) or plica or "joint space" or "osteochondritis dissecans" or OCD)	138 results

Categorization: Treatments

1. ACL

ACL	
(TAC) contains (((ACL or PCL or cruciate* or cranial* or MCL or LCL) w/3 (reconst* or repair* or rebuild* or replac*)) or (articulate w/2 restor*))	14 results

2. NON SURGICAL

a. Drug Administration

Drug Administration	
(TAC) contains (chondroitin* or cortisone* or inject* or corticosteroid* or drug* or medicine* or "synovial fluid")	190 results

b. Orthotic Devices

Orthotic Devices	
(TAC) contains (cane* or walker *or crutche* or orthotic* or (knee w/2 (brace* or bracing or splint* or supports or belts or belt)) or bandage* or shoe* or orthosis* or intercondyloid*)	211 results

c. Therapies

Therapies	
(TAC) contains (gait* or therapies and therapy* or posture* or exercise*)	4 results

3. SURGICAL

a. Arthroplasty

Arthroplasty	
(TAC) contains (osteotom* or arthroplast*)	117 results

b. Graft

Graft	
(TAC) contains (((auto or allo) w/2 graft*) or graft*)	144 results

d. Implants

Implants	
(TAC) contains ((prosthesis or prosthetic* or operat* or surg* or reconstruct* or rebuild* or transplant* or replac* or fix* or implant* or repair* or bear* or screw*) w/3 (knee* or ligament* or condyle* or tendon or cartilage* or femur* or femul* or fibula* or menisci* or patellar or tibia) or condrocyte* or unicondylar*)	230 results

4. Viscosupplementation

Viscosupplementation	
(TAC) contains (viscosupplement* or Hyaluronic*)	40 results

Categorization: Diagnostic Devices

1. Arthroscopy

Arthroscopy	
(TAC) contains (arthroscop* or endoscop*)	93 results

2. Biomarker

Biomarker	
(TAC) contains (biomarker*)	3 results

3. MRI

MRI	
(TAC) contains ("magnetic resonance imaging" or MRI or “MR” or "image scan")	50 results

4. Tomograph

Tomograph	
(TAC) contains (CT or tomograph* or CAT)	57 results

5. Radiological Devices

Radiological Device	
(TAC) contains (“electron paramagnetic resonance” or EPR or arthrograph* or phonophoresis or iontophoresis or radiolog* or radiograph* or ultrasonograph* or serelogic* or sonograph* or radionuclide* or ultrasound*)	68 results

6. X-Ray

X-Ray	
(TAC) contains (x-ray* or x ray* or (x w/2 ray*))	116 results

Summary

The report graphically analyzes knee anatomy from various perspectives, categorizes and highlights the key companies involved, defines various knee problem areas including arthritis and its types, diagnostic methods and treatments.

About Patent iNSIGHT Pro

Patent iNSIGHT Pro™ is a comprehensive patent analysis platform that allows you to accelerate your time-to-decision from patent analysis activities. Designed from inputs by experienced patent researchers, Patent iNSIGHT Pro easily blends into your existing Research workflow. Patent iNSIGHT Pro is used by leading legal services, Pharmaceutical & biotech, electronics companies and research organization across US, Europe, South America and India with more than 400 end users. Patent iNSIGHT Pro is developed and marketed by Gridlogics , a research driven IT Company specializing in providing intellectual property analysis and visualization solutions to aid R&D and corporate strategy.

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Sources & References

1. http://en.wikipedia.org/wiki/Anterior_cruciate_ligament
2. http://en.wikipedia.org/wiki/Knee_replacement
3. http://en.wikipedia.org/wiki/Knee_cartilage_replacement_therapy
4. http://en.wikipedia.org/wiki/Posterolateral_Knee_Injuries#Anatomy_and_Function
5. http://en.wikipedia.org/wiki/Orthotics
6. http://en.wikipedia.org/wiki/Knee_arthritis
7. http://www.nlm.nih.gov/medlineplus/kneeinjuriesanddisorders.html#cat5
8. http://www.childrenshospital.org/az/Site1103/mainpageS1103P0.html
9. https://www.cimit.org/about-stories-kneesurgery.html